11.0 NOISE & VIBRATION

11.1 ASSESSMENT METHODOLOGY

The methodology adopted for this noise and vibration assessment is as follows:

- characterisation of the receiving environment;
- characterisation of the proposed development;
- prediction of the noise impact associated with the proposed development;
- evaluation of noise and vibration impacts;
- specification and evaluation of mitigation measures (where required).

11.2 NOISE

11.2.1 Receiving Environment

Environmental Noise Survey

A series of environmental noise surveys were conducted in order to quantify the existing noise environment. The surveys were conducted in general accordance with ISO 1996: 1982: Acoustics – Description and measurement of environmental noise. Specific details are set out below.

Choice of Measurement Locations

Eleven measurement locations were selected to obtain a measure of the existing noise climate in the vicinity of the closest neighbouring dwellings to the proposed development.

These locations were identified through the following process:

- Review of the proposed route and identification of closest residential properties to the proposed development.
- Identification of significant existing noise sources in the area that influence the existing noise environment.
- Identification of open areas of land where development has been approved in the vicinity of the proposed route.

Each is described in turn in Table 11.1 and shown in Appendix 11.C.

Table 11.1 Details of Noise Survey Locations

Location	Description of Survey Location
S01	Located at the gable end of 8 Cairnwood Green some 45m from the edge of the proposed line.
S02	On open lands to the rear of 17 Belgard Green. The proposed line is some 40m from the rear façade of this location.
S03	Front façade of houses along Fettercairn Road, opposite Youth Horse Project building. This location is some 65m from the proposed line.
S04	On open lands to the rear of houses 1 to 5 on Kilmartin Crescent. This location is some 25m from the proposed line.
S05	On open lands to the rear of 38 Kilmartin Drive. This location is some 20m from the proposed line.
S06	On open lands to the rear of 37 Brookview Court. This location is some 15m from the proposed line.
S07	On open lands to rear of 14 Brookview Walk. This location is some 30m from the proposed line.
S08	Land to rear of houses at 39 Ard Mor Green. This location is some 30m from the proposed line.
S09	Land north of Fortunestown Lane opposite proposed residential and shopping developments. This location is some 15m from the proposed line.
S10	Land north of Fortunestown Lane opposite Carrigmore Downs. This location is some 20m from the proposed line.
S11	Land north of Fortunestown Lane close to proposed Saggart Stop. This location is some 5m from the proposed line.

Survey Periods

Noise measurements were conducted at Locations S01 to S11 over the course of two survey periods as follows:

Daytime 12:59 to 15:47 on 09 February 2006;
13:25 to 18:21 on 28 February 2006;
20:20 to 00:05 on 28 Feb / 01 March 2006.
Night time 00:00 to 02:15 on 02 November 2006.

The measurements cover a period that was selected in order to provide a typical snapshot of the existing noise climate.

The weather during the daytime survey period was dry, around 3 - 7°C with a light breeze and occasionally gusting moderate breeze. Weather during the night survey period was dry, around 1-3°C and calm.

Personnel and Instrumentation

AWN performed the measurements during the survey periods.

The noise measurements were performed using a Brüel & Kjær Type 2260 Precision Sound Level Analyser. Before and after the survey the measurement apparatus was check calibrated using a Brüel & Kjær Type 4231 Sound Level Calibrator.

Procedure

Measurements were conducted at Locations S01 to S11 on a cyclical basis. Sample periods for the noise measurements were nominally 15 minutes during both the daytime and evening periods. 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.

Results and Discussion

The survey results are summarised in Table 11.A.1 in Appendix 11.A.

The following semantic scale shows noise (sound) levels for typical everyday sources and recognised noise criteria. Noise levels stated in the table have been derived from the AWN database of common noise levels and noise criteria.

Table 11.2 Typical Noise Levels

Noise Level (dBA)	Example
130	Threshold of pain.
120	Jet aircraft take-off at 100 metres.
110	Chainsaw at 1 metre.
100	Inside disco - general level.
90	Heavy lorries at 5 metres. Shout at 1 metre.
80	Kerbside of busy street.
70	Loud radio (in typical domestic room). Car at 7.5 metres.
60	Office or restaurant - general level. Normal conversation at 1 metre.
50-55	WHO guideline values (external day) - at sound levels lower than these values moderate/serious annoyance can be assumed to be negligible.
50	Domestic fan heater at 1 metre. Background noise - urban, night.
45	WHO Guideline value (external night) - at sound levels lower than this value sleep disturbance can be assumed to be negligible (windows open).
40	Living room - typical, day.
30	Theatre. Whisper at 1 metre.
25-35	Background noise - typical, rural, night.
10	Sound insulated test chamber.
0	Threshold of hearing.

