Chapter 14
Noise and Vibration

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14. NOISE & VIBRATION

14.1 Introduction

This chapter of the Environmental Impact Assessment Report (EIAR) assesses the impact of the DART+ West (hereafter referred to as the proposed development), on Airborne Noise and Vibration during the construction phase and operational phase.

This chapter should be read in conjunction with the following Chapters, and their appendices (where applicable), which present related impacts arising from the proposed development and proposed mitigation measures to ameliorate the predicted impacts:

- Chapter 6: Traffic and Transportation.
- Chapter 7: Population.
- Chapter 8: Biodiversity.
- Chapter 23: Human Health.

This EIAR chapter identifies, describes and assesses the likely direct and indirect significant impacts of the proposed development on Airborne Noise and Vibration. The assessment is based on a reasonable worst-case scenario with respect to potential Airborne Noise and Vibration arising from the proposed development as described in Chapter 4 to Chapter 5 in Volume 2 of this EIAR. The proposed development description is based on the design prepared to inform the planning stage of the project and to allow for a robust assessment as part of the Environmental Impact Assessment (EIA) process.

14.2 Legislation, policy and guidance

14.2.1 Legislation

Córas Iompair Éireann is applying to An Bord Pleanála for a Railway Order for the DART+ West project under the Transport (Railway Infrastructure) Act 2001 (as amended and substituted) ("the 2001 Act") and as recently further amended by the European Union (Railway Orders) (Environmental Impact Assessment) (Amendment) Regulations 2021 in Statutory Instrument No. 743/2021 ("the 2021 Regulations"). The purpose of the 2021 Regulations was to give further effect to the transposition of the EIA Directive (EU Directive 2011/92/EU as amended by Directive 2014/52/EU) on the assessment of the effects of certain public private projects on the environment by amending the 2001 Act. In accordance with the aforementioned legal requirements, this assessment describes and assesses the likely direct and indirect significant effects of the proposed development on Airborne Noise and Vibration.

14.2.2 Policy

The project extends over the administrative areas of four local authorities, namely Dublin City Council, Fingal County Council, Meath County Council and Kildare County Council. The following noise action prepared by the local authorities have been considered as part of this chapter:

- Dublin Local Authorities including Dublin City Council (DCC) and Fingal County Council (FCC). Dublin Agglomeration Third Environmental Noise Action Plan December 2018 – November 2023. (hereafter referred to as the Dublin Agglomeration NAP 2018 – 2023) (DCC; FCC; 2018).
- Kildare County Council (KCC) Third Noise Action Plan 2019 – 2023 (KCC 2019).
- Meath County Council (MCC) County Meath Noise Action Plan 2019 (MCC 2019).

14.2.3 Guidance

The assessment has been undertaken with reference to the most appropriate guidance documents relating to environmental noise and vibration which are set out in the following sections. In addition to specific noise and vibration guidance documents, the following guidelines were considered and consulted in the preparation of this chapter:

- Environmental Protection Agency (EPA) *Guidelines on the Information to be contained in Environmental Impact Assessment Reports* (hereafter referred to as the EPA Guidelines) (EPA 2022).
- Draft EPA *Advice Notes for Preparing Environmental Impact Statements* (hereafter referred to as the Draft EPA Advice 2015) (EPA 2015).

There are no statutory standards in Ireland relating to noise and vibration limit values for construction works or for environmental noise relating to the operational Phase. In the absence of specific statutory Irish guidelines, the assessment has made reference to non-statutory national guidelines, where available, in addition to international standards and guidelines relating to noise and / or vibration impact for environmental sources. These are summarised below:

- British Standard Institute (BSI) British Standard (BS) 5228 (2009 +A1 2014) Code of Practice for noise and vibration control of construction and open sites - Part 1: Noise (hereafter referred to as BS 5228 – 1 BSI 2009 +A1 2014a).
- BS 5228 (2009 +A1 2014) Code of Practice for noise and vibration control of construction and open sites - Part 2: Vibration (hereafter referred to as BS 5228 – 2) (BSI 2009 +A1 2014b).
- BS 7385 (1993) Evaluation and measurement for vibration in buildings Part 2: Guide to damage levels from ground borne vibration (hereafter referred to as BS 7385 – 2). (BSI 1993).
- BS 6472 (2008) Guide to Evaluation of human exposure to vibration in buildings, Part 1 Vibration sources other than blasting (hereafter referred to as BS 6472 – 1). (BSI 2008).
- BS 8233:2014 Sound Insulation and Noise Reduction for Buildings (hereafter referred to as BS 8233 (BSI 2014.
- BS 4142 (2014+A1 2019) Methods for rating and assessing industrial and commercial sound (hereafter referred to as BS 4142) (BSI 2014 +A1 2019).
- UK Highways Agency (UKHA) Design Manual for Roads and Bridges (DMRB) LA 111 Sustainability & Environmental Appraisal. Noise and Vibration Rev 2, (hereafter referred to as DMRB Noise and Vibration) (UKHA 2020).
- European Communities (EC) (Environmental Noise) Regulations 2018 (S.I. No. 549 / 2018).
- EC (Environmental Noise) Regulations 2006 (S.I. No. 140/2006).
- EC Noise Emission by Equipment for Use Outdoors (Amendment) Regulations (S.I. No. 241 / 2006).
- International Organization for Standardization (ISO) 9613-2:1996 Acoustics – Attenuation of sound during propagation outdoors - Part 2: General method of calculation (hereafter referred to as ISO 9613 – 2) (ISO 1996).
- ISO 1996-1:2016 Acoustics - Description, measurement and assessment of environmental noise. Part 1: Basic quantities and assessment procedures (hereafter referred to as ISO 1996 – 1) (ISO 2016).
- ISO 1996-2:2017 - Description, measurement and assessment of environmental noise - Part 2: Determination of sound pressure levels (hereafter referred to as ISO 1996 – 2) (ISO 2017).
- Transport Infrastructure Ireland (TII) Guidelines for the Treatment of Noise and Vibration in National Road Schemes, Revision 1 (hereafter referred to as the TII Noise Guidelines 2004) (TII 2004).
- Transport Infrastructure Ireland (TII) Code of engineering practice for works on, near, or adjacent the Luas light rail system (TII 2016).
- Good Practice Guide for the Treatment of Noise during the Planning of National Road Schemes (hereafter referred to as the TII Noise Guidelines 2014) (TII 2014).
- Reken- en Meetvoorschrift Railverkeerslawaai (RMR) ’96, Ministerie Volkshuisvesting, Ruimtelijke Ordening en Milieubeheer, 20 November 1996. (Calculation and Measurement requirements for rail

