Chapter 12

Noise and Vibration

Chapter 12 Noise and Vibration

12.1 Introduction

This chapter of the EIAR outlines the assessment of the potential noise and vibration impacts associated with the Foynes to Limerick Road (including Adare Bypass) including the HGV Service Area.

12.2 Methodology

12.2.1 General

In order to assess the noise and vibration impact of the proposed road development, the following methodology has been adopted:

- The first stage is to assess and quantify the existing noise environment in the vicinity of sensitive receptors that may be affected by the proposed road development. Noise sensitive receptors include residential properties, education buildings, hospitals and areas of high amenity value in existing low noise settings. In the case of a road scheme, the selected noise-sensitive locations are those in closest proximity to the proposed road development (typically within 300m distance) and along sections of existing roads where changes in traffic volumes are expected.
- The noise levels resulting from both the construction and operational phases of the proposed development are calculated using established prediction techniques.
- An assessment of potential likely vibration impacts associated with the construction phase are reviewed based on the proposed construction phases and adjacent sensitive properties. There are no significant vibration impacts associated with the operational phase.
- The results of the predicted assessment are compared against the most appropriate criteria for both construction and operational phases. Where predicted noise levels are in excess of the adopted criteria, mitigation measures are proposed.
- Further details of each phase of the assessment are set out in the individual sections of this chapter.

12.2.2 Relevant Guidelines

The assessment has been undertaken with reference to the most appropriate guidance documents relating to environmental noise and vibration from road traffic and construction noise and vibration which are set out within the relevant sections of this chapter and included in the references section at the end of this chapter. The key guidance documents relating to this chapter are:

- TII 2004 *Guidelines for the Treatment of Noise and Vibration in National Road Schemes;*
- TII 2014 *Good Practice Guidelines for the Treatment of Noise during the Planning of National Road Schemes*.

In addition to specific noise guidance documents, the following guidelines were considered and consulted for the purposes of the proposed road development:

- *Guidelines on the Information to be contained in Environmental Impact Statements'*, (EPA, 2002)
- '*EPA Advice Notes on Current Practice (in the preparation of Environmental Impact Statements*), (EPA, 2003)
- '*EPA Advice Notes for Preparing Environmental Impact Statements*, (Draft, September 2015)
- *EPA Guidelines on the information to be contained in Environmental Impact Assessment Reports* (Draft August 2017)
- *Environmental Impact Assessment of Projects: Guidance on the preparation of the Environmental Impact Assessment Report* (European Commission, 2017);
- ISO 1996-2:*2017: Acoustics - Description, measurement and assessment of environmental noise - Part 2: Determination of sound pressure levels*

12.2.2.1 Construction Phase Assessment Guidelines

Guidelines relating to construction noise and vibration limits are set out within the TII guidance documents and other relevant national and international documentation for the control of noise and vibration from construction sites. These are discussed in the following sections.

Construction Noise

The TII noise guidance documents specify noise levels that are deemed acceptable in terms of construction noise for new national roads. These design goals are set out in Table 12.1.

Table 12.1 Maximum Permissible Noise Levels at the Façade of Dwellings During Construction Phase

Road Link	Noise Levels (dB re. $2x10^{-5}$ Pa)	
	$L_{Aeq,1hr}$	$L_{A\ Smax}$
Monday to Friday 07:00 to 19:00hrs	70	80
Monday to Friday 19:00 to 22:00hrs	60*	65*
Saturdays 08:00 to 16:30hrs	65	75
Sundays & Bank Holidays 08:00 to 16:30hrs	60*	65*

Note * Construction activity at these times, other than that required for emergency works, will normally require the explicit permission of the local authority.

The TII guidelines do not include specific night-time construction noise limit values. In order to determine appropriate limits for any scheduled night-time works, best practice guidelines are taken from the British Standard BS5228 – 1: 2009 +A1 2014: *Code of practice for noise and vibration control on construction and open sites – Noise*. The standard provides guidance on setting appropriate limit values for construction based on existing ambient noise levels in the absence of construction noise. The guidance levels for night-time periods are summarised in Table 12.2.

Table 12.2 Example Night-time Construction Noise Thresholds at Dwellings

Period	Threshold Values (dB)		
	Category A [A]	Category B [B]	Category C [C]
Night-time 23:00 to 07:00hrs	45	50	55

Note A: Category A: threshold values to use when ambient noise levels (when rounded to the nearest 5dB) are less than these values.

Note B: Category B: threshold values to use when ambient noise levels (when rounded to the nearest 5dB) are the same as category A values.

Note C: Category C: threshold values to use when ambient noise levels (when rounded to the nearest 5dB) are higher than category A values.

Construction Vibration

Vibration standards are generally split into two categories, those dealing with human comfort and those dealing with cosmetic or structural damage to buildings. In both instances, it is appropriate to consider the magnitude of vibration in terms of Peak Particle Velocity (PPV).

With regards to building response, the TII guidelines outline the following design goals in respect of ensuring that no cosmetic or structural damage occurs to buildings in the vicinity of construction works.

Table 12.3 Allowable Vibration During Road Construction in Order to Minimise the Risk of Building Damage

Allowable vibration velocity (Peak Particle Velocity) at the closest part of any sensitive property to the source of vibration, at a frequency of		
Less than 10Hz	10 to 50Hz	50 to 100Hz (and above)
8mm/s	12.5mm/s	20mm/s

Humans are particularly sensitive to vibration stimuli and perception of vibration at very low levels may lead to concern. Vibration typically becomes perceptible at around 0.15 to 0.3 mm/s and may become disturbing or annoying at higher magnitudes. However, higher levels of vibration are typically tolerated for single events or events of short-term duration, particularly during construction projects and when the origin of vibration is known. For example, blasting and piling, two of the primary sources of potential vibration during the construction phase of the proposed road development, can typically be tolerated at vibration levels up to 12 mm/s and 6 mm/s respectively if adequate public relations are in place. These values refer to the day time periods only.

Blasting

When assessing the potential impact of blasting, the relevant parameters used are both air overpressure and Peak Particle Velocity (PPV) mm/s. The TII guidelines recommends a PPV design goal of 12mm/s for blasting control. The Irish EPA Guidance Environmental *Management in the extraction industry* (2006) also recommend a PPV limit of 12mm/s in addition to an acceptable limit for air overpressure of 125dB (Lin) Peak Value. In addition, the EPA recommends blasting is only carried out between 09:00 – 18:00 Monday to Friday.

BS 6472 -2:2008: *Guide to Evaluation of Human Exposure to vibration in buildings. Part 2: Blast Induced Vibration* suggests satisfactory vibration magnitudes from blasting relating to human response. The document notes that for up to three blasts per day, a PPV limit value between 6 and 10mm/s is deemed reasonable, however it

states these limit values relate to long term blasting operations from surface mineral extraction sites. The standard notes that '*for civil engineering projects, such as tunnel and foundation excavations, it should be recognised that the application of human response criteria, rather than conservative damage criteria, could significantly prolong project durations. In turn this could lead to increased complaint levels'.*

The standard notes higher levels may be more appropriate for short term projects, where good public relations, property surveys etc. are undertaken.

Construction Traffic Impact Ratings

The classification of impacts relating to changes in traffic noise along existing road links during the construction phase are summarised in Table 12.4. These impact ratings are taken from the UK's Design Manual for Roads and Bridges, Volume 11 Section 3 Part 7 (2011) for the 'short term' impact ratings.

Table 12.4 Classification of Magnitude of Noise Impacts in the Short Term

Noise Change, dB(A)	Magnitude of Impact
0	No Change
0.1-0.9	Negligible
1 – 2.9	Minor
3 – 4.9	Moderate
5+	Major

12.2.2.2 Operational Phase Assessment Guidelines

TII Noise Guidance Documents - Road Traffic Noise

There are no statutory guidelines relating to noise from road schemes in Ireland. In the absence of statutory guidance, the most commonly applied standard is that issued by the TII within their 2004 and 2014 noise guidance documents. Both documents specify that the following absolute noise design criterion for new national road schemes in Ireland is appropriate:

- Day-evening-night value of: 60dB $L_{den.}$

This is a free field façade criterion, i.e. does not take account of reflections from building facades.

L_{den} is the 24-hour noise rating level determined by the averaging of the L_{day} with the $L_{evening}$ (plus a 5dB penalty) and the L_{night} (plus a 10dB penalty). L_{den} is calculated using the following formula:

$$L_{\text{den}} = 10log\left(\frac{1}{24}\right)\left(12 * \left(10^{\frac{Lday}{10}}\right) + 4 * \left(10^{\frac{Levening+5}{10}}\right) + 8 * \left(10^{\frac{Lnight+10}{10}}\right)\right)$$

Where:

- L_{day} is the A-weighted long-term average sound level as defined in ISO 1996 (2017) *Description, measurement and assessment of environmental noise. Part 2: Determination of sound pressure levels*, determined over all of the day periods of a year. This is defined as the period between 07:00 and 19:00hrs;
- $L_{evening}$ is the A-weighted long-term average sound level as defined in ISO 1996-2, determined over all the evening periods of a year. This is defined as the period between 19:00 and 23:00hrs; and

- L_{night} is the A-weighted long-term average sound level as defined in ISO 1996-2:2017, determined over all the night periods of a year. This is defined as the period between 23:00 and 07:00 hrs.

The average sound levels are based on the L_{Aeq} parameter. This is the equivalent continuous sound level. It is a type of average and is used to describe a fluctuating noise in terms of a single noise level over the sample period (T).

This criterion applies to new national roads. The following three conditions must be satisfied under the TII guidelines for noise mitigation to be provided:

- The combined expected maximum traffic noise level, i.e. the relevant noise level, from the proposed road development together with other traffic in the vicinity is greater than the design goal of 60dB L_{den};
- The relevant noise level is at least 1dB more than the expected traffic noise level without the proposed road development in place; and
- The contribution to the increase in the relevant noise level from the proposed road development is at least 1dB.

The proposed development under consideration is a new national road and hence the design goal and assessment methodology set out in the TII guidelines for the assessment of potential noise impacts are directly applicable.

The noise design goal is applied to existing receptors and those included in permitted planning projects in respect of both the year of opening and the Design Year, typically 15 years after the projected year of opening. In the case of this proposed road development, a commencement year of 2024 and a future Design Year of 2039 have been assessed.

Heavy Good Vehicle Service Area

In addition to the proposed road development, a Heavy Goods Vehicle (HGV) Service Area, is proposed at the western terminal of the route at Foynes Port in accordance with the requirements of the EU TEN-T Directive. This service area will provide parking for up to 35 HGV's and will provide some basic facilities for drivers including toilets, showers and a small common room. A description of this area including proposed site layout is included in Chapter 4 and Figure 4.2.

The TII document does not contain guidance or noise design goals for stationary sources such as those associated with the HGV Service Area. Potential sources of noise from this area will relate to vehicles parked in this area and the potential for refrigerated units serving refrigerated vehicles, where relevant.

In order to set appropriate operational noise criteria for these sources, guidance has been taken from BS 8233 (2014) *Guidance on sound insulation and noise reduction for buildings.*

The recommended internal noise levels for dwellings are set out in Table 12.5.

Table 12.5 Summary of Recommended Internal Noise Levels from BS 8233 (2014)

Typical Situation	Design Range, $L_{Aeq,T}$ dB	
	Daytime, $L_{Aeq,16hr}$	Night-time, $L_{Aeq,8hr}$
Living rooms/ dining rooms	35 – 40	n/a
Bedrooms	35	30

In order to set an external noise level based on the internal criteria noted above, this is done by factoring in the degree of noise reduction afforded by a partially open window is quoted as 15dB within the standard. Taking this information into consideration and taking account of road traffic noise levels in the area, the following criteria relate to the nearest noise sensitive properties external to the site for fixed noise sources.

Daytime & Evening	(07:00 to 23:00hrs)	55dB L_{Aeq}
Night-time	(23:00 to 07:00hrs)	45dB L_{Aeq}

Limerick City and County Council Noise Action Plan (2018 - 2023)

The Limerick City and County Council Noise Action Plan (NAP) relates to the management of environmental noise in accordance with the Environmental Noise Directive (END) (2002/49/EC). The purpose of the Action Plan is to manage and reduce, where necessary, environmental noise through the adoption of the action plans.

In the case of Limerick City and County Council, noise due to road traffic sources from sections of roads with a traffic flow threshold above 3 million vehicle trips per annum were mapped in terms of the L_{den} and the L_{night} parameter in accordance with the third round of noise mapping studies within Europe. This relates to traffic flows for the year 2016 in line with the third mapping round. For Limerick City and County Council, sections of the N69, N21 and N20 roads within the study area of the proposed road development have been mapped. The maps are presented in noise contour bands in increments of 5 decibels starting at 55dB L_{den} and 45dB L_{night} .

The NAP includes the following onset noise levels for assessment of noise management measures as follows based on Guidance from the EPA.

- 70 dB, L_{den}
- 57, L_{night}

The onset levels for noise management in addition to a decision matrix is used to identify those areas which may require noise intervention or management.

An implementation plan outlines a proposed programme of works for the period 2018 – 2023. The programme is largely dependent on traffic management and construction projects with the aim to reduce vehicle numbers and to re-distribute traffic on the road network of the city. In terms of the proposed road development under consideration, this facilitates the reduction of traffic through Adare and other smaller towns and villages along the existing N21 and N69 where traffic will be diverted onto the proposed road development.

With respect to road traffic noise for national roads, the NAP refers to the TII guidelines for noise with respect to setting operational noise design goals.