Table 11.3 summaries the average noise levels measured at the various noise monitoring locations given in Table 11.1.

Table 11.3 Summary of Monitored Baseline Noise Levels

Location	Period	Measured Noise Levels (dB re. 2x10-5 Pa)		Comment
		L_{Aeq}	L_{A90}	
S01	Day Night	63 61	56 51	Traffic on Cookstown Road. Distant train and traffic movements.
S02	Day Night	53 53	50 49	Local and distant traffic movements. Distant train and traffic movements.
S03	Day Night	67 59	50 50	Traffic movements on Fettercairn Road. Distant construction and aircraft.
S04	Day Night	53 51	47 46	Distant quarry, traffic and aircraft noise.
S05	Day Night	53 47	48 44	Distant quarry, traffic and aircraft noise.
S06	Day Night	56 48	49 44	Distant quarry, traffic and aircraft noise.
S07	Day Night	52 47	50 45	Distant traffic and construction noise. Quarry audible during night time period.
S08	Day Night	54 45	51 43	Distant traffic noise and distant aircraft movements.
S09	Day Night	56 54	52 50	Distant N7 traffic noise and local traffic. Construction noise during daytime period.
S10	Day Night	60 52	53 48	Distant N7 traffic noise and local traffic. Construction noise during daytime period.
S11	Day Night	60 57	53 48	Distant N7 traffic noise and local traffic. Construction noise during daytime period.

Luas Noise Measurements

A number of noise measurements were made in the vicinity of the existing Luas system. The results of these noise measurements are outlined in Table 11.A2 in Appendix 11.A.

This survey work was conducted on 2 March 2006. Noise measurements in the vicinity of a Luas stop (i.e. arrivals and departures) were carried out in the vicinity of Belgard stop. Luas movements along the line were carried out at reference distances along the existing Red Line between Belgard and Cookstown stops. Noise level measurements were carried out at these locations as Luas movements were typically the dominant source and noise measurements were not affected by other noise sources (e.g. road traffic). Measurements have be normalised to a distance of 12.5m from track edge as this is the reference calculation distance stated in the Calculation of Rail Traffic Noise (CRN) standard used as part of this assessment.

Noise levels are presented in terms of Sound Exposure Levels. For information purposes an associated LAeq level associated with the event in question, assuming 12 Luas movements in a one hour period, is also presented.

Table 11.4 summaries the measured noise levels.

Table 11.4 Typical Luas Noise Levels

Notes	SEL (dB)	LAeq (dB)
Luas arrival at stop	77 - 80	52 - 56
Luas departure from stop	77 - 80	52 - 56
Luas movement 150m from stop – arrival (~30kph)	87 - 88	62 - 63
Luas movement on straight full speed (~70kph)	82 - 90	57 - 65
Luas movement on corner (brakes)	84 - 87	59 - 62
Luas movement 150m from stop – departure under acceleration (~30kph)	88 - 90	64 - 66

Noise predictions have been based on the SEL's detailed in the above table.

11.2.2 Characteristics of the Proposed Development

Noise Criteria

Construction Phase

There is no published statutory guidance relating to the maximum permissible noise level that may be generated during the construction phase of a project. Local authorities normally control construction activities by imposing limits on the hours of operation and consider noise limits at their discretion.

In the absence of specific noise limits appropriate criteria relating to permissible construction noise levels for a development of this scale may be found in the National Roads Authority (NRA) publication *'Guidelines for the Treatment of Noise and Vibration in National Road Schemes'*, which indicates the following criteria and hours of operation. The majority of the construction activity in relation to the proposed development is expected to occur during normal working hours.

Table 11.5 indicates the maximum permissible noise levels at the facade of nearest dwellings during the construction period as recommended by the NRA.

Table 11.5 Maximum Permissible Noise Levels at the Facade of Dwellings During Construction

Days and Times	Noise Levels (dB re. 2x10-5 Pa)	
	$L_{Aeq(1hr)}$	L_{Amax}
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 relevant local authority.