transport noise. Dutch Ministry Housing, Spatial Planning and the Environment) (Hereafter referred to as RMR) (Dutch Housing, Spatial Planning and the Environment 1996).
- The UK Department of Transport Calculation of Road Traffic Noise (hereafter referred to as CRTN) (UK Department of Transport 1998).
- World Health Organization (WHO) Environmental Noise Guidelines for the European Region (hereafter referred to as WHO Environmental Noise Guidelines) (WHO 2018).
- EN 16272-2: 2012 Railway Applications - Track - Noise Barriers and Related Devices Acting on Airborne Sound Propagation - Test Method for Determining the Acoustic Performance - Part 2: Intrinsic Characteristics - Airborne Sound Insulation in the Laboratory Under Diffuse Sound Field Conditions.

14.3 Methodology

14.3.1 Study Area

The proposed DART+ West project comprises the electrification of the Maynooth & M3 Parkway lines, with a total length of approximately 40 kilometres. The development is described from east to west from Dublin city centre (Connolly/Docklands) to the new depot located west of Maynooth and to M3 Parkway.

The proposed development has been divided into six zones (Zones A to F). Some of the proposed works are common to all sections of the proposed development and include:

- Overhead line electrification equipment (OHLE) will be required to provide electrical power to the network´s new electrified train fleet.
- Signalling upgrades and additional signalling.
- Improved boundary walls and fencing.
- Utility diversions, vegetation management and other ancillary works.

The six (6) zones are described in greater detail in Chapter 4 Description of the Proposed Development in Volume 2 of this EIAR. As a reference for this particular chapter the names of the sections are provided below:

- Zone A Loop Line Bridge to Phibsborough/Glasnevin (on GSWR line) and East Wall Junction (on Northern line).
- Zone B Spencer Dock Station to Glasnevin Junction.
- Zone C Glasnevin junction/ Phibsborough to Clonsilla Station/Junction.
- Zone D Clonsilla Station/Junction to M3 Parkway Station.
- Zone E Clonsilla Station/Junction to Maynooth Station.
- Zone F Maynooth Station to Depot.

The study area for the noise and vibration assessment is the area immediately adjacent to the red line of the development, nominally within a range of 50 to 100 m of the project boundary. Noise and vibration impacts are assessed to the closest sensitive locations to the proposed development.

14.3.2 Assessment methodology

In order to assess the noise impact associated with the proposed development, the following methodology has been adopted:

- Review of relevant standards and legislation and setting appropriate criteria for noise and vibration, see Section 14.5.
- Baseline noise and vibration surveys to be conducted along the length of the study area to determine the existing noise and vibration environment at the most sensitive properties along the length of the proposed development, see Section 14.4.

- Identification of key sources of noise and vibration issues relevant to the components of the proposed development.
- Noise and vibration impacts associated with new electrified fleet (DART) between Dublin and Maynooth and the M3 Parkway rail lines will be assessed in accordance with best practice, see Section 14.5.4.6.
- An assessment of the noise impacts associated with the construction of a new rail depot will be assessed, see Section 14.5.4.6.8.
- An assessment of the noise impact associated with new fixed plant serving the development will be assessed, see Section 14.5.4.6.7.
- An assessment of the noise impacts associated with road realignments and road closures in the vicinity of the affected level crossings has been undertaken in accordance with best practice, see Section 14.5.4.6.6.
- Assessment of potential impacts/effects associated with the construction phase using current best practice guidelines and standards, see Section 14.5.3.5.
- Identification of required mitigation measures required to reduce identified significant impacts to within the adopted criteria, see Section 14.6.
- Assessment of residual effects following implementation of mitigation, see Section 14.7.

14.3.3 Consultation

The development of the environmental impact assessment has been informed by consultation with prescribed bodies, other consultees and the public.

Difficulties encountered/ Limitations

No difficulties were encountered in the preparation of this assessment.

14.4 Receiving environment

This section includes a description of the baseline environment as it relates to noise and vibration.

14.4.1 Baseline Noise & Vibration Surveys

Baseline noise and vibration surveys have been conducted at locations representative of the nearest sensitive areas which have the potential to be impacted during construction phase and/or those likely to be impacted during the operational phase. Surveys were completed between September 2020 and July 2021. Full details of vibration surveys are contained in Appendix A14.1 Baseline Vibration Monitoring for DART+ West EIAR, and full details of noise surveys are contained in Appendix A14.2 Baseline Noise Monitoring for DART+ West EIAR. Both Appendices can be found in Volume 4 of this EIAR. The following sections present the baseline levels measured within each section of the proposed development.

For unattended noise survey locations, results are presented in terms for the 16 hour daytime period (07:00 – 23:00hrs) in terms of the L_{Aeq} and L_{A90} parameters and the 8 hour night-time period (23:00 – 07:00hrs) in terms of the L_{Aeq} and L_{A90} parameters. The derived L_{den} for each day is also presented.

For attended noise surveys, the survey results are presented as the average daytime L_{Aeq} and L_{A90} parameters over the three hour survey periods and the calculated L_{den} parameter.

The baseline vibration measurements are presented in terms of Peak Particle Velocity (PPV) and Vibration Dose Value (VDV). Full details of the survey methodologies, survey addresses, parameter definitions and results of the baseline surveys are included in full in Appendix A14.1 and Appendix A14.2 in Volume 4 of this EIAR.

The following sections summarise the monitoring undertaken in each zone of the proposed development.