Operational Vibration

The TII guidelines note that ground vibration produced by road traffic is unlikely to cause perceptible structural vibration in properties located near to well-maintained and smooth road surfaces. Therefore, this aspect should not generally constitute an issue.

Operational vibration levels from the proposed road development are not expected to generate any appreciable perceptible levels of vibration. Operational vibration criteria are therefore not included in this assessment.

12.3 Description of Receiving Environment

The existing environment of the study area is a mixture of sub-urban to urban in areas close to the towns and villages of Foynes, Askeaton, Rathkeale, Adare, Croagh and predominately rural in nature along sections of the new road between Ballyclogh and Rathkeale and sections of the proposed new M21 between Rathkeale and Adare. The land use is predominately a mixture of agricultural lands, residential properties and a small degree of commercial premises.

12.3.1 Study Area and Baseline Data Collection

The study area for the noise and vibration impact assessment is focused on the areas likely to be affected by the operation of the proposed road development. This includes the closest noise sensitive locations along the proposed road development in addition to those in proximity to existing roads in the vicinity of the proposed road development. Noise sensitive locations within a study area of approximately 300m from the centreline of the proposed road development was focused on for the baseline noise studies. This is considered to capture the baseline noise environment at locations likely to be impacted by the proposed road development.

A comprehensive baseline noise study has been undertaken within the study area in order to provide a context of the typical noise environment and to determine the main contributors to the existing environment. The surveying was completed in accordance with relevant guidance and standards including:

- *Guidelines for the Treatment of Noise and Vibration in National Road Schemes* (TII, 2004);
- *Good Practice Guidance for the Treatment of Noise during the Planning of National Road Schemes* (TII, 2014);
- *Calculation of Road Traffic Noise Shortened Measurement Procedure* (CRTN 1988); and
- ISO 1996-2: 2017 *Acoustics – Description, Measurement and Assessment of Environmental Noise – Part 2 Determination of sound pressure levels*.

The survey locations were selected to represent the environments through which the proposed road development will pass which is predominately agricultural and residential. Survey locations were therefore focused on residential areas set back from existing roads, along the proposed road development, residential estates, and residential properties located along local, regional and national roads.

Unattended 24-hour monitoring stations were selected to represent specific noise environments (including those listed above) and a range of satellite attended measurement locations were monitored in the vicinity of these locations to characterise the noise environment within each area.

The surveying programme encompassed attended surveys at 73 locations and unattended surveys at 31 locations.

A survey of vibration levels along the corridor of the proposed road development was not undertaken, as levels associated with existing roads would not be expected to be of a magnitude sufficient to cause disturbance to people or structural damage to property. Furthermore, vibration was not perceptible at any of the noise survey locations.

Unattended Noise Measurements

Unattended noise surveys were conducted using a Brüel & Kjær Type 2250 Sound Level Meter with Brüel & Kjær UA 1404 Environmental Outdoor Kit.

The measurement apparatus was calibrated before and after each survey using a Brüel & Kjær Type 4231 Sound Level Calibrator. The results were saved to the instrument memory for later analysis.

Unattended noise surveys were conducted over at least 24-hour periods at thirty-one locations. L_{den} values are derived directly from the measured $L_{Aeq,\,T}$ values and using the formula included in Section 12.2.2.2. In this instance, the L_{Aeq} sample period (T) was 1 hour. i.e. $L_{Aeq,1hr}$.

Attended Noise Measurements

Attended measurements were performed using a Larson Davis 831 Sound Level Meter. Measurements were conducted at survey locations on a cyclical basis. Sample periods were 15 minutes. The results were noted onto a Survey Record Sheet immediately following each sample and were also saved to the instrument memory for later analysis where appropriate. Survey personnel noted all primary noise sources contributing to noise build-up.

The survey work was conducted in accordance with the short-term measurement procedure as specified in the TII noise guidance documents. When surveying traffic noise, the acoustical parameters of interest are $L_{A10(1hour)}$ and $L_{A10(18hour)}$, expressed in terms of decibels (dB) relative to $2x10^{-5}$Pa.

The value of $L_{A10(1hour)}$ is the noise level exceeded for just 10% of the time over the period of one hour. $L_{A10(18hour)}$ is the arithmetic average of the values of $L_{A10(1hour)}$ for each of the one-hour periods between 06:00 and 24:00hrs. $L_{A10(18hour)}$ is the parameter typically used for the purposes of assessing traffic noise, where relevant.

The shortened measurement procedure involves a method whereby $L_{A10(18hour)}$ and L_{den} values are obtained through a combination of measurement and calculation as follows:

- Noise level measurements are undertaken at the chosen location over three consecutive hours between 10:00 and 17:00hrs;
- The duration of the sample period during each hour is selected to encompass sufficient traffic flows to ensure reliable results;
- The $L_{A10(18hour)}$ for the location is derived by subtracting 1dB from the arithmetic average of the three hourly sample values, i.e.
  $L_{A10(18hour)} = ((\sum L_{A10(15\ minutes)}) \div 3) - 1$ dB; and
- The derived L_{den} value is calculated from the $L_{A10(18hour)}$ value, i.e.
  $L_{den} = 0.86 \times L_{A10(18hr)} + 9.86$ dB;

The L_{den} is a long-term average indicator and represented the annual daily noise level.

The guidelines note that "*where traffic is not the dominant noise source, then the normal correction cannot be applied to convert the 15-minute samples to an 18-hour value. However, it may be possible to derive a site-specific correction from a nearby long-term site affected by the same noise sources. If there is no comparator site, a short-term measurement is inappropriate, and a 24-hour measurement will be required.*"

Monitoring Locations

The location of the surveyed baseline monitoring positions are presented in Figures 12.1 to 12.22 of Volume 3. The majority of monitoring locations were positioned within gardens of residential properties or at proxy locations to residential locations in public areas where access to private lands were not possible.

Survey Periods

The baseline noise survey was undertaken across the following dates:

- 5 to 8 February 2018;
- 12 to 15 February 2018;
- 19 to 22 February 2018;
- 5 to 8 March 2018; and
- 11 to 13 March 2018.

Survey Results

A summary of the measured and derived L_{den} values for each monitoring location is presented in Table 12.6 overleaf. The baseline monitoring which are grouped in attended and unattended satellite locations are presented together for each area.

Full survey results for all attended and unattended survey locations, along with the derived L_{den} values and L_{night} (2039) values, are presented in Tables A.12.1 in Appendix 12.1 of Volume 4 of this EIAR.

Table 12.6 Summary of Baseline Noise Survey Results

Location	Survey Type	Location	Calculated Noise (L_{den})	Location	Survey Type	Location	Calculated Noise (L_{den})
Section A - Foynes to Ballyclogh				***Section B - Ballyclogh to Askeaton***			
UML1	Unattended	Corgrig	61	ATT14	Attended	Ballyellinan	49
ATT1	Attended	Corgrig	64	UML6	Unattended	Ballycullen	47
ATT2	Attended	Corgrig	64	UML9	Unattended	Ballycullen	48
ATT3	Attended	Corgrig	60	ATT15	Attended	Ballycullen	49
ATT4	Attended	Corgrig	54	UML7	Unattended	Cloonreask	51
UML2	Unattended	Ardaneer	47	UML8	Unattended	Cloonreask	57
ATT5	Attended	Ardaneer	65	ATT16	Attended	Cloonreask	55
ATT6	Attended	Ardaneer	59	ATT17	Attended	Cloonreask	68
UML3	Unattended	Ardaneer	48	ATT18	Attended	Coolrahnee (N69)	63
UML4	Unattended	Robertstown	65	***Section C - Ballyclogh to Rathkeale***			
ATT7	Attended	Sroolane North	59	ATT19	Attended	Ballyclogh	50
ATT8	Attended	Robertstown	58	UML10	Unattended	Milltown South	54
ATT9	Attended	Sroolane	59	ATT20	Attended	Lismakeery	48
ATT10	Attended	Robertstown	54	ATT21	Attended	Ballynacaheragh	45
ATT11	Attended	Robertstown	65	ATT22	Attended	Milltown North	47
UML5	Unattended	Mulderricksfield	46	UML11	Unattended	Bullaun	45
ATT12	Attended	Mulderricksfield	53	ATT23	Attended	Nantinan	49
ATT13	Attended	Mulderricksfield	48	ATT24	Attended	Feeagh	45

Location	Survey Type	Location	Calculated Noise (L_{den})	Location	Survey Type	Location	Calculated Noise (L_{den})
Section C - Ballyclogh to Rathkeale (Continued)				***Section D - Rathkeale to Croagh (Continued)***			
ATT25	Attended	Ballingarrane	61	ATT39	Attended	Rathkeale	68
ATT26	Attended	Ballingarrane	60	ATT40	Attended	Rathkeale	65
UML12	Unattended	Graigeen	49	UML31	Unattended	Rathkeale	66
UML13	Unattended	Ballingarrane	58	UML16	Unattended	Rathkeale	59
ATT27	Attended	Stoneville	63	UML17	Unattended	Wolfesburgess East	67
ATT28	Attended	Ballingarrane	66	ATT41	Attended	Blossomhill	61
ATT29	Attended	Ballingarrane	63	ATT42	Attended	Clogh West	58
UML14	Unattended	Ballingarrane	56	UML18	Unattended	Amogan Beg	52
ATT30	Attended	Ballingarrane	58	ATT43	Attended	Clogh West	53
ATT31	Attended	Ballingarrane	51	ATT44	Attended	Clogh West	50
ATT32	Attended	Ballingarrane	54	UML19	Unattended	Croagh	55
UML15	Unattended	Kyletaun	50	ATT45	Attended	Ballycannon	54
ATT33	Attended	Rathkeale	57	ATT46	Attended	Ballycannon	50
Section D - Rathkeale to Croagh				UML20	Unattended	Croagh	59
				UML21	Unattended	Croagh	57
ATT35	Attended	Rathkeale	66	ATT47	Attended	Croagh	66
ATT36	Attended	Rathkeale	65	ATT61	Attended	Ardshanbally	55
ATT37	Attended	Rathkeale	69	ATT62	Attended	Gortaganiff	68
ATT38	Attended	Rathkeale	67				

Location	Survey Type	Location	Calculated Noise (L_{den})	Location	Survey Type	Location	Calculated Noise (L_{den})
Section D - Croagh to Adare				UML28	Unattended	Ardshanbally	55
UML22	Unattended	Graigue	59	ATT59	Attended	Curraghbeg	54
ATT48	Attended	Croagh	54	ATT60	Attended	Curraghbeg	57
ATT49	Attended	Graigue	51	***Section D - Adare to Gorteen***			
UML23	Unattended	Graigue	48	UML29	Unattended	Kilgobbin	55
ATT23	Attended	Graigue	46	ATT65	Attended	Kilgobbin	59
ATT50	Attended	Croagh	54	ATT64	Attended	Kilgobbin	67
ATT51	Attended	Clonshire More	51	ATT66	Attended	Rineroe	62
ATT52	Attended	Clonshire More	50	ATT67	Attended	Rineroe	62
UML25	Unattended	Clonshire Beg	66	ATT70	Attended	Ballyloughnaan	57
UML24	Unattended	Clonshire Beg	61	ATT68	Attended	Monearla	59
ATT53	Attended	Clonshire Beg	59	ATT69	Attended	Monearla	59
ATT54	Attended	Gortnagrour	51	UML30	Unattended	Ballycarrane	67
ATT55	Attended	Clonshire Beg	50	ATT71	Attended	Ballyloughnaan	59
ATT56	Attended	Rower More	52	***West of Rathkeale - Castlematrix***			
ATT57	Attended	Rower More	53	ATT72	Attended	Castlematrix	69
UML26	Unattended	Rower More	57	ATT72	Attended	Castlematrix	77
ATT58	Attended	Kilknockan	50				
UML27	Unattended	Curraghbeg	47				

Noise Survey Results Summary

The results of the baseline surveys indicate the range of noise levels measured across the extent of the study area as follows.

Foynes to Ballyclogh

At the western end of the proposed road development at properties in the vicinity of Corgrig, Ardaneer and Sroolane North, noise levels are dominated by traffic flows along the existing N69 Road. Noise levels were measured in the range of 58 to 65dB L_{den} at properties in closest proximity to the road. Moving east from Robertstown towards Ballyclogh, noise sensitive locations in proximity to the proposed road development are typically set back from heavily trafficked roads such as the N69 (some 1km away) but located in proximity to local road networks. The measured noise levels at these properties were typically in the range of 46dB to 53dB $L_{den.}$

Ballyclogh to Askeaton

The proposed road development between Ballyclogh and Askeaton passes through a rural landscape with a small number of residential properties in proximity to the proposed road. Noise levels measured at residential properties between Ballyclogh and Cloonreask were measured in the range of 47 to 51dB L_{den}. Local traffic movements, distant road traffic, rustling foliage, bird song and agricultural sources were the main noise sources noted.

At the tie into the existing N69 to the west of Askeaton, the noise environment at the closest noise sensitive locations are dominated by road traffic noise measuring up to 68dB L_{den} at ATT17. At monitoring locations UML8 and ATT16 adjacent to the tie in along the R158 noise levels of 57 and 55dB L_{den} respectively were measured.

Ballyclogh to Rathkeale

The proposed road development between Ballyclogh and Rathkeale passes through a rural landscape with residential properties clustered in proximity to local/regional road crossings and within individual land holdings set back from local roads. Between Ballyclogh and Feeagh, noise levels were measured in the range of 45 to 50dB L_{den} at the closest noise sensitive properties, with 54dB L_{den} being measured at UML10 at Milltown South which was measured in close proximity to the local road.