Operational Phase

Due consideration must be given to the nature of the primary noise sources when setting criteria. Criteria for assessing noise impacts from rail line operations have been derived from *The Noise Insulation (Railways and Other Guided Transport Systems)* Regulations 1996. This document outlines the following criteria where mitigation measures should be considered in relation to the operation of new or altered rail lines.

Daytime (06:00 to 00:00hrs) 68dB(A) $L_{Aeq,18hrs}$;

Night Time (00:00 to 06:00hrs) 63dB(A) $L_{Aeq,6hrs}$.

These criteria relate to specific noise from the proposed Luas Line A1.

Given the scale and nature of the development under consideration, it was also deemed appropriate to apply significance criteria through consideration of predicted changes in noise level due to the proposed development. This was done by calculating the change in L_{Aeq} and categorising the significance as follows:

Table 11.6 Changes in Noise Level – Significance Criteria

Change in Sound Level (dB)	Subjective Reaction	Significance Level
< 3	Inaudible	Imperceptible
4 – 5	Perceptible	Slight
6 – 10	Up to a doubling of loudness	Moderate
11-15 >16	Over a doubling of loudness	Significant Profound

Source: Based on a number of noise documents including EPA Guidelines, BS4142 and PPG24

11.2.3 Construction Impacts and Mitigation

Construction Impacts

It is envisaged that the construction phase of the development will be 28 to 30 months in duration. Section 3.3 outlines the various stages of the construction programme. In general the construction phase involves the following stages:

- Site preparation;
- Establishing site office, compounds and security;
- Utilities diversions;
- Installation of the trackbeds and rails;
- Installation of electrical and operating equipment;
- Development of stops and associated equipment;
- Finishing to surfaces and soft landscaping.

It is predicted that the construction programme will create typical construction related noise all along the line of the proposed route. During the construction phase of the proposed development, a variety of items of plant will be in use, such as excavators, lifting equipment, dumper trucks, compressors and generators. A haul road is proposed to run between the Cookstown Roundabout and the N82 (Citywest Road). This road will run parallel to and north of the proposed Luas alignment where possible.

Construction noise prediction calculations have been prepared in order to establish typical maximum noise levels at sensitive receptors in the immediate vicinity of the proposed development.

Table 11.7 lists typical items of plant that may be used as part of the construction programme along with associated sound power levels taken from BS5228.

Table 11.7 Source Noise Level Data for Construction Plant

Plant Item		Lw dB(A)re. 10^{-12}W	BS5228 Ref.
Typical Sources	Dozer	111	Pt. 1, Table C3: 65
	Dump Truck	102	Pt. 1, Table C9: 19
	Asphalt Spreader	101	Pt. 1, Table C8: 24
	Roller	101	Pt. 1, Table C8: 30

Table 11.8 summarises the predicted maximum expected noise levels at the stated distances back from construction works on the Luas mainline.

Table 11.8 Maximum Expected Values for Construction Noise Levels in the Vicinity of Mainline Construction Activities

Details	Plant Item	Highest predicted noise level at stated distance (m) from edge of works (dB $L_{Aeq(1hr)}$)				
		20	40	60	80	100
Typical Sources	Dozer	68	64	62	59	58
	Dump Truck	60	55	52	50	48
	Asphalt Spreader	59	55	52	49	48
	Roller	58	54	51	49	47
With basic mitigation in the form of exhaust silencers and a site hoarding	Dozer	58	54	52	49	48
	Dump Truck	50	45	42	40	38
	Asphalt Spreader	54	50	47	42	43
	Roller	48	44	41	39	37

Noise sensitive locations along a large extent of the route are a sufficient distance from the proposed development; standard construction mitigation measures will attenuate noise levels to an extent where the associated noise Impacts will not be significant.

It should be noted that the predicted noise levels referred to in this section are indicative only and are intended for comparison with the construction noise criteria. It should also be noted that the predicted maximum levels expected to occur for only short periods of time at a very limited number of properties. Construction noise levels will generally be lower than these levels for the majority of the time at the majority of properties in the vicinity of the proposed development, although greater levels may also occur. It is anticipated that these activities will not be excessively intrusive.

The impact on the noise environment due to construction activities will be transient (i.e. short term) in nature and mitigation measures will be implemented to minimise the impact of construction activities on the noise environment.