14.4.2 Baseline Surveys – Zones A & B

The location reference and a summary description of survey positions for Zones A & B are included in Table 14-1 and Figure 14-1.

Table 14-1 Baseline Noise & Vibration Survey Locations – Zones A & B

Location	Description of Survey Location
Unattended (Long term) Noise & Vibration Survey Locations	
N01	Canon Lillis Avenue, Seville, Place Dublin 1
N02	Shamrock Terrace, North Strand, Dublin 3
N04	Newcomen Ave, North Strand, Dublin 3
N07	Clonliffe Avenue, Ballybough, Dublin 3
N08	Ardilaun Square, Ballybough, Dublin 13
N09	Fitzroy Avenue, Drumcondra, Dublin 3
N10	Drumcondra Park, Drumcondra, Dublin 3
N11	St Patrick's Road, Drumcondra, Dublin 9
N13	Lindsay Road, Glasnevin, Dublin 7
N52 note 1	Access road to Docklands Coach Park at Spencer Dock
Attended (Short term) Noise Survey Locations	
N03	Ossory Road, Dublin 3
N05	Bessborough Avenue, Dublin 3
N06	Spring Gardens Street, Dublin 3
N12	Whitworth Road, Dublin 3

Note 1 Vibration monitoring did not take place at Spencer Dock

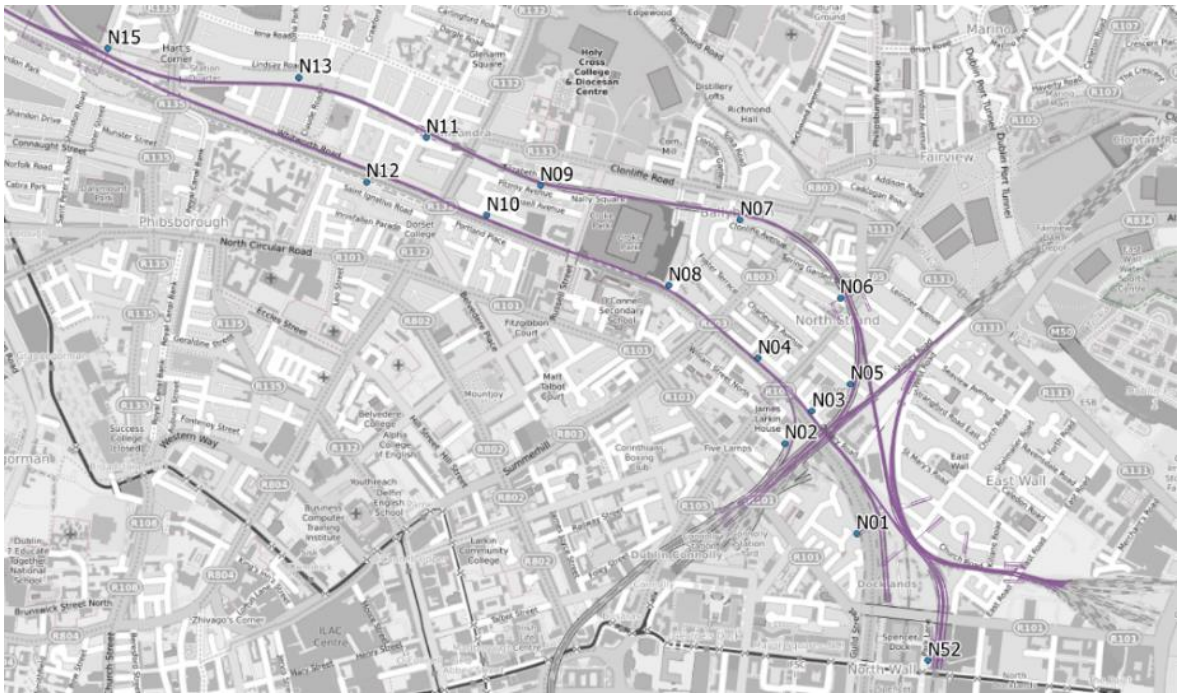


Figure 14-1 Noise & Vibration Survey Locations Zones A & B

The noise survey results recorded at baseline surveys locations within the Zone A & B study area are summarised in Table 14-2.

Table 14-2 Noise Survey Results within Zones A & B

Location	Daytime dB $L_{Aeq,16hr}$	Daytime dB $L_{A90,16hr}$	Night-time, dB $L_{Aeq,8hr}$	Night-time, dB $L_{A90,8hr}$	Measured dB L_{den}	Average dB $L_{Aeq,15min}$	Average dB $L_{A90,15min}$	Derived dB L_{den}
N01	52	47	44	40	54	-	-	-
N02	60	47	47	42	61	-	-	-
N04	49	43	44	39	52	-	-	-
N07	60	44	55	45	63	-	-	-
N08	53	46	52	47	58	-	-	-
N09	53	42	45	37	55	-	-	-
N10	55	50	51	48	59	-	-	-
N11	58	42	53	39	61	-	-	-
N52	59	49	56	45	63	-	-	-
N03	-	-	-	-	-	66	45	63
N05	-	-	-	-	-	62	41	58
N06	-	-	-	-	-	55	46	57
N12	-	-	-	-	-	51	47	55

The Zone A & B noise survey results are influenced by rail noise from the adjacent railway line in addition to local road traffic. During daytime periods, average ambient noise levels were in the range 49 to 60 dB $L_{Aeq,16hr}$ at the unattended survey positions. At the attended survey locations, daytime noise levels were measured in the range of 51 to 66 dB $L_{Aeq,15mins}$. Background noise levels were measured in the range of 37 to 50 dB L_{A90} at the unattended survey positions and between 41 and 47 dB L_{A90} at the attended survey locations.

The vibration survey results for PPV recorded at baseline surveys locations within the Zone A & B study area are summarised in Table 14-3.