At residential properties along the R518 in proximity to the proposed road crossing, noise levels are dominated by passing traffic along this road with noise levels measured generally in the range of 60 to 66dB $L_{den,}$ depending on the proximity and line of sight to the road. At properties set back at further distances from the road in the vicinity of Ballingarrane and Kyletaun, noise levels were generally measured in the range of 50 to 58dB L_{den}.

Rathkeale

Noise levels at the closest noise sensitive locations to the proposed road development within Rathkeale are located in proximity to the existing N21 Road and are dominated by traffic along this road. Noise levels were measured in the range of 65 to 69dB L_{den} at properties surveyed in this area.

Rathkeale to Croagh

East of Rathkeale, the proposed road veers north of the existing N21 and passes a small number of local roads and agricultural lands to a new tie in junction to the north-east of Croagh. The closest noise sensitive properties to this section of the proposed road development are typically clustered along the existing local roads where they

intersect with the proposed road development. Noise levels are measured in the range of 50 to 55dB L_{den} at residential properties set back from the road edge or in rear gardens of properties and in the range of 57 to 67dB L_{den} at properties in closer proximity to the local roads. The highest value of 67dB L_{den} being recorded at Location UML17 at Wolfesburgess East in close proximity to the existing N21.

Croagh to Adare

The proposed road development between Croagh and Adare runs north of the existing N21 and passes a number of local roads, an inactive railway line and agricultural lands to a new tie-in junction to the north-east of Adare. The closest noise sensitive properties to this section of the proposed road are typically clustered along the existing local roads where they intersect with the proposed road and at individual land holdings. Noise levels were measured in the range of 47 to 55dB L_{den} at residential properties set back from the road edge or in rear gardens of properties and in the range of 57 to 68dB L_{den} at properties in closer proximity to roads, the highest value being recorded at location ATT62 at Gortaganiff measured to the front of a residential property along the N21 to the east of Adare village.

Adare to Gorteen

The proposed road to the east of Adare continues north of the existing N21, parallel and south of the railway line. It connects to the existing N21 north of Rineroe. Noise levels in this area are dominated by the existing N21 road, agricultural and environmental sources. Noise levels were measured in the range of 55 to 67dB L_{den} with highest levels being recorded at properties in close proximity to the N21 road.

Summary of Baseline Noise Environment

The results of the baseline noise survey indicate that the noise environment varies across the proposed road development depending on the surrounding noise sources. In general, properties facing directly onto existing roads are dominated by road traffic and experience noise levels in excess of 60dB L_{den}. Properties in more rural settings set back from road traffic experience noise levels typically in the range of 45 to 60dB L_{den} depending on local sources such as local passing traffic, agricultural sources, bird song and rustling foliage in the vicinity.

The range of noise levels measured during the baseline surveys are an accurate representation of the baseline noise environment at properties likely to be affected by the proposed road development.

12.4 Predicted Impacts for Noise & Vibration

12.4.1 Construction Phase

The construction phase of the proposed road development will involve predominately ground breaking, earthworks and earthworks haulage, drainage works, construction of drainage ponds and surfacing works, construction of bridges and overpasses, as well as the movement of machinery and materials within and to and from the construction compounds and along a limited number of local roads.

A variety of items of plant will be in use during these construction works all of which have the potential to generate high levels of noise and potential levels of perceptible vibration. These will include breakers, rock drills, excavators, dump trucks, and generators in addition to general road surfacing and levelling equipment.

Blasting of bedrock will also be required on certain sections of the proposed road development depending on the ground conditions and the required depth of excavations. Chapter 4 Description of the Proposed Road Development provides a full description of the proposed construction works for the proposed road development.

12.4.1.1 Construction Phase Noise

Whilst the phasing of works and location of activities and work sites have been progressed to detailed stages as part of the EIA Report, the specifics in terms of plant items, plant numbers, their locations and operational duration will be subject to site conditions, work scheduling and contractor proposals. In this instance, it is not possible to perform detailed calculations or detailed impact assessment for any one area given the variations in the items above on a week to week or day to day basis. It is however possbile to determine noise levels from typical construction activities associated with the various phases.

The TII guidelines note that it is more appropriate to address the way in which potential construction impacts will be assessed and how they will be managed, including forms of mitigation and codes of practices that will be applied.

The guidelines also note, however, that areas of major earthworks or blasting should be noted and locations where particularly noisy activities such as piling (depending on the method used), rock breaking, and or night-works are identified.

In the absence of an Irish or international standard relevant to construction noise, reference can be made to BS 5228 - *1:2009+A1: 2014 Code of Practice for Noise and Vibration Control on Construction and Open Sites Part 1 Noise* and Part 2 *Vibration.* This standard includes recommended methodologies for calculating construction noise levels and includes a range of best practice mitigation and management measures for the control of noise and vibration from construction sites.

In terms of calculation, this standard sets out sound power levels for a wide range of plant items normally encountered on construction sites, which in turn enables the prediction of indicative noise levels at distances from the works. The standard also includes empirical data on vibration levels measured at set distances from specific vibration generating activities in different ground and site conditions.

The following section discusses typical noise levels associated with road construction activities and comments on potential noise impacts across the proposed road development.

Intrusive Works and High Noise Activities

Reference to BS 5288-1:2009+A1 2014: Part 1 Noise indicates that highest noise levels are associated with activities associated with rock breaking, rock drilling, rock crushing and some impact piling works. These activities would occur during excavation works, structure foundation works, and during excavation / breaking during utility diversion works. Noise levels from each of these activity types are typically in the range of 85 to 95dB L_{Aeq} at 10m. All of the above activities will be required as part of the construction of the proposed road development.

For construction activities associated with rock extraction and processing a construction noise level of 95dB L_{Aeq}, at 10m has been used for the purposes of indicative calculations. This would involve for example, 1 item of plant at 93dB L_{Aeq} and 3 items of plant at 85dB L_{Aeq} operating simultaneously within one work area which is considered a highly worst-case scenario.

Bulk Excavation, Bridge Works and Road Works

For construction works associated with activities such as site clearance, excavation, and fill, bridge works etc. including excavators, loaders, dozers, cranes, generators, concreting works etc., noise levels are typically in the range of 70 to 80dB L_{Aeq} at 10m.

For ongoing construction activity associated with the above activities used for the construction of the road, a total construction noise level of 85dB L_{Aeq} at 10m has been used for the purposes of indicative calculations. This would include, for example two items of plant at 80dB L_{Aeq} and three items of plant at 75dB L_{Aeq} operating simultaneously within one work area.

Compounds and Lower Noise Activities

For construction work areas with lower noise levels such as site compounds (for storage, offices and material handling, generators etc.), smaller items of mobile plant (excavators, cranes, dozers), landscaping and concreting works with lower noise emissions, a total construction noise level of 78dB L_{Aeq} at 10m has been used for the purposes of indicative calculations. This would include, for example one item of plant at 75dB L_{Aeq} and three items of plant at 70dB L_{Aeq} operating simultaneously within a work area.

Given the variations of on-site activities and noise levels over any one day and considering that all activities will not operate simultaneously, the values noted above are considered robust for the purposes of assessing potential construction impacts.

There are approximately 30 properties at distances of up to 50m from the proposed works. Remaining properties are located at distances of 50 to >300m from different work phases.

Table 12.7 presents the calculated noise levels at distances between 20 and 250m representing the closest noise sensitive properties to the construction works. The calculations assume that plant items are operating for 66%[1] of the time and do not include any attenuation from screening of site hoarding, road cuttings, buildings or structures, and hence relate only to distance attenuation over hard ground.

Table 12.7 Indicative Construction Noise Calculations at Varying Distances

Construction Activities	Combined L_{Aeq} at 10m	Calculated Noise Level at Increasing Distances					
		20m	50m	80m	100m	150m	250m
Rock breaking/ drilling/ rock crushing/ impact piling	95	87	79	75	73	70	65
Site clearance/ utilities/ excavation & fill/ structures / Road works	85	77	69	65	63	60	55
Site Compounds / Landscaping/ Concreting Works	78	69	62	57	55	52	48

[1] This estimate assumes that the plant will operate a full 8-hour shift over the proposed 12 hour working period which equates to a 66% operating time over a daytime period or 40 minutes over a 1-hour period. The dynamic nature of construction sites is such that this is deemed to be a conservative estimate, particularly for breaking and drilling work.

The reference values outlined in Table 12.7 indicate that for construction activities with highest noise levels (L_{Aeq} up to 95dB at 10m), the daytime construction noise limit value of 70dB L_{Aeq} Monday through Friday (07:00 to 19:00hrs) is likely to be exceeded at distances of up to 100m from the works boundary in the absence of any noise mitigation. Weekend and evening construction noise limits would likely be exceeded at distances up to 250m in the absence of noise mitigation. Noise mitigation will therefore be required to reduce construction noise levels from this type of activity during all periods at the closest properties to avoid short-term significant impacts.

During normal road construction works including site clearance, bulk excavation, structures etc. with site works up to 85dB L_{Aeq} at 10m, the daytime construction noise limit value of 70dB L_{Aeq} Monday through Friday (07:00 to 19:00hrs) is likely to be exceeded at distances of up to 50m from the works boundary in the absence of any noise mitigation. Evening and weekend construction noise limits would be exceeded at distances up to 150m in the absence of any mitigation. Noise mitigation will therefore be required to reduce construction noise levels from this type of activity, particularly during any scheduled evening and weekend works at the closest properties, to avoid short-term significant impacts.

During general site work with lower noise emissions (L_{Aeq} up to 78dB at 10m) the daytime construction noise limit value of 70dB L_{Aeq} Monday through Friday (07:00 to 19:00hrs) can be complied with at distances of 20m and beyond. Evening and weekend construction noise limits would be exceeded at distances up to 80m in the absence of any mitigation. Noise mitigation will therefore be required to reduce construction noise levels from this type of activity, specifically during any scheduled evening and weekend works at the closest properties, to avoid short-term significant impacts.

It should be noted that the calculations set out in the above tables are indicative and are used for the purposes of comparison only with the adopted criteria. Where exceedance of the recommended criteria is expected, the use of noise mitigation measures will be used as part of the construction works. Further details are set out in Section 12.5.1.

In line with the TII Guidelines on assessment of construction noise impacts, areas of major earthworks, blasting and piling (depending on the method to be used) should be reviewed for potential noise impacts. These are discussed in the following sections.

Construction Compounds

Construction compounds will be required at numerous locations along the proposed road development to provide for storage of construction equipment and materials as well as for offices, parking and welfare facilities for staff. These compounds will generally be located at the various access points from public roads, and where bridges are to be constructed, including the larger bridges over rivers to be crossed by the proposed road development.

The lands to be acquired for the proposed road development include lands which are suitable for use as construction compounds at all of the necessary locations. A general restriction will apply for all construction compounds not to be located within 100m of any inhabited dwelling so as to limit risk of noise nuisance impacts. The main construction compound will be accommodated within the lands immediately west of the proposed Rathkeale Junction. This site is likely to remain in place for the duration of the construction stage.

The closest noise sensitive locations to this area are properties to the south of the existing N21 at distances of approximately 100m from this proposed work area. Potential noise impacts will depend on the level of activity occurring within this area. Particularly noisy operations such as rock crushing or other material handling activities will not be permitted in this area to avoid the potential for elevated levels of noise at the nearest residential properties. Crushing activities will be located at source within the two main cuttings set back from noise sensitive areas.

Smaller temporary sites required for the construction of particular structures and bridges, excavation and processing of materials, specialised earthwork construction and at certain drainage areas may also be sited at various locations along the length of the proposed road development. It is ultimately at the contractor's discretion where these construction compounds are located.

For the purpose of the Environmental Impact Assessment (EIA), the following areas have been identified as potential locations of site compounds:

- Foynes HGV Rest Area (Ch 1+000)
- Robertstown (Ch 2+760 to Ch 2+990)
- Askeaton Tie in with N69 (Ch 11+400 to 11+650)
- Croagh Junction (Ch 55+150 to 55+620)
- Islandea (Ch 60+670 to Ch 60+870)
- Ardshanbally (Ch 61+800 to 62+050)

As noted above, the compound areas will be set back at least 100m from noise sensitive locations. Reference to Table 12.5 confirms that assuming standard construction activities within these areas, the construction noise emission limits can be complied with at this distance. Noise emissions from these areas can be largely controlled through the use of boundary screening and site layout planning, as required. Further discussion on best practice control measures for construction compounds are included in Section 12.5.1.

Night Works

Temporary night-time closure of existing roads will be required where overbridges are to be constructed at locations such as the Robertstown overbridge crossing the N69 Road, the L-1220 South at Ballyclogh, R518 at Graigeen Letteragh Road, N21 West at Rathkeale, and the existing N21 at Attyflin tie-in. This is required to avoid road closure during day time periods to facilitate lifting beams into place and other key works. Heavy or noisy construction activities will be avoided outside normal hours and the amount of work outside normal hours will be strictly controlled.

Noise levels associated with night-time works will tyically involve lifting equipment for beam construction. There is potential for the use of generators to power temporary lighting and other small items of mobile plant. Noise levels will be strictly controlled during these phases to ensure noisy items of plant (e.g. generators) are sited away from noise sensitive properties and are enclosed or screened. Specific noise limits for night-time works will be set taking into account the pre-existing noise environment as per Table 12.2. These limits will be site specific, hence will be fully reviewed prior to commencement of any night works and specific noise control measures put in place. Best practice control measures that will form part of the noise mitigation are included in Section 12.5.1.