Construction Mitigation Measures

In instances where proposed construction works are in close proximity to noise sensitive locations (e.g. along sections of Fortunestown Lane) reference will be made to BS5228: *Noise control on construction and open sites*, which offers detailed guidance on the control of noise and vibration from construction activities. In particular, it is proposed that various practices be adopted during construction where appropriate, including:

- Application of construction noise limits and limiting the hours during which site activities likely to create high levels of noise or vibration are permitted;
- Establishing channels of communication between the contractor, developer, Local Authority and residents;
- Appointing a site representative responsible for matters relating to noise;
- Monitoring typical levels of noise during critical periods and at sensitive locations.

Furthermore, it is envisaged that a variety of practicable noise control measures will be employed. These may include:

- Selection of plant with low inherent potential for generation of noise;
- Erection of barriers as necessary around items such as generators or high duty compressors;
- Locating noisy plant as far away from sensitive properties as permitted by site constraints;
- All site access roads will be kept even so as to mitigate the potential for vibration from lorrys.

Where it is anticipated that construction noise levels may exceed the limits, or activities may occur outside the periods for which the any such limits have been recommended, the contractor will be obliged to present clear justification and details of mitigation measures proposed.

Where night time works are required, the contractor will be obliged to notify local residents likely to be affected of the nature, duration and extent of the works.

11.2.4 Operational Impacts and Mitigation

Operational Impacts

There are three primary sources of noise in the operational context of the proposed development.

- Luas Activities;
- Car Park Activities;
- Changes in traffic flows on local road network.

Each of these primary noise sources is addressed in turn.

Luas Activities

The noise predictions have been carried out using a noise prediction template implementing calculation routines based on the Calculation of Railway Noise (CRN) procedure. See Appendix 11.B for further details on this procedure. The source noise levels were based on measurements taken on equivalent sections of existing Luas lines.

Noise levels are predicted at the upper floor level of receiver locations during night time periods and ground floor levels during daytime periods. The assessment locations typically correspond to the noise monitoring location (e.g. A01 is the closest residential façade to the monitoring location S01) unless where otherwise stated.

The 'existing ambient noise level' at each location is detailed in the table along with the predicted 'specific' noise level associated with the proposed Luas system. This specific noise level is then compared to the adopted day and night time criteria.

Predictions have been carried out to the following fifteen locations which are representative of noise sensitive buildings along the proposed route. Appendix 11.C details the approximate position of the assessment locations.

Table 11.9 Assessment Locations

Location	Description	Closest Noise Monitoring Location
A01	No. 8 Cairnwood Green.	S01
A02	No. 17 Belgard Green.	S02
A03	No. 28 Fettercairn Road.	S03
A04	No. 5 Kilmartin Crescent.	S04
A05	No. 40 Kilmartin Drive.	S05
A06	No. 39 Brookview Court.	S06
A07	No. 14 Brookview Walk.	S07
A08	No. 22 Ard Mor Close.	S08
A09	Residential Block North West of Ard Mor Green.	S08
A10	Place Property Housing Development.	S09
A11	Proposed Residential adjacent Citywest Shopping Centre.	S09
A12	Carrigmore Downs.	S10
A13	Residential Development North of Carrigmore Downs.	S10
A14	Residential Development North of Carrigmore Downs.	S10
A15	Retail and Residential development opposite Saggart stop.	S11

Table 11.10 Comparison of Predicted Levels with Relevant Criteria

Location	Period	Existing Ambient Noise Level dB L_{Aeq}	Predicted Specific Luas Noise Level dB L_{Aeq}	Relevant Criterion dB L_{Aeq}	Excess dB	Compiles
A01	Day	63	54	68	-14	Yes
	Night	61	45	63	-18	Yes
A02	Day	53	54	68	-14	Yes
	Night	53	45	63	-18	Yes
A03	Day	67	52	68	-16	Yes
	Night	59	43	63	-20	Yes
A04	Day	53	55	68	-13	Yes
	Night	51	46	63	-17	Yes
A05	Day	53	55	68	-13	Yes
	Night	47	46	63	-17	Yes
A06	Day	56	53	68	-15	Yes
	Night	48	44	63	-19	Yes
A07	Day	52	56	68	-12	Yes
	Night	47	47	63	-16	Yes
A08	Day	54	59	68	-9	Yes
	Night	45	50	63	-13	Yes
A09	Day	54	58	68	-10	Yes
	Night	45	49	63	-14	Yes
A10	Day	56	60	68	-8	Yes
	Night	54	51	63	-12	Yes
A11	Day	56	56	68	-12	Yes
	Night	54	47	63	-16	Yes
A12	Day	60	56	68	-12	Yes
	Night	52	47	63	-16	Yes
A13	Day	60	67	68	-1	Yes
	Night	52	57	63	-6	Yes
A14	Day	60	64	68	-4	Yes
	Night	52	54	63	-9	Yes
A15	Day	60	55	68	-13	Yes
	Night	57	46	63	-17	Yes