Table 14-3 Vibration Survey Results within Zones A & B – PPV

Location	Maximum PPV mm/s	Minimum PPV mm/s	Median PPV (mm/s)	Typical train pass by PPV (mm/s)
N01	0.11 - 0.16	0.01	0.01	0.02 - 0.02
N02	0.82 - 0.88	0.02	0.04	0.14 - 0.17
N04	0.57 - 0.69	0.01	0.02	0.26 - 0.27
N07	0.14 - 0.26	0.01	0.01	0.09 - 0.14
N08	0.99 - 1	0.02	0.04	0.28 - 0.29
N09	0.27 - 0.3	0.01	0.01	0.09 - 0.17
N10	1.31 - 1.4	0.02	0.03	0.27 - 0.28
N11	0.37 - 0.61	0.01	0.02	0.09 - 0.15
N13	1.18 - 1.27	0.02	0.03	0.14 - 0.15

Median PPV values measured at between 0.02 and 0.04 mm/s indicating a low vibration environment. Analysis of the data indicates the typical PPV value associated with passing rail is between 0.02 and 0.29 mm/s.

The vibration survey results for VDV recorded at baseline surveys locations within the Zone A & B study area are summarised in Table 14-4.

Table 14-4 Vibration Survey Results within Zones A & B – VDV

Location	$VDV_{b, day}$ ($m/s^{1.75}$)	$VDV_{b, night}$ ($m/s^{1.75}$)	Typical train pass by VDV_b ($m/s^{1.75}$)
N01	0.0007 - 0.003	0.0005 - 0.0015	0.0001 - 0.0006
N02	0.0042 - 0.045	0.0017 - 0.0223	0.0007 - 0.007
N04	0.0008 - 0.0032	0.0006 - 0.0016	0.0017 - 0.0126
N07	0.0022 - 0.0243	0.0014 - 0.0148	0.0007 - 0.0072
N08	0.0034 - 0.0048	0.0021 - 0.0048	0.0024 - 0.0072
N09	0.0022 - 0.0259	0.0012 - 0.014	0.0006 - 0.0076
N10	0.0022 - 0.003	0.0012 - 0.0016	0.0022 - 0.007
N11	0.003 - 0.0332	0.0019 - 0.0213	0.0006 - 0.0076
N13	0.0183 - 0.0338	0.0012 - 0.0026	0.0011 - 0.0036

The calculated daytime VDV values are between 0.0007 and 0.045 $m/s^{1.75}$ over the monitoring period. The calculated night-time VDV values at these locations are between 0.0005 and 0.0223 $m/s^{1.75}$. Analysis of the data indicates the typical VDV associated with passing rail is of the order of 0.0001 to 0.0126 $m/s^{1.75}$.

The VDV_{day} and VDV_{night} values are below a value where a low probability of adverse comment would be expected within a building as defined within BS 6472-1 (2008).

14.4.3 Baseline Surveys – Zone C

The location reference and a description of the survey positions are included in Table 14-5 and Figure 14-2.

Table 14-5 Baseline Noise & Vibration Survey Locations – Zone C

Location	Description of Survey Location
Unattended (Long term) Noise & Vibration Survey Locations	
N15	Dalcassian downs, Glasnevin, Dublin 9
N16	Garden to rear of residential building in Coke Oven Cottages
N17 **Note 1**	Garden to rear of residential building in Claremont Crescent
N18	Claremont Court, Glasnevin, Dublin 11
N19	Ratoath Estate, Cabra, Dublin 7.
N20	Ashington Gardens, Navan Road, Dublin 7.
N21	Glendhu Road, Navan Road, Dublin 7.
N22	Martin Savage Park, Navan Road, Ashtown, Dublin 15
N24	Castleknock Meadows, Laurel Lodge, Dublin 15
N25	Cherry Drive, Carpenterstown, Dublin 15
N26	Riverwood Square, Carpenterstown, Dublin 15
N28	Larch Grove, Clonsilla, Co. Dublin
N53 **Note 1**	Trackside at Iarnród Éireann compound, Carnlough Road, Cabra, Dublin 7
Attended (Short term) Noise Survey Locations	
N54	Clareville Court, Glasnevin, Dublin 9
N23	Castleknock Park, Castleknock, Dublin 15

Note 1 Vibration monitoring did not take place at N17 or N53

Figure 14-2 Noise & Vibration Survey Locations Zone C

The noise survey results recorded at baseline surveys locations within the Zone C study area are summarised in Table 14-6.

Table 14-6 Noise Survey Results within Zone C

Location	Daytime dB $L_{Aeq,16hr}$	Daytime dB $L_{A90,16hr}$	Night-time, dB $L_{Aeq,8hr}$	Night-time, dB $L_{A90,8hr}$	Measured dB L_{den}	Average dB $L_{Aeq,15min}$	Average dB $L_{A90,15min}$	Derived dB L_{den}
N15	59	42	54	39	62	-	-	-
N16	57	42	52	38	60	-	-	-
N17	58	41	51	37	60	-	-	-
N18	60	46	56	45	64	-	-	-
N19	62	44	56	36	64	-	-	-
N20	56	48	52	45	60	-	-	-
N21	66	45	59	41	68	-	-	-
N22	57	45	46	35	58	-	-	-
N24	63	51	54	32	65	-	-	-
N25	55	47	49	44	58	-	-	-
N26	57	49	52	39	60	-	-	-
N28	53	44	46	36	55	-	-	-
N53	61	48	46	44	61	-	-	-
N23	-	-	-	-	-	63	61	64
N54 (Day)	-	-	-	-	-	44	39	49
N54 (Night)	-	-	-	-	-	36	32	-

The Zone C noise survey results are influenced by rail noise from the adjacent railway line in addition to road traffic and local residential activities set back from road traffic. During daytime periods, average ambient noise levels were in the range of 53 to 66 dB $L_{Aeq,16hr}$ at the unattended survey position. At the attended survey locations, daytime noise levels were measured in the range of 44 to 63 dB $L_{Aeq,15mins}$. Background noise levels

were measured in the range of 32 to 51 dB L_{A90} at the unattended survey positions and between 39 and 61 dB L_{A90} at the attended survey locations. Note that in survey location N09 there was a very high boundary wall between the survey location and the rail line (~6 m high) that resulted in lower noise levels at this location.

The vibration survey results for PPV recorded at baseline surveys locations within the Zone C study area are summarised in Table 14-7.