12.4.1.2 Construction Traffic Noise

In general, materials excavated within the site will be hauled along the route of the proposed road between sections without the need to use the public road network. The contractor will be prohibited from moving earthworks materials sourced from within the site via the public road network.

Import of fill materials for embankments will be required due to the earthworks deficit within the proposed road development. Crushed rock for road foundations, pavement materials, concrete, bridge beams and other items will also be transported to the site by the National and Regional road network and a limited number of local roads.

It is proposed that access to the site for the mainline works will be primarily off and along the following national, regional and a limited number of local roads:

- N69, N21, R518, L1220, L1222, L1422 and L1423

An analysis of construction traffic volumes has been conducted to determine the expected lorry movements required to transport the materials extracted and delivered to site along the public roads noted above in terms of AADT with percentage HGV's. The additional HGV and LGV flows per day associated with construction traffic along each road including construction staff vehicles, deliveries and earthworks material haulage are added to the base traffic volumes. In order to determine the potential noise impacts associated with additional construction traffic on the identified haul routes, a comparison between traffic noise levels for the base (Do Minimum) scenario and the Do Something (base plus construction) scenario has been determined.

Noise levels associated with passing events such as road traffic may be expressed in terms of its Sound Exposure Level (L_{AX}). The Sound Exposure Level can be used to calculate the contribution of an event or series of events to the overall noise level in a given period using the following formula:

$$L_{Aeq,T} = L_{AX} + 10\log10(N) - 10\log10(T) \text{ dB}$$

where:

$L_{Aeq,T}$ is the equivalent continuous sound level over the time period T (in seconds);

L_{AX} is the "A-weighted" Sound Exposure Level of the event considered (dB); and,

N is the number of events over the course of time period T.

The mean value of Sound Exposure Level for a truck moving at low to moderate speeds is in the order of 82dB L_{AX} at 10 metres from the vehicle. The mean value of Sound Exposure Level for a car or light good vehicle passing at low to moderate speeds is in the order of 68dB L_{AX} at 10 metres from the vehicle. These figures are based on a series of controlled measurements made by AWN and also align with values within BS5228-1.

Noise levels associated with additional construction traffic volumes are calculated over a 12hr period, relating to the typical construction working day (i.e. 07:00 to 19:00hrs). This level is added to the total traffic noise using the AADT values over a daily (24hr) period to provide a robust assessment.

Table 12.8 presents a summary of the construction traffic noise assessment. Traffic noise levels at a distance of 10m from the haul roads is calculated for the base (Do-

Minimum) scenario and the Do-Something (base plus construction) scenario. The increase in noise levels between both scenarios is also presented.

Table 12.8 Indicative construction noise calculations at varying distances

Road Link	Do Minimum		Do Something (Construction)			Change in Noise Levels, dB, $L_{Aeq,T}$
	Total Vehicles (AADT)	Do Minimum Noise Level at 10m, dB $L_{Aeq,T}$	Additional (AADT HGV)	Additional (AADT LGV)	Cumulative Noise Level at 10m, dB $L_{Aeq,T}$	
N69: East of Askeaton	6,350	64	82	400	65	+1.1
N69: West of Askeaton	8,600	65	68	400	66	+0.7
N21: East of Adare	17,150	66	154	400	67	+1.2
N21: West of Adare	14,300	66	99	400	66	+0.9
R518	2,550	59	89	100	62	+2.6
L1220	650	50	28	80	55	+5.2
L1222	420	48	28	80	54	+6.6
L1422	900	51	22	80	55	+3.7
L1423	790	51	22	80	55	+4.0

The increase in noise level along the nominated construction access roads is in the range of 0.7 to 6.6dB. Along the N21 and N69 national roads, due to the existing high volumes of traffic along these roads, the relative increase in noise level from the addition of construction traffic is determined to be negligible to minor perceptible impact in accordance with the magnitude of change impact table in Table 12.4.

The greatest increase in noise levels is calculated along the regional and local roads where lower baseline traffic flows are on these roads. Along the R518 road, existing traffic volumes are moderate with an associated low number of HGV's. Noise levels are calculated to increase by the order of 2.6dB along this road. An increase of this magnitude is of minor perceptible impact.

Along the local roads L1220, L1222, L1422, L1423, existing traffic volumes are low with an associated low number of HGV's. Noise levels are calculated to increase by the order of 3.7 to 6.6dB. An increase of this magnitude is of moderate to major perceptible impact. Whilst a perceptible change in noise level is calculated, the overall noise level along these roads will remain moderate, between 54 and 55dB $L_{Aeq,\ T}$ at 10m from the road edge. Considering the above, the overall impact is deemed to be moderate, short-term along these roads.

12.4.1.3 Construction Stage Vibration

The potential for elevated levels of vibration at sensitive locations during construction is typically associated with excavation works, rock-breaking and blasting operations. Depending on the method and equipment used, there is potential for some vibration relating to piling operations, demolition works and lorry movements on uneven road surfaces. The more significant of these relates to vibration from excavation and rock-breaking operations.

Piling Vibrations

At sensitive locations close to receptors where piling is required, low vibration methods involving bored or augured piles will be selected where ground conditions permit. This piling method significantly minimises the levels of both noise and vibration generated as it is a non-percussive piling technique. The proximity of sensitive receptors to piling works are limited to Roberststown bridge construction.

For the purposes of this assessment, however, vibration levels associated with driven piles are assessed in order to determine potential worst-case impacts. British Standard BS 5228 - *1:2009 + A1:2014:Part 2 Vibration* , includes measured magnitudes of vibration associated with different piling types. Table 12.9 reproduces those associated with steel sheet piling. The soil conditions relating to soft ground clay conditions are the most likely ground conditions to be encountered.

Table 12.9 Vibration Magnitudes Asssociated with Steel Sheet Piling

Soil Conditions	Pile Dimension	Distance m	PPV, mm/s
Very soft to soft (0 – 10m), soft to medium clay (10 – 20m)	U-shaped LX 16 sheet piles	4.8 – 24	4.3 – 0.5
Not recorded	U-shaped piles	7.1	0.7 – 0.3
Made ground 0 – 3m, loose and very dense sand and silt 3 – 17m, firm to stiff clay 17 – 25m	244mm diameter driven tubular steel piles	5 – 20	13.9 – 4.3
Made ground 0 – 3m, loose and very dense sand and silt 3 – 17m, firm to stiff clay 17 – 25m	275mm driven square piles	5 – 20	11.4 – 4.3

The vibration magnitudes outlined in Table 12.9 indicate that at distances beyond 20m, vibration magnitudes are significantly reduced to well below the PPV limit values outlined in Table 12.3 to avoid any form of cosmetic or structural damage to buildings. There are no locations along the proposed road where structures requiring piled foundations are located at distances of 20m or less from dwellings. The nearest dwellings are located at distances of 50m or more from proposed bridges that may require piled foundations.

Rock-Breaking Vibrations

During rock breaking, there is potential for vibration to be generated through the ground. Empirical data for this activity is not provided in the BS 5228-*1:2009+A1:2014:Part 2 Vibration*, however the likely levels of vibration from this activity is expected to be significantly below the vibration criteria for building damage from experience on other sites. AWN Consulting have previously conducted vibration measurements under controlled conditions, during trial construction works, on a sample site where concrete slab breaking was carried out. The trial construction works

consisted of the use of the following plant and equipment when measured at various distances:

- 3 tonne hydraulic breaker on small CAT tracked excavator; and
- 6 tonne hydraulic breaker on large Liebherr tracked excavator.

Vibration measurements were conducted during various staged activities and at various distances.

Peak vibration levels during staged activities using the 3 Tonne Breaker ranged from 0.48 to 0.25 PPV (mm/s) at distances of 10 to 50m respectively from the breaking activities. Using a 6 Tonne Breaker, measured vibration levels ranged between 1.49 to 0.24 PPV (mm/s) at distances of 10 to 50m respectively.

Whilst these measurements relate to a solid concrete slab, the range of values recorded provides some context in relation to typical ranges of vibration generated by construction breaking activity.

Demolition of existing structures will involve careful deconstruction using controlled techniques. There may be a requirement for breaking ground as part of specific demolition procedures, depending on the structure. Vibration levels associated with this activity will be of similar or lower magnitude to rock breaking as discussed above.

Referring to the vibration magnitudes above, vibration impacts due to ongoing construction works will be not significant and short term in terms of building response. Notwithstanding the above, any construction activities undertaken on the site will be required to operate below the recommended vibration criteria set out in Table 12.3.

During surface construction works (piling, rock breaking etc.) the vibration limits set within Table 12.3 will be perceptible to humans and will potentially cause a significant impact over temporary periods. The level of impact is however greatly reduced when the origin and time frame of the works are known. In this regard, the use of clear communication and information circulars relating to planned works, their duration and vibration monitoring can significantly reduce vibration impacts to a large portion of the population.

12.4.1.4 Blasting

Ground investigations have indicated that due to rock conditions, blasting is a likely excavation technique that will be used in areas where cuttings are proposed. The extent of blasting will depend on the rock type and depth in the area and the depth of the cutting involved.

Blasting is likely to be employed at the 19m deep cut at Mulderricksfield (Ch.5+150 to 6+400) and potentially at the lowest levels of cut at Ballycannon (Ch.52+400 to 56+000).

Whilst rock blasting is likely to only specifically be required at the deep cutting at Mulderricksfield in Section A (Chainage 5+100 to 6+400), it will also potentially be used to excavate portions of the other cut locations along the route e.g. at the lowest level of the cut at Ballycannon (Ch 52+400 to 56+000). The location of all cuttings along the route are summarised in Table 12.10 below. Whilst blasting may not be required for all these cut locations, the distance to the closest sensitive buildings are provided for reference.

Table 12.10 Distance of Sensitive Buildings to Road Cuttings

From Ch.	To Ch.	Length (m)	Max. Cut Depth (m)	Closest Sensitive Buildings
1+350	1+750	400	8	~100 - 150m
5+100	6+400	1,300	19	~120m – 200m
52+400	56+000	3,600	11	~55 – 200m
60+000	60+500	500	9	~50 – 100m

The closest buildings to the deep cut at Mulderricksfield are between 120 and 200m from this area. The closest buildings to the other cuttings are in the range of 50m to approximately 200m away. The design of all blasts will be undertaken to ensure the limit value of 12mm/s PPV is not exceeded at the nearest sensitive buildings discussed above. Discussion on the control of ground vibration from blasting is discussed in Section 12.5.2.

Whilst drill and blast methods generate intermittent high noise levels when taking place, the time period over which impacts are experienced are significantly shorter compared to other extraction methods. For the proposed road development where a significant portion of hard rock is required to be excavated, the use of drill and blast will enable extraction works to be undertaken at a significantly faster rate compared to traditional rock breaking techniques.

Blasting impacts relate to both ground vibration and air overpressure, the magnitude of which depends on a variety of factors.

Air Overpressure (AOP)

Air overpressure is energy transmitted from the blast site within the atmosphere in the form of pressure waves. As such a wave passes a given position, the pressure of the air at this point rises very rapidly to a value above the ambient pressure, and then falls more slowly to a value below, before returning to the ambient value after a series of oscillations. The maximum excess pressure in this wave is known as the peak air overpressure. This value is typically measured in terms of dB (L_{in}), i.e. a linear value which is unweighted.

These pressure waves will consist of energy over a wide range of frequencies, some of which are audible and known as sound waves or noise, but most of the energy is inaudible at frequencies of less than 20Hz which is not heard by the human ear but is sensed as pressure.

The main sources of air overpressure from blasting relate to blast design and set up (e.g. detonating cord, stemming release and gas venting) and physical properties of the site (movement of rock and reflection of stress waves). The intensity of air overpressure levels at a receiver location is highly dependent on meteorological conditions which affect ambient air pressure including temperature, cloud cover, humidity, wind speed and direction etc. Due to the large variability in these conditions, it is not possible to reliably calculate AOP. The control of its intensity is therefore undertaken at source through careful blast design.

It is important to note that routine open-pit blasting operations regularly generate air overpressures up to a magnitude of 120dB (L_{in}), with levels in excess of 125dB (L_{in}) being relatively rare. Damage levels are rarely approached let alone exceeded. BS

5228-2 notes that there is no known evidence of structural damage to structures from excessive air overpressure levels from quarry blasting in the UK.

Ground Vibration due to Blasting

The level of vibration at a receiver location from a blast depends predominately on the distance from the blast, the maximum instantaneous charge (MIC), sequencing of charges and ground conditions between the blast area and the receiver location. Whilst it is possible to undertake indicative predictive calculations for ground vibrations from a blast site using information on the MIC, distance and ground factors, the most accurate methodology for determining vibration levels is through controlled trial blasts at specific sites and undertaking scaled distance regression analysis to determine maximum charge values in order to comply with the criteria included in Section 12.2.2.1.

In the case of the proposed road development, blast events will be clearly perceptible at the nearest sensitive receptors due to ground vibration and air overpressure levels, however the duration of the effects are intermittent. The overall impacts are therefore considered to be significant, momentary and localised. The closest sensitive properties to the identified likely blast sites are at distances of approximately 50m. Careful blast design will be required if blasting is proposed at these distances to ensure the vibration and AOP limits are not exceeded. Discussion on the implementation of best practice blasting control measures are outlined in Section 12.5.2.

12.4.2 Operational Phase Impacts for Noise & Vibration

12.4.2.1 Noise in Operational Phase – Road Traffic

A computer-based prediction model has been prepared in order to quantify the traffic noise level associated with the operational phase of the proposed road development and associated road traffic changes on the surrounding network. This section discusses the methodology behind the noise modelling process.