Predicted noise levels at all locations assessed satisfy the adopted criterion of 68dB $L_{Aeq,18hrs}$ for daytime periods and 63dB $L_{Aeq,6hrs}$ for night time periods. It should be noted that for the majority of situations assessed the predicted levels are an order of magnitude below the adopted criteria.

For the next stage of the assessment predicted noise levels associated with the Luas are compared against existing noise levels measured in the area. A cumulative noise level is derived by the addition of the existing noise level and predicted specific noise level associated with the development. This cumulative level is then compared against the existing ambient noise level.

The increase in noise level is compared against the criteria outlined in Table 11.5 in order to assign an associated significance level.

Table 11.11 Cumulative Noise Levels and Associated Significance Rating

Location	Period	Existing Ambient Noise Level dB L_{Aeq}	Predicted Specific Luas Noise Level dB L_{Aeq}[2]	Cumulative Level dB L_{Aeq}	Increase dB	Significance Level
A01	Day	63	51	63	0	Imperceptible
	Night	61	42	61	0	Imperceptible
A02	Day	53	52	56	3	Imperceptible
	Night	53	43	53	0	Imperceptible
A03	Day	67	49	67	0	Imperceptible
	Night	59	40	59	0	Imperceptible
A04	Day	53	52	56	3	Imperceptible
	Night	51	43	52	1	Imperceptible
A05	Day	53	52	56	3	Imperceptible
	Night	47	43	48	1	Imperceptible
A06	Day	56	50	57	1	Imperceptible
	Night	48	41	49	1	Imperceptible
A07	Day	52	54	56	4	Slight
	Night	47	45	49	2	Imperceptible
A08	Day	54	56	58	4	Slight
	Night	45	47	49	4	Slight
A09	Day	54	55	58	4	Slight
	Night	45	46	49	4	Slight
A10	Day	56	58	60	4	Slight
	Night	54	49	55	1	Imperceptible
A11	Day	56	54	58	2	Imperceptible
	Night	54	45	55	1	Imperceptible
A12	Day	60	54	61	1	Imperceptible
	Night	52	45	53	1	Imperceptible
A13	Day	60	65	66	6	Moderate
	Night	52	55	57	5	Slight
A14	Day	60	61	64	4	Slight
	Night	52	52	55	3	Imperceptible
A15	Day	60	52	61	1	Imperceptible
	Night	57	43	57	0	Imperceptible

2. Note the predicted specific noise levels presented in this instance are free field values in order to compare them directly with the free field survey measurements.

Predictions indicate that the operation of the proposed development will have an imperceptible impact in terms of ambient noise along the majority of the proposed route. The predicted noise increases are imperceptible or slight in all cases with the exception of location A13 during daytime periods where the predicted impact is moderate. Notwithstanding this, given the nature of the environment under consideration (i.e. urban area where the dominant noise source is related to existing infrastructure) this change in noise level would not be considered excessive and the resultant noise level would not be considered to be out of character for the area in question.

It should be noted that a number of infrastructural developments are planned for construction in the vicinity of the development in the upcoming years. These include the development of the Embankment Road and the extension of the Outer Ring Road Phase 3 from the N7 to the N82.

The Embankment Road development will run north of the proposed Luas Line A1 from the existing Luas line at Cookstown to the junction of the proposed road at Cheeverstown with the planned Outer Ring Road Phase 3. The development of these items of infrastructure will result in a change in the day and night time noise environments at nearby noise sensitive locations (i.e. A01 to A06). It would be expected that in the majority of these instances the predicted relative increases in cumulative noise levels would decrease.

The L_{Aeq} parameter is commonly used to assess annoyance and this is the parameter adopted in this instance. Sleep disturbance during night time periods is commonly assessed using the L_{Amax} parameter.