Table 14-7 Vibration Survey Results within Zone C – PPV

Location	Maximum PPV mm/s	Minimum PPV mm/s	Median PPV (mm/s)	Typical train pass by PPV (mm/s)
N15	0.2 - 0.26	0.01	0.01	0.11 - 0.14
N16	0.8 – 1.5	0.02	0.03	0.11 – 0.2
N18	0.26 - 0.43	0.02	0.03	0.12 - 0.2
N19	1.08 - 1.13	0.02	0.03	0.11 - 0.12
N20	0.15 - 0.21	0.01	0.01	0.08 - 0.1
N21	0.27 - 0.66	0.01	0.01	0.13 - 0.26
N22	1.13 - 1.19	0.02	0.05	Note 1
N24	0.16 - 0.53	0.02	0.03	0.08 - 0.27
N25	0.17 - 0.22	0.01	0.01	0.03 - 0.04
N26	0.06 - 0.07	0.02	0.03	0.04 - 0.04
N28	0.26 – 1.07	0.01	0.01	0.03 - 0.04

Note 1 Note that at location N22 the vibration associated with rail movements was not detected at a level sufficiently above the background vibration level to allow an estimate of the vibration associated with a typical train movement. This is due to the large distance between the rail line and the monitoring position, ~50 metres.

Median PPV values were measured in the range of 0.01 to 0.05 mm/s indicating a low vibration environment. Analysis of the data indicates the typical PPV value associated with passing rail is in the range of 0.03 to 0.27 mm/s.

The vibration survey results for VDV recorded at baseline surveys locations within the Zone C study area are summarised in Table 14-8.

Table 14-8 Vibration Survey Results within Zone C – VDV

Location	$VDV_{b,\ day}$ ($m/s^{1.75}$)	$VDV_{b,\ night}$ ($m/s^{1.75}$)	Typical train pass by VDV_b ($m/s^{1.75}$)
N15	0.0031 - 0.0306	0.0016 - 0.0166	0.0007 - 0.0072
N16	0.03 - 0.05	0.011 - 0.015	0.002 - 0.01
N18	0.0028 - 0.0339	0.0018 - 0.0223	0.0007 - 0.0073
N19	0.0146 - 0.0263	0.0014 - 0.0036	0.0008 - 0.0028
N20	0.0019 - 0.0189	0.0012 - 0.0122	0.0005 - 0.0052
N21	0.0137 - 0.0528	0.0022 - 0.0337	0.0009 - 0.0126
N22	0.0179 - 0.0357	0.0046 - 0.0202	Note 1
N24	0.0019 - 0.0534	0.0013 - 0.0298	0.0004 - 0.0131
N25	0.0009 - 0.0087	0.0006 - 0.0038	0.0002 - 0.0019
N26	0.0018 - 0.0094	0.0012 - 0.0022	0.0003 - 0.0016
N28	0.0016 - 0.028	0.0007 - 0.004	0.0005 - 0.0052
N23	0.0009 - 0.0055	-	-

Note 1 Note that at location N22 the vibration associated with rail movements was not detected at a level sufficiently above the background vibration level to allow an estimate of the vibration associated with a typical train movement. This is due to the large distance between the rail line and the monitoring position, ~50 metres.

The calculated daytime VDV values are between 0.0009 and 0.0534 m/s$^{1.75}$ over the monitoring period. The calculated night-time VDV values at these locations are between 0.0006 and 0.0337 m/s$^{1.75}$. Analysis of the data indicates the typical VDV associated with passing rail is of the order of 0.0002 to 0.0131 m/s$^{1.75}$.

The VDV_{day} and VDV_{night} values are below a value where a low probability of adverse comment would be expected within a building as defined within BS 6472-1 (2008).

14.4.4 Baseline Surveys – Zone D

The location reference and a description of survey positions are included in Table 14-9 and Figure 14-3.

Table 14-9 Baseline Noise & Vibration Survey Locations – Zone D

Location	Description of Survey Location
Unattended (Long term) Noise & Vibration Survey Locations	
N46	Barnhill, Clonsilla, Co Dublin
N48	Edenmore House, Loughsallagh, Dunboyne, Co. Meath
N49	Elton Grove, Millfarm, Dunboyne, County Meath
N50	Silver Birches Crescent, Millfarm, Dunboyne, Co. Meath
N51	Bennetstown, Dunboyne, County Meath
N55 **Note 1**	Dunboyne, Co. Meath
Attended (Short term) Noise Survey Locations	
N47	Stirling Road, Hilltown, Co. Meath

Note 1 Vibration monitoring did not take place at M3 Parkway

Figure 14-3 Noise & Vibration Survey Locations Zone D

The noise survey results recorded at baseline surveys locations within the Zone D study area are summarised in Table 14-10.

Table 14-10 Noise Survey Results within Zone D

Location	Daytime dB $L_{Aeq,16hr}$	Daytime dB $L_{A90,16hr}$	Night-time, dB $L_{Aeq,8hr}$	Night-time, dB $L_{A90,8hr}$	Measured dB L_{den}	Average dB $L_{Aeq,15min}$	Average dB $L_{A90,15min}$	Derived dB L_{den}
N46	51	44	47	33	55	-	-	-
N48	57	50	51	45	60	-	-	-
N49	57	47	51	35	60	-	-	-
N50	56	47	51	37	59	-	-	-
N51	55	52	49	40	58	-	-	-
N55	57	50	56	46	63	-	-	-
N47	-	-	-	-	-	57	45	61

The Zone D noise survey results are influenced by rail noise from the Dublin to M3 Parkway railway line in addition to local residential activities set back from road traffic and construction noise at Spencer Dock. During daytime periods, average ambient noise levels were in the range of 51 to 57 dB $L_{Aeq,16hr}$ at the unattended survey positions. At the attended survey location, daytime noise levels were measured at 57 dB $L_{Aeq,15mins}$. Background noise levels were measured in the range of 33 to 52 dB L_{A90} at the unattended survey positions and at 45 dB L_{A90} at the attended survey location.