Brüel & Kjær Type 7810 Predictor

Proprietary noise calculation software was used for the purposes of this impact assessment. The selected software, Brüel & Kjær Type 7810 *Predictor*, calculates traffic noise levels in accordance with the UK's Department of Transport, Calculation of Road Traffic Noise (CRTN) 1988 and relevant TRL correction procedures for calculating L_{den}.

Predictor calculates noise levels in different ways depending on the selected prediction standard. In general, however, the resultant noise level is calculated taking into account a range of factors affecting the propagation of sound, including:

- The magnitude of the noise source in terms of sound power or traffic flow and average speed;
- The distance between the source and receiver;
- The presence of obstacles such as screens or barriers in the propagation path
- The presence of reflecting surfaces; and
- The hardness of the ground between the source and receiver.

Prediction of Traffic Noise

Noise emissions during the operational phase of the proposed road development have been modelled using Predictor in accordance with the CRTN methodology and the TRL 'Method 1' calculation procedure to calculate L_{den} values, using hourly traffic flows.

The CRTN method of predicting noise from a road development consists of the following five elements:

- Divide the proposed road development into segments so that the variation of noise within this segment is small;
- Calculate the basic noise level at a reference distance of 10 metres from the nearside carriageway edge for each segment;
- Assess for each segment the noise level at the reception point taking into account distance attenuation and screening of the source line;
- Correct the noise level at the reception point to take account of site layout features including reflections from buildings and facades, and the size of source segment; and
- Combine the contributions from all segments to give the predicted noise level at the receiver location for the whole proposed road development.

Note that all calculations are performed to one decimal place. For the purposes of comparison with the design goal of 60dB L_{den}, the relevant noise level is to be rounded to the nearest whole number in accordance with TII guidance.

Noise Model Inputs

The noise model was prepared using the following data:

- 3D road alignment drawings of the proposed road development supplied by the design team;
- 3D topographical contour data for the surrounding study area incorporating the noise sensitive assessment locations;
- background ordnance survey mapping; and
- the Annual Average Daily Traffic (AADT), % Heavy Goods Vehicles (HGV's) and traffic speeds.

Traffic flow data was provided for the Do-Nothing and Do-Something scenarios for the Opening Year of 2024 and Design Year of 2039 based on TII High Growth Forecasts. Specific details of traffic flows used for both assessment years are included in Chapter 5 Traffic Analysis.

A standard road surface type, such as hot rolled asphalt (HRA), has been assumed for all roads as part of the base model development.

Receiver Locations

Free-field traffic noise levels have been predicted at a number of properties in the vicinity of proposed and existing roads. A total of 458 assessment locations have considered. For some noise sensitive buildings, 2 facades have been considered where noise impacts from new and existing roads affect different sides of the building. The modelled locations represent the closest noise sensitive locations to the proposed road development and along sections of the existing road network where traffic volumes are modelled to change as a result of the proposed road development. Receptor locations were positioned at locations representing clusters or rows of properties where a number of noise sensitive buildings are in close proximity to each other.

The locations of all receptors are shown on Figures 12.1 to 12.23 in Volume 3 of this EIAR.

Noise Model Output

The output of the model is a calculated traffic noise level in terms of the L_{den} parameter at specific modelled receiver locations. Four scenarios have been considered as follows:

- Year 2024 – Do-Minimum (i.e. proposed road development is not built);
- Year 2024 – Do-Something (i.e. proposed road development in place);
- Year 2039 – Do-Minimum (i.e. proposed road development is not built); and
- Year 2039 – Do-Something (i.e. proposed road development in place).

Criteria for Noise Mitigation

The calculated noise levels at each modelled location are reviewed and compared against the three criteria for noise mitigation set out in the TII noise guidance documents as included in Section 12.2.2.2. Where modelled locations are determined to meet the three criteria, the use of noise mitigation has been recommended to reduce noise levels to within the relevant design criterion.

The predicted noise level at receptors requiring mitigation in the Design Year (2039), i.e. greater than 60 L_{den} (dB), is included in Table 12.11.

Table 12.11 Predicted Noise Levels at Receptors Requiring Mitigation

Receiver Location Reference	Opening Year 2024		Mitigation Required? (Yes/No)	Design Year 2039		Mitigation Required? (Yes/No)
	Predicted Noise Level			Predicted Noise Level		
	Do Minimum	Do Something		Do Minimum	Do Something	
	L_{den} (dB)	L_{den} (dB)		L_{den} (dB)	L_{den} (dB)	
A01-001	55	63	Yes	54	64	Yes
A01-002	54	61	Yes	53	62	Yes
A01-003	58	60	No	57	61	Yes
A02 007A	55	60	No	53	62	Yes
A02-007B	58	64	Yes	56	66	Yes
A02-008	58	61	Yes	56	62	Yes
A02-017	56	59	No	54	61	Yes
C26-002	59	59	No	59	61	Yes
C26-005	47	61	Yes	47	63	Yes
C26-006	58	61	Yes	58	62	Yes
C26-008	60	63	Yes	60	65	Yes
C26-009	58	63	Yes	58	64	Yes
C26-011	59	64	Yes	59	65	Yes
C27-001	53	63	Yes	53	65	Yes
C27-002	62	63	No	63	65	Yes
C27-003	56	62	Yes	57	63	Yes
C27-004	55	60	No	56	62	Yes
C27-005	56	60	No	57	62	Yes

Receiver Location Reference	Opening Year 2024		Mitigation Required? (Yes/No)	Design Year 2039		Mitigation Required? (Yes/No)
	Predicted Noise Level			Predicted Noise Level		
	Do Minimum	Do Something		Do Minimum	Do Something	
	L_{den} (dB)	L_{den} (dB)		L_{den} (dB)	L_{den} (dB)	
C27-006	55	59	No	55	61	Yes
C27-008	58	60	No	58	62	Yes
C27-009	62	62	No	62	64	Yes
C27-011	60	61	No	60	62	Yes
C27-012	60	60	No	60	62	Yes
C27-013	59	60	No	59	61	Yes
C27-019	43	63	Yes	44	64	Yes
C27-021	45	61	Yes	46	62	Yes
C27-027	46	64	Yes	46	66	Yes
C27-031	46	61	Yes	46	62	Yes
D50-013	61	69	Yes	62	70	Yes
D51-001a	62	68	Yes	62	69	Yes
D51-003	53	66	Yes	53	67	Yes
D51-006	44	64	Yes	45	65	Yes
D51-007	45	63	Yes	45	64	Yes
D51-011	45	62	Yes	45	63	Yes
D51-012	47	65	Yes	48	67	Yes
D52-001	46	64	Yes	46	65	Yes
D54-011	46	60	No	47	61	Yes
D54-012	47	64	Yes	48	65	Yes
D55-016	47	60	No	48	61	Yes
D56-003	46	61	Yes	46	62	Yes
D56-004	36	67	Yes	36	69	Yes
D56-005	45	64	Yes	46	65	Yes
D56-008	45	60	No	46	61	Yes
D56-009	44	67	Yes	45	68	Yes
D56-010	42	64	Yes	43	65	Yes
D56-011	44	63	Yes	44	65	Yes
D56-012	43	62	Yes	43	63	Yes
D56-013	36	65	Yes	37	67	Yes
D56-014	43	63	Yes	44	64	Yes
D56-015	44	62	Yes	45	63	Yes
D57 009A	36	65	Yes	37	66	Yes

Receiver Location Reference	Opening Year 2024		Mitigation Required? (Yes/No)	Design Year 2039		Mitigation Required? (Yes/No)
	Predicted Noise Level			Predicted Noise Level		
	Do Minimum	Do Something		Do Minimum	Do Something	
	L_{den} (dB)	L_{den} (dB)		L_{den} (dB)	L_{den} (dB)	
D57-001	41	64	Yes	42	65	Yes
D57-006	35	60	No	36	61	Yes
D57-007	35	68	Yes	36	69	Yes
D57-008	34	67	Yes	35	68	Yes
D57-009	36	67	Yes	36	68	Yes
D57-012	35	65	Yes	36	66	Yes
D57-013	34	62	Yes	34	64	Yes
D57-014	31	61	Yes	32	63	Yes
D57-015	33	60	No	34	61	Yes
D57-017	34	64	Yes	35	65	Yes
D58-002	35	66	Yes	36	67	Yes
D58-003	35	64	Yes	35	65	Yes
D58-004	20	59	No	20	61	Yes
D58-005	34	60	No	35	61	Yes
D59-001	35	64	Yes	36	65	Yes
D59-002	31	66	Yes	32	68	Yes
D59-004	34	65	Yes	35	67	Yes
D59-006	34	63	Yes	35	65	Yes
D59-007	35	61	Yes	36	62	Yes
D59-009	32	60	No	33	61	Yes
D59-011	32	60	No	33	61	Yes
D60-001	41	60	No	42	62	Yes
D60-003	39	65	Yes	39	66	Yes
D60-004	34	65	Yes	35	66	Yes
D60-005	36	59	No	37	61	Yes
D60-007	37	60	No	38	61	Yes
D60-008	37	59	No	38	61	Yes
D60-009	35	59	No	36	61	Yes
D60-011	41	64	Yes	42	66	Yes
D60-012	38	59	No	39	61	Yes
D60-013	40	61	Yes	40	62	Yes
D61-003	41	65	Yes	42	67	Yes
D61-004	41	63	Yes	42	64	Yes

Receiver Location Reference	Opening Year 2024		Mitigation Required? (Yes/No)	Design Year 2039		Mitigation Required? (Yes/No)
	Predicted Noise Level			Predicted Noise Level		
	Do Minimum	Do Something		Do Minimum	Do Something	
	L_{den} (dB)	L_{den} (dB)		L_{den} (dB)	L_{den} (dB)	
D61-005	42	62	Yes	43	63	Yes
D61-006	42	61	Yes	43	62	Yes
D61-007	43	59	No	44	61	Yes
D61-008	46	61	Yes	47	63	Yes
D61-009	47	61	Yes	47	62	Yes
D61-010	50	59	No	51	61	Yes
D61-015	57	61	Yes	58	62	Yes
D62 006A	49	68	Yes	50	69	Yes
D62-004	47	65	Yes	48	66	Yes
D62-005	47	62	Yes	48	64	Yes
D62-006	48	66	Yes	49	67	Yes
D62-007	48	64	Yes	48	65	Yes
D62-008	48	63	Yes	49	64	Yes
D62-009	48	62	Yes	48	64	Yes
D62-010	48	61	Yes	48	62	Yes
D62-011	48	62	Yes	49	63	Yes
D62-012	56	62	Yes	56	63	Yes
D62-016	47	60	No	48	61	Yes
D62-017	47	60	No	48	61	Yes
D63-003	56	63	No	57	61	Yes
D63-004	50	63	No	51	65	Yes
D63-005	55	62	Yes	56	63	Yes
D63-006	53	61	Yes	54	63	Yes
D63-007	54	64	Yes	55	64	Yes
D64-001	60	70	Yes	60	71	Yes
D64-002	54	63	Yes	55	64	Yes
D64-003	53	61	Yes	54	62	Yes
D64-004	55	63	Yes	56	65	Yes
D64-005	52	60	No	53	62	Yes
D64-006	54	62	Yes	55	63	Yes
D64-007	54	62	Yes	54	64	Yes
D64-008	54	62	Yes	55	64	Yes
D64-009	54	62	Yes	55	64	Yes

Receiver Location Reference	Opening Year 2024		Mitigation Required? (Yes/No)	Design Year 2039		Mitigation Required? (Yes/No)
	Predicted Noise Level			Predicted Noise Level		
	Do Minimum	Do Something		Do Minimum	Do Something	
	L_{den} (dB)	L_{den} (dB)		L_{den} (dB)	L_{den} (dB)	
D64-010	53	61	Yes	54	63	Yes
D64-011	54	62	Yes	55	63	Yes
D64-012	55	62	Yes	56	64	Yes
D66-001	61	64	Yes	62	65	Yes

Noise Model Results

Year 2024 Predicted Noise Levels

On review of the modelled results and subsequent analysis, a total of 86 of the modelled locations exceed the requirements for noise mitigation i.e. the predicted road traffic noise level is above 60dB L_{den} and noise levels are increased by 1dB or more as a direct result of the proposed road development. Noise mitigation is therefore deemed necessary at these locations based on the TII criteria. The number of properties determined to require noise mitigation excludes properties which are likely to be demolished as part of the proposed road but includes those that are to be acquired.

Year 2039 Predicted Noise Levels

On review of the modelled results and subsequent analysis, a total of 121 of the modelled locations satisfy the requirements for noise mitigation i.e. the predicted road traffic noise level is above 60dB L_{den} and noise levels are increased by 1dB or more as a direct result of the proposed road. Noise mitigation is therefore deemed necessary at these locations based on the TII criteria. The number of properties determined to require noise mitigation excludes properties which are likely to be demolished as part of the proposed road but includes those that are to be acquired.

Summary of Receptors Requiring Mitigation

Analysis of the modelled results indicates that during the Design Year of 2039, 121 properties meet the three criteria for noise mitigation. These locations are along section A (Foynes to Ballyclogh), Section C (Ballyclogh to Rathkeale) and Section D (Rathkeale to Adare).

Further discussion on the recommended mitigation measures for the operational phase is included in Section 12.5.3 with Table 12.14 summarising proposed noise barrier locations, lengths and heights as grouped to suit clusters of receptors.