Along the majority of the proposed line LAmax levels will be sufficiently attenuated by distance between the line and noise sensitive locations. In areas where the line is in close proximity to residential units the magnitude of LAmax noise levels from proposed Luas operations would be expected to be comparable to other noise sources in the area (e.g. local traffic movements, aircraft movement in the area). Furthermore it should be noted that Luas movements will be significantly reduced during night time periods.

Car Park Activities

As part of the proposals a Park and Ride facility is planned for the vicinity of the Cheeverstown Stop.

Typical noise levels 10m beyond the boundary of a busy car park during peak periods are of the order of 48dB $L_{Aeq,1hr}$.

The closest noise sensitive locations to the proposed Park and Ride facility are located in the Brookview Estate. The relevant noise monitoring location in this instance is S06.

Allowing for the additional distance from the Park and Ride facility to the nearest noise sensitive locations in the Brookview Estate, the noise level due to car parking activity is 44dB $L_{Aeq,1hr}$. This is some 12dB below the existing ambient noise levels of 56dB L_{Aeq} monitored in the vicinity (i.e. S06). It is not envisaged that a significant amount of activity will occur in the car park during the night-time periods.

In summary, the likely noise impact of car park activity on the local environment is not significant and mitigation measures in the form of boundary walls need not be considered in this instance in terms of noise.

Change in Traffic Flows on Local Road Network

Information from the Traffic Impact Assessment (TIA) prepared by Scott Wilson has been used to determine the predicted change in noise levels in the vicinity of a number of roads and junctions in the area surrounding the proposed development.

When considering traffic noise, the acoustical parameters considered here is the $L_{A10(1hour)}$ expressed in terms of decibels (dB) relative to 2x10-5Pa. The value of $L_{A10(1hour)}$ is the noise level exceeded for just 10% of the time over the period of one hour. $L_{A10(1hour)}$ is a parameter typically used in Ireland for the purposes of describing traffic noise.

Traffic volumes with and without the proposed development for the Year 2015 are detailed in Table 11.12. The predicted increase in traffic noise levels is also presented.

Table 11.12 Summary of AADT traffic flows Year 2015 and calculated relative change in traffic noise levels

Junction Arm	2015 No Luas		2015 With Luas		Change in Noise Level dB
	AADT*	% HGV**	AADT	% HGV	
Garter Lane (N)	5,830	5	5,811	10	1.9
F'town Lane	8,429	4	7,601	5	0.2
Garter Lane (S)	12,272	4	11,923	8	1.2
F'town Lane (W)	8,429	4	7,601	5	0.2
F'town Lane (E)	6,338	0	6,774	1	0.8
Carrigmore Ave	3,022	1	2,777	1	-0.3
Future Distributor Rd	4,598	7	3,102	11	-0.3
F'town Lane (W)	6,338	0	6,774	1	0.8
Citywest Rd (N)	16,949	2	15,061	2	-0.5
F'town Lane (E)	17,826	0	19,187	0	0.5
Citywest Rd (S)	16,422	2	14,994	2	-0.4
Citywest Ave (W)	16,441	2	16,864	3	0.3
Kingswood Rd	13,572	1	13,320	2	0.3
Embankment Rd	21,988	2	20,621	2	0.1
Cheeverstown P&R	1,232	0	1,404	0	0.5
Embankment Rd (W)	21,988	2	20,621	2	0.1
Outer Ring Rd (N)	12,340	2	12,174	2	0.0
Embankment Rd (E)	11,800	3	11,616	4	0.4
Outer Ring Rd (S)	18,795	1	18,084	1	0.0
Embankment Rd (W)	11,800	3	11,616	4	0.4
Cookstown Rd (N)	4,450	16	3,929	18	-0.2
Embankment Rd (E)	8,637	6	9,244	5	-0.1
Cookstown Way	6,167	3	6,032	2	-0.6
Cookstown Rd (S)	7,681	9	7,803	8	-0.3\

* *AADT – Average Annual Daily Traffic*
** *%HGV – Percentage Heavy Goods Vehicles*

In summary, the highest predicted increase in noise levels due to additional vehicular traffic due to the proposed development is less than 1.9dB. Reference to Table 11.6 confirms that such an increase is imperceptible and the associated noise impact is not significant.

Operational Mitigation Measures

Proposed trams will be required to incorporate noise control measures in the design to comply with noise performance specifications and track and tram wheels will be maintained in good order.