The vibration survey results for PPV recorded at baseline surveys locations within the Zone D study area are summarised in Table 14-11.

Table 14-11 Vibration Survey Results within Zone D – PPV

Location	Maximum PPV mm/s	Minimum PPV mm/s	Median PPV (mm/s)	Typical train pass by PPV (mm/s)
N46	0.1 - 0.14	0.02	0.03	Note 1
N48	1.01 - 1.08	0.02	0.03	0.23 - 0.23
N49	0.66 - 0.82	0.01	0.01	0.1 - 0.12
N50	0.27 - 0.32	0.01	0.01	0.05 - 0.11
N51	1.16 - 1.23	0.02	0.03	0.16 - 0.17

Note 1 Note that at location N46 the vibration associated with rail movements was not detected at a level sufficiently above the background vibration level to allow an estimate of the vibration associated with a typical train movement.

Median PPV values measured in the range of 0.01 to 0.03 mm/s indicating a low vibration environment. Analysis of the data indicates the typical PPV value associated with passing rail is in the range of 0.05 to 0.23 mm/s.

The noise survey results for VDV recorded at baseline surveys locations within the Zone D study area are summarised in Table 14-12.

Table 14-12 Vibration Survey Results within Zone D – VDV

Location	$VDV_{,b,\ day}$ ($m/s^{1.75}$)	$VDV_{,b,\ night}$ ($m/s^{1.75}$)	Typical train pass by VDV_b ($m/s^{1.75}$)
N46	0.0017 - 0.0036	0.0012 - 0.0015	Note 1
N48	0.0175 - 0.0326	0.0016 - 0.0118	0.0018 - 0.0063
N49	0.0026 - 0.0219	0.0027 - 0.0187	0.0006 - 0.0048

Location	$VDV_{b,\ day}$ ($m/s^{1.75}$)	$VDV_{b,\ night}$ ($m/s^{1.75}$)	Typical train pass by VDV_b ($m/s^{1.75}$)
N50	0.0009 - 0.0151	0.0014 - 0.0108	0.0003 - 0.0042
N51	0.0158 - 0.0293	0.0012 - 0.002	0.0013 - 0.0038

Note 1 Note that at location N46 the vibration associated with rail movements was not detected at a level sufficiently above the background vibration level to allow an estimate of the vibration associated with a typical train movement.

The calculated daytime VDV values is between 0.0009 and 0.0326 $m/s^{1.75}$ over the monitoring period. The calculated night-time VDV value at this location is between 0.0012 and 0.0187 $m/s^{1.75}$. Analysis of the data indicates the typical VDV associated with passing rail is of the order of 0.0003 to 0.0063 $m/s^{1.75}$.

The VDV_{day} and VDV_{night} values are below a value where a low probability of adverse comment would be expected within a building as defined within BS 6472-1 (2008).

14.4.5 Baseline Surveys – Zone E

The location reference and a description of survey positions are included in Table 14-13 and Figure 14-4.

Table 14-13 Baseline Noise & Vibration Survey Locations – Zone E

Location	Description of Survey Location
Unattended (Long term) Noise & Vibration Survey Locations	
N29	Barberstown House, Clonsilla, Dublin 15
N30	Station House, Clonee Road, Allenswood, Lucan
N31	Glendale Meadows, Leixlip, County Kildare
N33	River Forest, Leixlip, County Kildare
N34	Riverforest, Captains Hill, Leixlip, County Kildare
N35	River Forest View, Leixlip, County Kildare
N37	Glen Easton Way, Leixlip, County Kildare
N39	Donoughmore House, Pyke Bridge, Maynooth, County Kildare
N41	Silken Vale, Maynooth, County Kildare
Attended (Short term) Noise Survey Locations	
N32	Glendale Meadows, Leixlip, County Kildare
N36	Louisa Bridge, Leixlip, County Kildare
N38	Blakestown, Leixlip, County Kildare
N40	Parklands Grove, Maynooth, Co. Kildare

Figure 14-4 Noise & Vibration Survey Locations Zone E

The noise survey results recorded at baseline surveys locations within the Zone E study area are summarised in Table 14-14.

Table 14-14 Noise Survey Results within Zone E

Location	Daytime dB $L_{Aeq,16hr}$	Daytime dB $L_{A90,16hr}$	Night-time, dB $L_{Aeq,8hr}$	Night-time, dB $L_{A90,8hr}$	Measured dB L_{den}	Average dB $L_{Aeq,15min}$	Average dB $L_{A90,15min}$	Derived dB L_{den}
N29	54	47	46	38	56	-	-	-
N30	64	45	57	37	67	-	-	-
N31	61	39	55	31	63	-	-	-
N33	60	37	54	31	62	-	-	-
N34	55	41	48	37	58	-	-	-
N35	59	42	54	41	63	-	-	-
N37	62	44	53	38	63	-	-	-
N39	56	48	49	39	58	-	-	-
N41	57	48	48	39	58	-	-	-
N32	-	-	-	-	-	56	41	54
N36	-	-	-	-	-	56	39	56
N38	-	-	-	-	-	60	54	61
N40	-	-	-	-	-	56	47	55

The Zone E noise survey results are influenced by rail noise from the adjacent railway line in addition to road traffic and local residential activities set back from road traffic. During daytime periods, average ambient noise levels were in the range of 54 to 64 dB $L_{Aeq,16hr}$ at the unattended survey positions. At the attended survey locations, daytime noise levels were measured in the range of 56 to 60 dB $L_{Aeq,15mins}$. Background noise levels were measured in the range of 31 to 48 dB L_{A90} at the unattended survey positions and between 39 and 54 dB L_{A90} at the attended survey locations.

The vibration survey results for PPV recorded at baseline surveys locations within the Zone E study area are summarised in Table 14-15.