12.4.2.2 Noise in Operational Phase – HGV Service Area

A HGV service area will be provided at the western terminal of the route at Shannon - Foynes Port. This service area will provide parking for up to 35 HGV's and will provide some basic facilities for drivers including toilets, showers and a small common room. The facility is located some 300m from the closest noise sensitive locations to the west of the site. As noted above, the facility is primarily a rest area for drivers with toilets and wash facilities. Once traffic has entered the site and parked in the designated parking areas there are no significant sources of noise associated with this facility. Depending on the type of vehicles using the facility, there is potential for some HGV's to operate refrigerated units, depending on the type of goods being transported from the port (e.g. fresh produce requiring refrigeration). Under this scenario the vehicle

engine and the refrigerated unit operates when the vehicle is parked and is a source of noise.

A number of operational scenarios have been modelled to determine a range of operational noise levels associated with parked HGV's with refrigerated units in operation. This included a review of vehicles with diesel engines powering refrigerated units and those with electric plug in points. The outcome of the assessment has determined the following with respect to noise controls at the facility:

- Electric plug in points will be provided for parking spaces within the western side of the car park. Up to 10 electric plug in points will be provided for HGV's to facilitate refrigerated units to operate without diesel engines running.
- HGV's with diesel engines running will be required to park in the eastern side car park area, where relevant.

The following scenario has been modelled to represent a highly conservative scenario based on the outcome of the assessment above :

- 10 HGV's operating refrigerated units are parked in the western car park using electric plug in points;
- 8 HGV's operating refrigerated units are parked in the eastern car park with diesel engines running;
- All 18 vehicles with refrigerated units are assumed to be operating simultaneously;
- The modelled source height is 4m above ground to represent the refrigerated unit;
- The source noise level used for both scenarios are listed in Table 12.12 below. The source data is taken from the *Imagine data base* (https://www.imagine-project.org/) which are incorporated in the noise modelling software Brüel and Kjaer *Predictor* – Softnoise application used for this assessment;
- The calculations methodology is based on ISO 9613 (1996) *Attenuation of Sound During Propagation Outdoors.* The source data have been verified against measurements previously made by AWN for refrigerated units and are considered robust and conservative;
- Noise levels are calculated at the closest noise sensitive locations to the HGV Service area.

Table 12.12 Source Noise Levels for Refrigerated HGV's

Source	$L_{W(A)}$	Octave Band Sound Power Levels, dB(A)							
		63Hz	125Hz	250 Hz	500 Hz	1k Hz	2k Hz	4k Hz	8k Hz
Refrigerated Unit on HGV – diesel operation	96	76	86	88	90	91	87	83	77
Refrigerated Unit on HGV – plug in point	91	65	68	80	84	86	84	81	77

The calculated noise levels associated with the scenario discussed above are summarised in Table 12.13 for the closest noise sensitive locations to the proposed service area. These locations are illustrated in Figure 12.1. The results are presented for a one-hour scenario, representing the specific noise contribution of all modelled vehicles operating simultaneously at any one time. The calculated L_{den} is based on continual operation of all HGV sources noted above over a 24 hour period, representing a highly worst case and unlikely scenario.

The calculated L_{den} noise level associated with the service area sources is added to the calculated road traffic noise levels (with mitigation) to obtain a cumulative noise level.

Table 12.13 Calculated Noise Levels Associated with HGV Refrigerated Units

Receiver Location Reference	Service Area - Calculated operational noise level, dB $L_{Aeq,1hr}$	Service Area Calculated operational noise level, dB L_{den}	Road Traffic only, dB L_{den}	Cumulative Road and HGV refrigerated sources, dB L_{den}
A00-005	39	46	55	56
A00-006	40	46	55	56
A00-007	42	49	54	55
A00-008	38	45	54	55
A00-009	38	45	54	55
A00-010	43	49	54	55
A00-011	43	49	53	55
A00-012	43	49	54	55
A00-013	34	40	55	55
A00-019	36	43	56	56
A00-021	30	36	56	56
A01-001	37	44	60	60
A01-002	37	43	58	58
A01-003	34	40	57	57
A01-006	36	42	54	54
A01-007	36	42	55	55
A01-010	37	43	56	56

The results of the assessment have determined that operational noise levels associated with up to 50% of parked HGV's operating refrigerated units simultaneously are below the recommended day and night-time noise levels for continual fixed sources. (Refer to Section 12.2.2.2.).

Once combined with road traffic noise in the area, the contribution of activities from this area is determined to be negligible and not significant. The calculated cumulative noise level is below 60dB L_{den} at the assessment locations and remains dominated by road traffic flows.

12.4.2.3 Vibration in the Operational Phase

As a vehicle travels along a road, vibration can be generated in the road and subsequently propagate towards nearby buildings. Such vibration is generated by the interaction of a vehicle's wheels and the road surface and by direct transmission through the air of energy waves. Some of these waves arise as a function of the size, shape and speed of the vehicle, and others from pressure fluctuations due to engine, exhaust and other noises generated by the vehicle.

The TII 2004 document notes that ground vibrations produced by road traffic are unlikely to cause perceptible structural vibration in properties located near to well-maintained and smooth road surfaces. Perceptible road traffic vibration can therefore be largely avoided by maintenance of the road surface.

12.5 Mitigation and Monitoring Measures

12.5.1 Construction Phase Mitigation for Noise Impact

The construction contract documents will clearly specify the construction noise criteria included in this chapter which the construction works must operate within. The contractor undertaking the construction of the works will be obliged to take specific noise abatement measures and comply with the recommendations of *BS 5228-1:2009+A1:2014 Code of Practice for Noise and Vibration Control on Construction and Open Sites – Part 1: Noise* and *BS 5228-2:2009+A1:2014 Code of practice for noise and vibration control on construction and open sites - Part 2: Vibration* and the European Communities (Noise Emission by Equipment for Use Outdoors) Regulations, 2001. These measures will ensure that:

- The best means practicable, including proper maintenance of plant, will be employed to minimise the noise produced by on site operations;
- All vehicles and mechanical plant will be fitted with effective exhaust silencers and maintained in good working order for the duration of the contract;
- Compressors will be attenuated models fitted with properly lined and sealed acoustic covers which will be kept closed whenever the machines are in use and all ancillary pneumatic tools will be fitted with suitable silencers;
- Machinery that is used intermittently will be shut down or throttled back to a minimum during periods when not in use; and
- Any plant, such as generators or pumps that is required to operate before 07:00hrs or after 19:00hrs will be surrounded by an acoustic enclosure or portable screen.

During the course of the construction programme, the contractor will be required to manage the works to comply with the limits detailed in Tables 12.1 and 12.2 using methods outlined in *BS 5228-1:2009+A1 2014. Part 1 – Noise.* BS 5228 *-1:2009+A1 2014* includes guidance on several aspects of construction site practices, which include, but are not limited to:

- Selection of quiet plant;
- Control of noise sources;
- Screening;
- Hours of work;
- Liaison with the public; and
- Monitoring.

Specific control measures relating to construction activities undertaken by the contractor will be set out within the construction noise and vibration management plan to be prepared in advance of the works and updated as the construction phase progresses. Noise control measures that will be considered include the selection of quiet plant, enclosures and screens around noise sources, limiting the hours of work and noise monitoring. The contractor will be required to conduct construction noise predictions prior to works taking place and put in place the most appropriate noise control measures depending on the level of noise reduction required at any one location.

Selection of Quiet Construction Plant

The potential for any item of plant to generate noise will be assessed prior to the item being brought onto the site. The least noisy item of plant will be selected wherever possible. Should a particular item of plant already on the site be found to generate high noise levels, the first action will be to identify whether or not said item can be replaced with a quieter alternative. Where this is not possible, noise control at source or pathway screening is then required.

For static plant such as compressors and generators used at work areas such as construction compounds etc., the units will be supplied with manufacturers' proprietary acoustic enclosures where possible. The contractor will evaluate the choice of piling, excavation, breaking or other working method taking into account various ground conditions and site constraints. Where possible, where alternative lower noise generating equipment that would economically achieve, in the given ground conditions, equivalent structural/ excavation/ breaking results, these will be selected to minimise potential disturbance.

The decision regarding the type of pile, excavation technique, rock breaking, crushing etc. to be used on a site will normally be governed by other engineering, and environmental constraints. In these instances, it may not be possible for technical reasons to replace a noisy process by a quieter alternative (e.g. rotary bored piling over driven piles). Even if it is possible, the adoption of a quieter method may prolong the overall process (e.g. rock breaking versus blasting); the net result being that the overall disturbance to the community will not necessarily be reduced.

Construction Noise Control at Source

If replacing a noisy item of plant is not a viable or practical option, consideration will be given to noise control "at source". This refers to the modification of an item of plant, or the application of improved sound reduction methods in consultation with the supplier or the best practice use of equipment and materials handling to reduce noise.

In practice, a balance may need to be struck between the use of all available techniques and the resulting costs of doing so. It is therefore proposed to adopt the concept of "*Best Available Techniques"* as defined in EC Directive 210/75/EU. In this context *"best"* means *"the most effective in achieving a high general level of protection of the environment as a whole"*.

The expression *"Best available techniques"* means *"means the most effective and advanced stage in the development of activities and their methods of operation which indicates the practical suitability of particular techniques for providing the basis for emission limit values and other permit conditions designed to prevent and, where that is not practicable, to reduce emissions and the impact on the environment as a whole".*

The term *"techniques"* includes *"both the technology used and the way in which the installation is designed, built, managed, maintained, operated and decommissioned"*.

Thus, the concept of Best Available Techniques requires a degree of balance between the attainment of environmental benefits and the likely cost implications. Proposed techniques will also be evaluated in light of their potential effect on occupational health and safety. The following outline guidance relates to practical noise control at source techniques which relate to specific site considerations:

- For mobile plant items such as cranes, dump trucks, excavators and loaders, the installation of an acoustic exhaust and/or maintaining enclosure panels closed during operation can reduce noise levels by up to 10dB. Mobile plant will be switched off when not in use and not left idling;
- For piling plant, noise reduction can be achieved by enclosing the driving system in an acoustic shroud. For steady continuous noise, such as that generated by diesel engines, it is possible to reduce the noise emitted by fitting a more effective exhaust silencer system or utilising an acoustic canopy to replace the normal engine cover;
- For percussive tools such as pneumatic concrete breakers, rock drills and tools a number of noise control measures include fitting muffler or sound reducing equipment to the breaker 'tool' and ensuring any leaks in the air lines are sealed. Installation of localised screens around the breakers or drill bits when in operation in close proximity to noise sensitive boundaries are other suitable forms of noise reduction;
- For concrete mixers, control measures will be employed during cleaning to ensure no impulsive hammering is undertaken at the mixer drum; and
- For all materials handling, the contractor will ensure that best practice site noise control measures are implemented including ensuring that materials are not dropped from excessive heights and drop chutes/dump trucks are lined with resilient materials. This is an important consideration for site compounds where materials are loaded and unloaded.

Site compounds in close proximity to noise sensitive areas will incorporate a strict noise control policy relating to materials handling;

- Where compressors, generators and pumps are located in areas in close proximity to noise sensitive properties/ areas and have potential to exceed noise criterion, these will be surrounded by acoustic lagging or enclosed within acoustic enclosures providing air ventilation;
- Resonance effects in panel work or cover plates can be reduced through stiffening or application of damping compounds; rattling and grinding noises can be controlled by fixing resilient materials in between the surfaces in contact;
- Demountable enclosures can also be used to screen operatives using hand tools and may be moved around site as necessary; and,
- All items of plant will be subject to regular maintenance. Such maintenance can prevent unnecessary increases in plant noise and can serve to prolong the effectiveness of noise control measures.

Noise Screening for Construction

Typically noise screening is an effective method of reducing the noise level at a receiver location and can be used successfully as an additional measure to other forms of noise control. The effectiveness of a noise screen will depend on the height and length of the screen, its mass, and its position relative to both the source and receiver.

The length of the screen should in practice be at least five times the height, however, if shorter sections are necessary then the ends of the screen will be wrapped around the source.

BS 5228 -*1:2009+A1 2014* states that on level sites the screen should be placed as close as possible to either the source or the receiver. The construction of the barrier will be such that there are no gaps or openings at joints in the screen material. In most practical situations the effectiveness of the screen is limited by the sound transmission over the top of the barrier rather than the transmission through the barrier itself. In practice screens constructed of materials with a mass per unit of surface area greater than 10kg/m^2 will give adequate sound insulation performance. As an example, the use of a standard 2.4m high construction site hoarding will provide a sufficient level of noise screening once it is installed at a suitable position between the source and receiver. Annex B of *BS 5228-1:2009+A1:2014* (Figures B1, B2 and B3) provide typical details for temporary and mobile acoustic screens, sheds and enclosures that can be constructed on site from standard materials.

In addition, careful planning of the site layout will also be considered. Within site compounds, the placement of site buildings such as offices and stores between the site and sensitive locations can provide a good level of noise screening. Similarly, in some instances materials such as topsoil or aggregate along the proposed road development can provide a degree of noise screening if placed between the source and the receiver.

Hours of Work

Construction activity will mostly take place during daytime hours Monday to Friday and Saturdays.

It will be necessary to work overtime (including weekends) at certain critical stages during the project to minimise public disturbance such as temporary road closures at night during installation of bridge beams above. Consideration will be given to the scheduling of activities in a manner that reflects the location and sensitivity of the site and the nature of neighbouring properties. Each potentially noisy event/activity will be considered on its individual merits and scheduled according to its noise level, proximity to sensitive locations and possible options for noise control within the contractors' construction management plan. In situations where a particularly noisy activity is scheduled e.g. activities identified in Table 12.7(rock breaking/ crushing / impact piling etc.) or other activities of similar noise level, the use of other on-site activities will be scheduled to ensure control of cumulative noise levels.