In order to reduce the risk of additional noise when light rail vehicles are moving around tight curves, anti wear and anti squeal measures will be applied to the rails.

11.3 VIBRATION

11.3.1 Receiving Environment

Vibration Survey

Vibration monitoring has been carried out at Locations S01 to S11 (see Table 11.1) to give an indication of the existing vibration levels in the vicinity of the proposed Luas Line A1 prior to any development.

Further vibration monitoring has been carried out close to an existing stretch of the proposed Luas Line A1 in the vicinity of the Belgard and Cookstown stations at sixteen locations.

Specific details of the vibration monitoring are set out in the following sections.

Personnel and Instrumentation

AWN conducted the vibration surveys.

The vibration measurements were conducted using an Instantel Blastmate Type III Vibration Analyser with attached tri-axial geophone. This unit performs the measurement of vibration velocity in the three orthogonal axes (vertical, longitudinal and transverse). The unit stores the greatest peak particle velocity (ppv) measured in each axis during each measurement period. The period selected here was 1 minute. As well as storing the greatest peak particle velocity during each measurement period, the unit also stores the frequency (in Hertz) at which the greatest velocity occurred.

Existing Vibration Levels along Proposed Route

Table 11.13 reviews the results of the vibration monitoring carried out along the proposed Luas route at Locations S01 to S11. Full details of the baseline vibration monitoring carried out at these locations are presented in Appendix 11.D.

Table 11.13 Maximum Levels Monitored in Frequency Bands

Frequency of vibration	Tran PPV (mm/s)	Vert PPV (mm/s)	Long PPV (mm/s)
Less than 10Hz	Not Significant	Not Significant	Not Significant
10 to 50Hz	0.64	0.89	0.64
50 to 100Hz (and above)	0.38	0.25	0.25

While a number of infrastructural developments are proposed in the area in the upcoming years (e.g. Outer Ring Road, Embankment Road) the results presented in Table 11.14 are considered representative of existing levels of vibration in the vicinity of sensitive locations close to the proposed development and include contributions from typically quarrying operations in the area.

The results measured during the baseline survey are typical of those expected for an urban area. No significant levels of vibration were monitored during the survey period.

Vibration Measurements in the Vicinity of Luas

Measurements have been undertaken at various distances from Luas trams along existing sections of the line between Belgard and Cookstown stations. Full measurement results are presented in Appendix 11.E and in summary form below.

Table 11.14 Maximum Levels Monitored in Frequency Bands – Luas Line

Frequency of Vibration	Distance from Line (m)	Tran PPV (mm/s)	Vert PPV (mm/s)	Long PPV (mm/s)
Less than 10Hz	<6	Not Significant	Not Significant	Not Significant
	6 – 20	Not Significant	Not Significant	Not Significant
	20 – 24	Not Significant	Not Significant	Not Significant
10 to 50Hz	<6	Not Significant	Not Significant	Not Significant
	6 – 20	Not Significant	Not Significant	Not Significant
	20 – 24	Not Significant	Not Significant	Not Significant
50 to 100Hz (and above)	<6	0.89	1.90	1.52
	6 – 20	0.51	0.51	0.64
	20 – 24	0.13	0.13	0.13

11.3.2 Characteristics Of The Proposed Development

Vibration Guidelines

Construction Phase

Vibration standards come in two varieties: those dealing with human comfort and those dealing with cosmetic or structural damage to buildings. Cosmetic damage includes the formation of hairline cracks on plaster surfaces or hairline cracks in mortar joints. Structural damage includes the formation of cracks in support columns, loosening of joints or splaying of masonry cracks. In both instances, it is appropriate to consider the magnitude of vibration in terms of Peak Particle Velocity (PPV).

It is acknowledged that humans are particularly sensitive to vibration stimuli and that any perception of vibration may lead to concern. In the case of road traffic, vibration is perceptible at approximately 0.5mm/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 duration. For example, excavation and piling, two of the primary sources of vibration during construction activities, are typically tolerated at vibration levels up to 12mm/s and 5mm/s respectively. This guidance is applicable to the daytime only; it is unreasonable to expect people to be tolerant of such activities during night-time.

Guidance relevant to acceptable vibration within buildings is contained in the following documents:

- British Standard BS 7385 (1993): *Evaluation and measurement for vibration in buildings Part 2: Guide to damage levels from ground borne vibration, and;*
- British Standard BS 5228 (1992): *Noise control on construction and open sites Part 4 Code of practice for noise and vibration control during piling.*

Vibration from construction activities will be limited to the values set out in Table 11.15 below.