Table 14-15 Vibration Survey Results within Zone E – PPV

Location	Maximum PPV mm/s	Minimum PPV mm/s	Median PPV (mm/s)	Typical train pass by PPV (mm/s)
N29	1.07 - 1.14	0.02	0.03	Note 1
N30	0.27 - 0.49	0.01	0.01	0.15 - 0.23
N31	0.26 - 1.01	0.01	0.02	0.15 - 0.2
N33	0.41 - 1.37	0.01	0.02	0.05 - 0.06
N34	0.57 - 0.62	0.01	0.01	0.1 - 0.16
N35	1.01 - 1.09	0.02	0.03	0.16 - 0.18
N37	0.3 - 0.68	0.01	0.02	0.1 - 0.24
N39	0.46 - 0.98	0.01	0.01	0.05 - 0.16
N41	0.11 - 0.57	0.01	0.01	0.03 - 0.05

Note 1 Note that at location N29 the vibration associated with rail movements was not detected at a level sufficiently above the background vibration level to allow an estimate of the vibration associated with a typical train movement.

Median PPV values measured in the range of 0.01 to 0.03 mm/s indicating a low vibration environment. Analysis of the data indicates the typical PPV value associated with passing rail is in the range of 0.03 to 0.24 mm/s.

The vibration survey results for VDV recorded at baseline surveys locations within the Zone E study area are summarised in Table 14-15.

Table 14-16 Vibration Survey Results within Zone E – VDV

Location	$VDV_{b,\ day}$ ($m/s^{1.75}$)	$VDV_{b,\ night}$ ($m/s^{1.75}$)	Typical train pass by PPV (mm/s)
N29	0.0137 - 0.0242	0.0152 - 0.029	Note 1
N30	0.0037 - 0.0303	0.002 - 0.0162	0.0011 - 0.0083
N31	0.0038 - 0.0368	0.0025 - 0.0209	0.0011 - 0.0099
N33	0.0051 - 0.0083	0.0006 - 0.0047	0.0003 - 0.0021
N34	0.0043 - 0.0235	0.0021 - 0.0112	0.001 - 0.0047
N35	0.0169 - 0.0307	0.0012 - 0.0051	0.0014 - 0.0043
N37	0.0027 - 0.034	0.0016 - 0.0177	0.0006 - 0.0076
N39	0.0015 - 0.0285	0.0006 - 0.0129	0.0003 - 0.0079
N41	0.0007 - 0.0053	0.0005 - 0.0039	0.0002 - 0.0018

Note 1 Note that at location N29 the vibration associated with rail movements was not detected at a level sufficiently above the background vibration level to allow an estimate of the vibration associated with a typical train movement.

The calculated daytime VDV values is between 0.0007 and 0.0368 $m/s^{1.75}$ over the monitoring period. The calculated night-time VDV value at this location is between 0.0005 and 0.029 $m/s^{1.75}$. Analysis of the data indicates the typical VDV associated with passing rail is of the order of 0.0002 to 0.0099 $m/s^{1.75}$.

The VDV_{day} and VDV_{night} values are below a value where a low probability of adverse comment would be expected within a building as defined within BS 6472-1 (2008).

14.4.6 Baseline Surveys – Zone F

The location reference and a description of survey positions are included in Table 14-17 and Figure 14-5.

Figure 14-5 Baseline Survey Locations - Zone F

Table 14-17 Baseline Noise & Vibration Survey Locations – Zone F

Location	Description of Survey Location
Unattended (Long term) Noise & Vibration Survey Locations	
N42	Woodlands, Maynooth, County Kildare
N56	Treadstown House, Millfarm, Co. Kildare
N57 **Note 1**	Gragadder, Kilcock, Co. Kildare
N43	Braganstown, Kilcock, Co. Kildare
N44	Connaught Street, Kilcock, Co. Kildare
N45	Brayton Park, Kilcock, Co. Kildare

Note 1 Vibration monitoring did not take place at N56 or N57.

Figure 14-6 Noise & Vibration Survey Locations Zone F

The noise survey results recorded at baseline survey locations within the Zone F study area are summarised in Table 14-18.

Table 14-18 Noise Survey Results within Zone F

Location	Daytime dB $L_{Aeq,16hr}$	Daytime dB $L_{A90,16hr}$	Night-time, dB $L_{Aeq,8hr}$	Night-time, dB $L_{A90,8hr}$	Measured dB L_{den}
N42	52	46	46	41	55
N56	48	45	44	37	52
N57	50	40	48	34	55
N43	53	46	45	35	55
N44	57	47	49	36	59
N45	50	46	43	38	52

The Zone F noise survey results are influenced by rail noise from the Dublin to Maynooth railway line in addition to local residential activities set back from road traffic. During daytime periods, average ambient noise levels were in the range of 48 to 57 dB $L_{Aeq,16hr}$ at the unattended survey positions. Background noise levels were measured in the range of 34 to 47 dB L_{A90} at the unattended survey positions.

The vibration survey results for PPV recorded at baseline surveys locations within the Zone F study area are summarised in Table 14-19.

Table 14-19 Vibration Survey Results within Zone F – PPV

Location	Maximum PPV mm/s	Minimum PPV mm/s	Median PPV (mm/s)	Typical train pass by PPV (mm/s)
N42	0.08 - 0.14	0.01	0.01	0.03 - 0.07
N43	0.14 - 0.44	0.02	0.03	0.04 - 0.05
N44	0.04 - 0.05	0.01	0.01	0.02 - 0.02
N45	0.38 – 0.40	0.02	0.05	0.04 - 0.05

Median PPV values for measured in the range of 0.01 to 0.05 mm/s indicating a low vibration environment. Analysis of the data indicates the typical PPV value associated with passing rail is in the range of 0.02 to 0.07 mm/s.

The vibration survey results for VDV recorded at baseline surveys locations within the Zone F study area are summarised in Table 14-20.