Liaison with the Public during Construction

On typical road construction sites, the major sources of noise are essentially mobile, and the noise received at any control points will therefore vary from day to day as work proceeds. The duration of piling, excavation, breaking and other high noise or vibration activities works is usually short in relation to the length of construction work as a whole, and the amount of time spent working near to sensitive areas can represent only a part of the overall period. It is important, therefore, that clear forms of communication are established between the contractor and noise sensitive areas in proximity so that residents or building occupants are aware of the likely duration of activities likely to generate higher noise or vibration.

A designated noise liaison officer will be appointed to site during construction works. All noise complaints will be logged and followed up in a prompt fashion by the liaison officer.

Noise Monitoring

During the construction phase noise monitoring will be undertaken at the nearest sensitive locations to ensure construction noise limits outlined in Table 12.1 are not exceeded. Contractual obligations will ensure that the operations causing noise exceedance must be suspended until suitable protections are adopted to prevent any further exceedance. Noise monitoring will be conducted in accordance with the International Standard ISO 1996-2: 2017 *Acoustics – Description, measurement and assessment of environmental noise* Part 1 (2016) and Part 2 (2017). The selection of monitoring locations will be based on the nearest sensitive buildings to the working area which will progress along the length of the road construction.

12.5.2 Construction Phase Mitigation for Blasting and Air Overpressure

Air overpressure from a blast is difficult to control because of its variability. However, much can be done to reduce the effect and the control of the blast design at source.

In terms of blast design control, specific guidance will be obtained from the recommendations contained within *BS 5228-2:2009+A1:2014 Code of Practice for* Noise *and Vibration Control on Construction and Open Sites – Vibration* in relation to blasting operations in addition to experienced blast control techniques used by the contractor. These will include some or all of the following:

- All blasting will be undertaken by professionally trained blast contractors;
- Restriction of hours within which blasting can be conducted (09:00 –18:00hrs);
- Trial blasts will be tested in less sensitive areas to assist in blast designs and identify potential zones of influence;
- Explosive charges will be properly confined by a sufficient amount of stemming
- Blasting contractors will ensure that the minimum amount of primer cord is used, and that no primer cord is located above ground;
- Profiling will be carried out after each blast in order to ensure the geometry of the rock face can be established, enabling the optimum burden and spacing to be applied for subsequent blasts;
- The design, execution and completion of any blasting within 150 metres of any existing structure will require special considerations. This will include the use of pre and post condition structural surveys by a competent structural engineer;
- Ground vibration and air overpressure (AOP) will be recorded simultaneously for each blast at the most sensitive locations, depending on the works area being blasted;
- When blasting moves into a new area, an initial low-level blast will be carried out (i.e. a low Maximum Instantaneous Charge (MIC)) and monitoring will be carried out simultaneously at a number of sensitive properties in different directions in order to generate specific scaled distance graphs;
- The scaled distance graphs will be used to determine the optimum MIC for subsequent blast areas in order to control vibration and AOP limits below the relevant limit values at the nearest sensitive buildings.

In line with best practice mitigation measures from vibration sources, good communication and public relations are a key factor in reducing any startle effects to residents. In this instance, a Public Communications Strategy will be implemented by the contractor prior to the commencement of any blast works. In such cases, the following mitigation measures are proposed:

- Relevant nearby residents will be notified before any work and blasting starts (e.g. a minimum of 24-hour written notification);
- The firing of blasts will be undertaken, where possible, at similar times to reduce the 'startle' effect;
- Ongoing circulars will be issued informing people of the progress of the blasting works;
- The implementation of an onsite documented complaints procedure will be maintained by the contractor; and
- The use of independent monitoring will be undertaken by external bodies for verification of results.
- The Public Communications Strategy will be implemented by the contractor prior to the commencement of intrusive works in close proximity (i.e. <50m) to occupied buildings with potential for high vibration levels.

12.5.3 Construction Phase Mitigation for Vibration

The TII Guidelines recommend that in order to ensure that there is no potential for vibration damage during construction, vibration from construction activities should be limited to the values set out in Table 12.3.

On review of the likely vibration levels associated with construction activities, the construction of the proposed road development is not likely to give rise to vibration that is either significantly intrusive or capable of giving rise to cosmetic or structural damage to buildings.

In the case of vibration levels giving rise to human discomfort, in order to minimise such impacts, the following measures will be implemented during the construction period:

- A clear communication programme will be established to inform adjacent building occupants in advance of any potential intrusive works which may give rise to vibration levels likely to exceed perceptible levels. The nature and duration of the works will be clearly set out in all communication circulars;
- Alternative less intensive working methods and/or plant items will be employed, where feasible;
- Appropriate vibration isolation will be applied to plant, where feasible; and
- Cut off trenches to isolate the vibration transmission path will be installed where required.

In the case of impact piling or demolition works for instance, a reduction in the input energy per blow will be considered where required. Monitoring will be undertaken at identified sensitive buildings, where proposed works have the potential to be at or exceed the vibration limit values.

Property Condition Surveys

Property condition surveys will be offered for all buildings within 150m of proposed blasting works along the proposed road development. Property condition surveys will also be carried out at buildings and structures considered appropriate relative to their proximity to the works. Such property condition surveys will be carried out by a Chartered Surveyor or Chartered Structural Engineer. Such property condition surveys, subject to the written agreement of relevant property owners, will be carried out in two stages as follows:

- the first stage will consist of pre-construction condition surveys including photographic records which will be carried out prior to the commencement of construction; and
- the second stage will consist of post-construction condition surveys which will include photographic records.

Vibration impacts to building occupants can be significantly reduced through the use of clear communication and information circulars relating to planned works, and their duration.

12.5.4 Operational Phase Mitigation for Noise

The following section details the mitigation measures deemed practicable to achieve the design goals previously defined in Section 12.2.2.

The mitigation measures required to reduce traffic noise levels are specified based on the predicted noise levels for the Design Year of 2039. The results of the modelling exercise show that noise mitigation is required for 121 properties along the proposed road development for this Design Year.

The first mitigation option is the inclusion of a low noise road surface (LNRS) along the following roads:

- Section A: Full extent of the proposed road between Foynes and Ballyclogh;
- Section C: Full extent of the proposed road between Ballyclogh and Rathkeale;
- Section D: Full extent of the proposed road between Rathkeale and Adare to the end of realigned N21 including junction slip roads;
- Existing N21 at tie in between the eastern end of Section D and the N20 Attyflin Junction, and;
- Adare Link Road.

In line with TII guidance, the correction applied to LNRS for noise mitigation purposes is -2.5dB compared to Hot Rolled Asphalt (HRA). Further options to reduce operational noise levels along the proposed road development will include the use of noise barriers to reduce noise levels along the propagation path between the source (proposed road development) and the specific receivers.

Barriers can take the form of proprietary acoustic screens, solid block walls, earth berms or other solid structures. The barriers chosen should be solid, with no gaps at the base or between vertical joints and should have a minimum surface mass of 10kg/m^2. The barriers will have a minimum sound insulation performance of B3 as classified in I.S. EN 1793 Part 2. All absorptive barriers will have a minimum absorptive index of A3 as classified in I.S. EN 1793 Part 1.

Table 12.14 overleaf summarises the barrier requirements. The location of the noise barriers are illustrated in Figures 12.1 to 12.22 in Volume 3.

Table 12.14 Noise Barrier Requirements

Barrier Ref.	Incident to	Road Link	Chainage Start (m)	Chainage End (m)	Height (m)	Length (m)	Alignment/ Notes
NB-001	A01-001/A01-002	N69	1+050	1+250	2	200	South
NB-002	A02-007A/A02-007B	N69	2+325	2+600	2.5	275	South
NB-003	A02-008/ A02-017	N69	2+325	2+600	2.5	275	North
NB-004	D51-001A	M21	51+150	51+325	3	175	South
NB-005	D51-001A	M21	51+325	51+450	3.5	125	South
NB-006	C26-005 - C26- 009 / C26-011 / C27-001	Ballyclogh to Rathkeale	26+555	27+175	2	620	East
NB-008	C27-002 - C27-007	Ballyclogh to Rathkeale	26+900	27+350	2	450	West
NB-009	C27-008/C27-009 - C27-014 /C27-019	Ballyclogh to Rathkeale	27+350	27+750	2.5	400	West
NB-010	C27-021, C27-027, C27-031	Ballyclogh to Rathkeale	27500	27+900	2.5	400	East
NB-012	D50-013	M21	50+750	51+025	3	275	North
NB-013	D51-003	M21	51+550	51+775	3.5	225	South
NB-014	D51-006/ D51-007/D51-011	M21	51+775	51+925	3	150	South
NB-015		M21	51+925	52+150	2.5	225	South
NB-016	D51-012/ D52-001	M21	51+775	52+225	2	450	North
NB-017A/B	D54-012	M21	54+350	54+450	2.5	125	North
NB-018		M21	54+475	54+560	2	100	North
NB-019	D56-003, D56-004, D56-005, D56-008	M21	55+975	56+300	3.5	325	South
NB-020	D56-012 / D56-013	M21	56+300	56+500	2	200	South
NB-021			56+500	56+730	2.5	230	South
NB-022	D56-009/ D56-010/ D56-014/ D56-015	M21	56+000	56+400	3.5	400	North
NB-023	D56-011	M21	56+400	56+875	2.5	325	North
NB-024	D57-001	M21	56+875	57+225	3	350	North

Barrier Ref.	Incident to	Road Link	Chainage Start (m)	Chainage End (m)	Height (m)	Length (m)	Alignment/ Notes
NB-025	D57-006 / D57-008/ D57-017	M21	57+475	58+025	3.5	550	South
NB-026	D57-007/ D57-009/ D57-009A/ D57-012/ D57-013 - D57-015	M21	57+475	58+075	3.5	50	North
NB-027	D58-002 - D58-005 / D59-001	M21	58+675	59+250	3	575	North
NB-028	D59-002/D59-004/ D59-006/ D59-007	M21	58+725	59+325	3	600	South
NB-029	D59-009/ D59-011	M21	59+675	60+100	3.5	425	South
NB-030	D60-004/ D60-005	M21	60+100	60+300	3.5	200	South (Absorptive)
NB-031	D60-003	M21	60+025	60+300	3.5	275	North
NB-032	D60-003 / D60-011	M21	60+325	60+510	2.5	185	North
NB-033	D60-011	M21	60+510	60+860	3	350	North
NB-034	D61-003	M21	60+975	61+325	3.5	350	South
NB-035	D61-004 / D61-005 / D61-006 / D61-008 - D61-010	M21	61+325	61+475	3	150	South
NB-036		M21	61+475	61+725	2.5	250	South
NB-037	D61-015	M21	61+650	62+125	2.5	475	South
NB-038	D62-004 - D62-011 / D62-016 / D62-017	M21	62+375	62+875	3.5	500	North
NB-039			62+875	63+025	3	150	North
NB-040	D62-011 /D63-004	M21	63+025	63+560	3.25	535	North
NB-041	D62-012 /D63-003 /D63-005	M21	62+625	63+630	3	1005	South
NB-042	D63-006	M21	63+775	64+025	3	250	North
NB-043	D63-002 / D64-004 /D63-006 - D64-009 - D64-012	M21	64+025	65+050	3.5	1025	North
NB-044	D64-001 /D64-003 / D64-005	M21	63+750	64+300	3.5	550	South
NB-045	D66-001	Existing N21	65+775	66+175	2	400	South

The proposed noise mitigation set out above have been designed to sufficiently reduce traffic noise levels to at, or below, the traffic noise design goal of 60dB $L_{den,}$ where relevant. A total length of approximately 15.5km of barrier is required, ranging in height from 2.0m to 3.5m, and on average just under 3.0m. Three-quarters of the proposed barriers will be located along Section D for the M21 motorway which carries the highest volumes of traffic and passes near to more houses than the rest of the route between Rathkeale and Foynes.

The combined mitigation measures associated with the use of a Low Noise Road Surface (LNRS) in addition to physical noise screening has been assessed to provide the most suitable available noise mitigation at the nearest sensitive locations. Discussion on the residual impacts taking account of the proposed mitigation measures are outlined in Section 12.6. A number of additional barriers have been specified along the proposed road development in order to reduce potential visual and noise impacts at equine holdings. These are illustrated also in Figures 12.1 to 12.23 in Volume 3. Specific discussion on potential impacts to equine holdings and recommended mitigation measures is included in Chapter 15 Material Assets and Land – Agriculture.

12.6 Residual Impacts for Noise and Vibration

12.6.1 Construction Phase Residual Impacts

During the construction phase of the proposed road development noise levels at properties closest to working areas will be temporarily increased above the ambient noise environment when works are occurring in proximity to the properties. Given the linear nature of the works, noise emissions related to construction works will be of temporary or short-term impact at any one area as the works progress along the length of the proposed road development.

Highest noise impacts will occur during periods of excavation, particularly in areas where sections of hard rock are to be excavated where drill and blast methods will likely be chosen, where large cuttings are required. Whilst high noise levels are associated with an individual blast, the effects are momentary, and the blast designs will be strictly controlled to ensure the AOP and PPV levels are within the specified limit values. The use of this form of rock breaking will expedite the level of rock extraction in any one blast and hence reducing overall exposure times and overall impacts. Mechanical breaking, crushing and excavation of rock and materials will be strictly controlled through the use of control of noise at source, screening, scheduling of works to control noise levels at the closest sensitive properties, as far as is practicable.