Table 11.15 Allowable Vibration During Construction Phase

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)
8 mm/s	12.5 mm/s	20 mm/s

Source: BS7385 Part 2 and BS5228 Part 4.

Measures shall be taken to minimise vibration due to plant and machinery on the site.

Operational Phase

BS6472 (1992) Guide to Evaluation of Exposure to Vibration in Buildings (1Hz to 80Hz) outlines a method where vibration dose values (eVDV) can be calculated in relation to a series of events and compared against a table which indicates probability of adverse comment in relation to the events. Table 11.16 details the values of eVDV where various comments from occupiers are possible.

Table 11.16 Vibration Dose Values ($M/S^{1.75}$) above which Various Degrees of Adverse Comment may be Expected in Residential Buildings.

Place	Low Probability of Adverse Comment	Adverse Comment Possible	Adverse Comment Probable
Residential Buildings – Day	0.2 to 0.4	0.4 to 0.8	0.8 to 1.6
Residential Buildings – Night	0.13	0.26	0.51

11.3.3 Construction Impacts and Mitigation

Construction Impacts

The construction phase of the programme is outlined previously in section 11.4.1.

It is not envisaged that vibration associated with construction works will be a significant issue at the vast majority of sensitive receptors in the vicinity of the proposed development due to the distance between these properties and the proposed route.

A number of properties along Fortunestown Lane are the closest sensitive properties to the proposed works. The potential for vibration at neighbouring sensitive locations during construction is typically limited to excavation works and lorry movements on uneven road surfaces. However, there is little likelihood of structural or even cosmetic damage to existing neighbouring dwellings.

The impact on the vibration environment due to construction activities will be transient (i.e. short term) in nature and mitigation measures will be implemented to minimise the impact of construction activities on the vibration environment.

Construction Mitigation Measures

In particular, it is proposed that various practices be adopted during construction where appropriate, including:

- Application of construction vibration limits and limiting the hours during which site activities likely to create high levels of vibration are permitted.;
- Establishing channels of communication between the contractor, developer, Local Authority and residents;
- Appointing a site representative responsible for matters relating to vibration;
- Monitoring typical levels of vibration during critical periods and at sensitive locations.

Furthermore, it is envisaged that a variety of practicable vibration control measures will be employed. These may include:

- Selection of plant with low inherent potential for generation of vibration;
- Location of vibratory plant as far away from sensitive properties as permitted by site constraints and the use of vibration isolated support structures where necessary;
- All site access roads will be kept even so as to mitigate the potential for vibration from lorrys.

11.3.4 Operational Impacts and Mitigation

Operational Impacts

Vibration measurements were conducted at various points along the proposed route and at various locations in the vicinity of existing sections of Luas line. The results of this monitoring programme are detailed in the relevant sections and appendices of this chapter.

Table 11.14 reviews the vibration levels measured in the vicinity of existing sections of Luas line. Measurements were carried out a various distances from the existing line (i.e. 2 to 24m from edge).

The propagation of vibration from the alignment via the ground will depend on a number of factors such as local ground conditions and distance to the sensitive receptor. Vibration measurements carried out in the vicinity of similar lines shows that significant perceptible ground vibration is unlikely at properties beyond 5m from the track. When a Luas tram is passing a location the perception of the event is likely to be dominated by the noise level rather than by ground vibration. Furthermore it should be noted that the levels of vibration measured in the vicinity of the operating Luas line are of a similar order of magnitude to those measured as part of the baseline vibration measurements carried out along the proposed route.

The estimated VDV levels of ground vibration are not expected to exceed the 0.4 m/s1.75 daytime or 0.13 m/s1.75 night time assessment criteria beyond approximately 5m from the tracks. Existing receptors are further from the tracks than this.

The measured levels of ground vibration are significantly below criteria which relate to the structural integrity of buildings. Operation of the proposed scheme is not expected to give rise to vibration that is either significantly intrusive or capable of giving rise to structural or even cosmetic damage.

Operational Mitigation Measures

To reduce vibration transmission from the interaction of wheels on tacks to the ground through to sensitive areas (i.e. to nearest dwellings along Fortunestown Lane), vibration isolation techniques will be incorporated into the track and track-bed design.