The various mitigation measures will be selected in order to control construction noise levels to within the limit values included in Table 12.1. The most appropriate noise mitigation measures for each work area will be determined taking account of the various control measures included within Section 12.5.1. It is likely that, even with the implementation of noise mitigation measures, a potential temporary significant impact will occur at properties up to 80m from high intrusive activities (rock breaking, drilling etc.).

Construction traffic noise will have a short term moderate impact at 4 local roads that may be used for access to the proposed works. For the remainder of construction activities beyond 50m from the works, with the implementation of controlled mitigation measures, construction activities can operate within the adopted noise limits for daytime periods at the nearest properties to the works.

The assessment has indicated that the use of standard construction activities can operate within the recommended vibration limits for standard residential and other light-framed buildings. With the adoption of best practice methodologies for the control of vibration from blasting, potential vibration impacts at the most sensitive premises can be adequately mitigated to within acceptable levels.

12.6.2 Operational Phase Residual Impacts

The predicted residual noise levels at receptors after mitigation is presented in Table 12.15.

Table 12.15 Predicted Residual Noise Levels at Receptors after Mitigation

Receiver Location Reference	Opening Year 2024		Design Year 2039		Comment
	Predicted Noise Level		Predicted Noise Level		
	Do Minimum	Do Something	Do Minimum	Do Something	
	L_{den} (dB)	L_{den} (dB)	L_{den} (dB)	L_{den} (dB)	
A01-001	55	59	54	60	Meets design goal
A01-002	54	57	53	58	Meets design goal
A01-003	58	56	57	57	Meets design goal
A02 007A	55	56	53	57	Meets design goal
A02-007B	58	56	56	57	Meets design goal
A02-008	58	57	56	58	Meets design goal
A02-017	56	55	54	56	Meets design goal
C26-002	59	59	59	60	Meets design goal
C26-005	47	55	47	56	Meets design goal
C26-006	58	58	58	59	Meets design goal
C26-008	60	59	60	61	Less than 1dB above Do Minimum value
C26-009	58	58	58	59	Meets design goal
C26-011	59	58	59	60	Meets design goal
C27-001	53	58	53	59	Meets design goal
C27-002	62	61	63	63	Same as do Minimum Value
C27-003	56	57	57	58	Meets design goal
C27-004	55	56	56	57	Meets design goal
C27-005	56	56	57	58	Meets design goal
C27-006	55	55	55	56	Meets design goal
C27-008	58	57	58	59	Meets design goal
C27-009	62	60	62	62	Same as do Minimum Value
C27-011	60	59	60	60	Meets design goal

Receiver Location Reference	Opening Year 2024		Design Year 2039		Comment
	Predicted Noise Level		Predicted Noise Level		
	Do Minimum	Do Something	Do Minimum	Do Something	
	L_{den} (dB)	L_{den} (dB)	L_{den} (dB)	L_{den} (dB)	
C27-012	60	58	60	60	Meets design goal
C27-013	59	58	59	59	Meets design goal
C27-019	43	55	44	57	Meets design goal
C27-021	45	56	46	57	Meets design goal
C27-027	46	56	46	58	Meets design goal
C27-031	46	56	46	57	Meets design goal
D50-013	61	60	62	61	Below Do Minimum Value
D51-001a	62	62	62	63	1dB above do min (reduction to front of house)
D51-003	53	58	53	60	Meets design goal
D51-006	44	57	45	58	Meets design goal
D51-007	45	56	45	57	Meets design goal
D51-011	45	57	45	58	Meets design goal
D51-012	47	57	48	58	Meets design goal
D52-001	46	57	46	58	Meets design goal
D54-011	46	58	47	59	Meets design goal
D54-012	47	59	48	60	Meets design goal
D55-016	47	57	48	58	Meets design goal
D56-003	46	57	46	58	Meets design goal
D56-004	36	59	36	60	Meets design goal
D56-005	45	58	46	59	Meets design goal
D56-008	45	56	46	57	Meets design goal
D56-009	44	59	45	60	Meets design goal
D56-010	42	56	43	57	Meets design goal
D56-011	44	55	44	57	Meets design goal
D56-012	43	57	43	58	Meets design goal
D56-013	36	55	37	56	Meets design goal
D56-014	43	56	44	57	Meets design goal
D56-015	44	56	45	57	Meets design goal
D57 009A	36	57	37	59	Meets design goal
D57-001	41	57	42	58	Meets design goal

Receiver Location Reference	Opening Year 2024		Design Year 2039		Comment
	Predicted Noise Level		Predicted Noise Level		
	Do Minimum	Do Something	Do Minimum	Do Something	
	L_{den} (dB)	L_{den} (dB)	L_{den} (dB)	L_{den} (dB)	
D57-006	35	56	36	57	Meets design goal
D57-007	35	59	36	60	Meets design goal
D57-008	34	58	35	59	Meets design goal
D57-009	36	59	36	60	Meets design goal
D57-012	35	58	36	59	Meets design goal
D57-013	34	56	34	57	Meets design goal
D57-014	31	55	32	56	Meets design goal
D57-015	33	55	34	56	Meets design goal
D57-017	34	57	35	58	Meets design goal
D58-002	35	58	36	60	Meets design goal
D58-003	35	57	35	58	Meets design goal
D58-004	20	55	20	57	Meets design goal
D58-005	34	55	35	56	Meets design goal
D59-001	20	58	20	59	Meets design goal
D59-002	31	56	32	57	Meets design goal
D59-004	34	56	35	57	Meets design goal
D59-006	34	55	35	56	Meets design goal
D59-007	35	55	36	56	Meets design goal
D59-009	32	56	33	57	Meets design goal
D59-011	32	56	33	57	Meets design goal
D60-001	41	57	42	59	Meets design goal
D60-003	39	59	39	60	Meets design goal
D60-004	34	59	35	60	Meets design goal
D60-005	36	56	37	58	Meets design goal
D60-007	37	57	38	59	Meets design goal
D60-008	37	57	38	59	Meets design goal
D60-009	35	58	36	60	Meets design goal
D60-011	41	58	42	59	Meets design goal
D60-012	38	57	39	59	Meets design goal
D60-013	40	59	40	60	Meets design goal
D61-003	41	58	42	60	Meets design goal
D61-004	41	57	42	59	Meets design goal
D61-005	42	56	43	58	Meets design goal

Receiver Location Reference	Opening Year 2024		Design Year 2039		Comment
	Predicted Noise Level		Predicted Noise Level		
	Do Minimum	Do Something	Do Minimum	Do Something	
	L_{den} (dB)	L_{den} (dB)	L_{den} (dB)	L_{den} (dB)	
D61-006	42	55	43	57	Meets design goal
D61-007	43	55	44	56	Meets design goal
D61-008	46	57	47	58	Meets design goal
D61-009	47	57	47	58	Meets design goal
D61-010	50	56	51	58	Meets design goal
D61-015	57	58	58	59	Meets design goal
D62 006A	49	58	50	59	Meets design goal
D62-004	47	57	48	58	Meets design goal
D62-005	47	57	48	58	Meets design goal
D62-006	48	56	49	57	Meets design goal
D62-007	48	56	48	57	Meets design goal
D62-008	48	56	49	57	Meets design goal
D62-009	48	56	48	57	Meets design goal
D62-010	48	55	48	57	Meets design goal
D62-011	48	56	49	57	Meets design goal
D62-012	56	58	56	59	Meets design goal
D62-016	47	54	48	55	Meets design goal
D62-017	47	54	48	55	Meets design goal
D63-003	56	57	57	59	Meets design goal
D63-004	50	59	51	60	Meets design goal
D63-005	55	57	56	59	Meets design goal
D63-006	53	56	54	57	Meets design goal
D63-007	54	58	55	60	Meets design goal
D64-001	60	60	60	61	Less than 1dB above Do Minimum value
D64-002	54	57	55	58	Meets design goal
D64-003	53	58	54	60	Meets design goal
D64-004	55	58	56	59	Meets design goal
D64-005	52	58	53	60	Meets design goal
D64-006	54	56	55	57	Meets design goal
D64-007	54	55	54	57	Meets design goal
D64-008	54	56	55	57	Meets design goal
D64-009	54	56	55	57	Meets design goal
D64-010	53	55	54	56	Meets design goal

Receiver Location Reference	Opening Year 2024		Design Year 2039		Comment
	Predicted Noise Level		Predicted Noise Level		
	Do Minimum	Do Something	Do Minimum	Do Something	
	L_{den} (dB)	L_{den} (dB)	L_{den} (dB)	L_{den} (dB)	
D64-011	54	55	55	57	Meets design goal
D64-012	55	57	56	59	Meets design goal
D66-001	61	61	62	62	Same as do Minimum Value

The results of the assessment have indicated that along the length of the proposed road, development traffic noise levels at or below 60dB L_{den} can be achieved, and/or the Do-Something noise levels can be reduced to the equivalent Do-Minimum traffic noise levels at all of locations with the recommended mitigation measures in place.

There are three locations where the residual Do Something noise level is calculated to be above the Do-Minimum scenario and remains above 60dB $L_{den.}$ Modelled Location D51-001A represents the rear façade of the property facing towards the new M21 alignment. An increase of 1dB is calculated above the Do-Minimum scenario. A difference in traffic noise of this magnitude is negligible and not perceptible. A reduction in noise level of 8dB L_{den} will, however, be experienced to the front façade of the same property due to the reduction in traffic along the existing N21 road which will result in a perceptible reduction in traffic noise along this façade of the property.

Calculated noise levels at modelled locations C26-008 and D64-001 are less than 1dB above the Do Minimum value, when rounded. An increase of this magnitude above the Do-Minimum scenario is negligible and is not perceptible. Whist these exceedances are strictly above the design goal, the negligible difference is outside the level of perceptibility to the human ear such that no subjective difference would be experienced by further reducing traffic noise levels to 60dB $L_{den.}$

The 2004 TII noise guidance document notes the following with respect to achievement of the noise design goal:

> *"The Authority accepts that it may not always be sustainable to provide adequate mitigation in order to achieve the design goal. Therefore, a structured approach should* be *taken in order to ameliorate as far as practicable."*

The 2014 noise guidance document notes that:

> *"in some cases the attainment of the design goal may not be possible by sustainable means".*

This guidance document also notes that caution should be exercised specifying substantial screening where small benefits (<3dB) are only achieved, given a change of 3dB(A) is the smallest change that would give a reliable difference in public response. Specifically, the TII 2014 document goes on to note that:

> *"It may be unsustainable to increase barrier dimensions significantly where the result would be a reduction of 1dB or less, as such a reduction would be close to*

imperceptible in a laboratory situation, and would not result in a difference in public response in the real world environment."

In this instance, the extent of screening deemed feasible to achieve the target design goal at the relevant properties has been assessed, taking into account a level of proportionality with respect to changes in noise levels.

Reduction in Traffic Along Existing Road Network

The proposed road will result in a reduction in traffic volumes along the existing road network, due to traffic being diverted onto the proposed road development. The modelled locations within the study area of the operational noise model has indicated that of the 467 locations assessed, 30% (143 noise sensitive locations) will experience either a reduction or no change as a result of the proposed road development.

It is possible to determine the approximate change in noise levels between the Do Minimum and Do Something scenarios using the traffic volumes calculated for the wider road network outside those assessed within the noise model using the same formulae included in Section 12.2.2.2. Based on information supplied by the traffic engineers for the wider road network, the greatest reduction in traffic volumes will be experienced along sections of the N69 between Foynes and Limerick and along the N21 between Rathkeale and Adare.

Between Foynes and Askeaton, an approximate reduction in traffic noise levels of 7dB(A) is calculated. There are approximately 52 residential properties within 50m of this section of this road in addition to those within the towns. A positive impact will therefore be experienced at these properties and those at further distances back from the road edge. Sections of the N69 between Askeaton and the M7 west of Limerick are calculated to experience a reduction in traffic noise between 1 and 3dB(A). A minor positive impact will be experienced at noise sensitive properties along these roads. There are approximately 153 noise sensitive properties located within 50m of this section of road, in addition to those within the village and town centres along the route.

Along the N21 between Rathkeale and Adare, a significant portion of existing traffic will divert onto the proposed road development. Noise level reductions in traffic noise between 10 and 13dB are calculated as a result of traffic reductions along this road, resulting in a major positive impact. There are approximately 72 properties along this section of road between Rathkeale and Adare. Noise sensitive properties within both town centres will also experience a similar reduction in traffic noise levels.

Properties along these routes are currently exposed to significantly higher noise levels from passing road traffic compared to those along the proposed road development and opportunities for noise mitigation are minimal along the existing roads. The re-direction of traffic onto the proposed road with the incorporation of noise mitigation measures will aid in addressing noise "hot spot" areas identified within the Limerick Noise Action Plan along the existing sections of the N69 and N21 noted above.

12.7 Difficulties Encountered

There were no difficulties encountered when carrying out this assessment.

12.8 References

BS 5228-1: 2009 +A1 2014: Code of Practice for noise and vibration control of construction and open sites - Part 1: Noise.

BS 5228-1: 2009+A1 2014: Code of Practice for noise and vibration control of construction and open sites - Part 2: Vibration.

BS 6472-2: 2008 - Guide to evaluation of human exposure to vibration in buildings - Part 2: Blast Induced Vibration.

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EC Directive 210/75/EU of 24 November2010 on Industrial emissions (integrated pollution prevention and control)

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TII. (2004) Guidelines for the Treatment of Noise and Vibration in National Road Schemes

TII. (2014) Good Practice Guidance for the Treatment of Noise during the Planning of National Road Schemes.

UK`s Department of Transport. (1988) Calculation of Road Traffic Noise (CRTN).

WHO Night Noise Guidelines for Europe (NNG 2009)