Table 14-20 Vibration Survey Results within Zone F – VDV

Location	$VDV_{,b,\ day}$ ($m/s^{1.75}$)	$VDV_{,b,\ night}$ ($m/s^{1.75}$)	Typical train pass by VDV_b ($m/s^{1.75}$)
N42	0.0006 - 0.0082	0.0004 - 0.0005	0.0001 - 0.0025
N43	0.0015 - 0.0024	0.0012 - 0.0017	0.0003 - 0.0005
N44	0.0006 - 0.0025	0.0005 - 0.0009	0.0001 - 0.0005
N45	0.0055 - 0.023	0.0058 - 0.023	0.0013 - 0.0055

The calculated daytime VDV values is between 0.0006 and 0.023 $m/s^{1.75}$ over the monitoring period. The calculated night-time VDV value at this location is between 0.0004 and 0.023 $m/s^{1.75}$. Analysis of the data indicates the typical VDV associated with passing rail is of the order of 0.0001 to 0.0055 $m/s^{1.75}$.

The VDV_{day} and VDV_{night} values are below a value where a low probability of adverse comment would be expected within a building as defined within BS 6472-1 (2008).

14.5 Description of potential impacts

14.5.1 Do-Nothing Scenario

The Do Nothing scenario represents the situation where the proposed development does not proceed and the current operation of DMU trains continues. During the Do Nothing scenario existing level crossings are retained, construction activity does not occur and diesel trains continue to use the tracks at the present level of service. Therefore, noise and vibration levels measured during the baseline surveys are considered representative of the Do Nothing scenario.

14.5.2 Do-Something Scenario

The Do-Something scenario defines the proposed DART+ West project which comprises the electrification of the Maynooth & M3 Parkway lines, with a total length of approximately 40 km. The development is described from east to west from Dublin city centre (Connolly/Docklands) to the new depot located west of Maynooth and to M3 Parkway. This scenario will result in diesel commuter trains being replaced with electric DART trains and the frequency of service increased. This scenario also includes for the closure of several level crossings.

14.5.3 Potential Construction Impacts

The construction noise assessment has been undertaken with reference to BS 5228 – 1 (BSI 2009 +A1 2014a). 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 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.

A series of noise predictions have been conducted in the vicinity of each of the construction work areas for the key phases of work representative of the likely worst-case scenarios associated with each. The assessments have been undertaken through detailed review of plant and vehicles, site layouts, proposed works phasing, durations and operational hours.

All construction noise calculations have been performed in general accordance with BS 5228 – 1 (BSI 2009 +A1 2014a), using the plant sound power level method. The 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. Noise levels are 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.
- 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.
- The hardness of the ground between the source and receiver.
- Attenuation due to atmospheric absorption.
- Meteorological effects such as wind gradient, temperature gradient and humidity.

14.5.3.1 Input Data

The following input data was used to develop the noise model for each area of construction:

- OS mapping.
- Construction works layout plans, construction activities and construction programme.
- Construction plant items and working hours.
- Sound power data (third-octave) for items of plant to be used on site taken from BS 5228 -1 1 (BSI 2009 +A1 2014a), from previous measurements carried out at other sites by AWN Consulting, from source data obtained by the construction team on other large infrastructural projects of similar construction.

A detailed description of the proposed surface construction works and proposed working hours is presented in Chapter 5 Construction Strategy in Volume 2 of this EIAR.

14.5.3.1.1 Assessment Periods

Noise levels have been assessed over the daytime (07:00 to 19:00hrs), evening (19:00 to 23:00hrs) and night-time (23:00hrs to 07:00hrs) periods as relevant for the construction works in accordance with the proposed construction working hours for the proposed development as outlined in Chapter 5 Construction Strategy in Volume 2 of the EIAR.

14.5.3.1.2 Vibration

For construction works reference has been made to BS5228-2 (BSI 2009 +A1 2014b) and measurement data compiled by AWN Consulting during other construction projects. The potential magnitudes of construction vibration impacts are determined through review of published data for varying construction activities with the potential for generation of vibration beyond the works boundary.

14.5.3.2 Construction Traffic

An assessment has been made of the impact of construction vehicles along the surrounding road network serving each of the construction compounds. Given that roads where construction traffic will travel is along the existing road network which already carry traffic volumes, it is appropriate to consider the change in traffic noise level that will arise as a result of changes in traffic flow in terms of volume and fleet mix. This also applies to roads where any traffic is redistributed onto. The key consideration in terms of impact assessment therefore relates to the change in traffic noise levels and the related impact/effect associated with the same.

14.5.3.3 Criteria for Rating Construction Noise Impact Significance

There is no published statutory Irish 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 general, higher noise levels are generally accepted during a short-term construction phase of a project compared to its long-term operational phase, as construction works are temporary and tend to be varied. The following sections discuss current best practice in determining criteria for rating construction noise impact/effect significance.

14.5.3.3.1 DCC – Air Quality Monitoring and Noise Control Unit's Good Practice Guide for Construction and Demolition

Dublin City Council's *"Air Quality Monitoring and Noise Control Unit's Good Practice Guide for Construction and Demolition*" (hereinafter referred to as DCC GPG) outlines a risk assessment methodology directly applicable to the specific construction activities on the proposed site.

The proposed development has been classed as a high risk category site based on the DCC GPG risk assessment factors as detailed below:

- Duration of the works.
- Distance to noise sensitive locations (NSLs).
- Ambient noise levels.
- Site operating hours.
- Location of works.
- Duration of demolition.
- Intrusive noise activities, including vibration generating activities.

The duration, nature and extent of construction activities associated with the construction phase of the proposed development would categorise it within the high risk category. The monitoring section (S.6) of the DCC GPG document identifies that for high risk category sites:

> *'The ABC Method detailed in Paragraph E.3.2 of BS 5228-1:2009 shall be used to determine acceptable noise levels for day, evening and night time work.'*

Whilst Fingal County Council (FCC), Meath County Council (MCC) or Kildare County Council (KCC) do not use an equivalent noise risk assessment procedure, the approach used by DCC has been applied across the full extent of the proposed development to ensure a uniform approach for construction noise assessment. The following sections set out the relevant ABC guidance taken from BS 5228–1 (BSI 2014a), and also refers to DMRB Noise and Vibration (UKHA 2020) in order to review and set appropriate construction noise significance ratings or significance thresholds for the DART+ West project.

14.5.3.3.2 British Standard BS 5228 – 1: 2009+A1:2014 – ABC Method

The ABC method detailed in Paragraph E.3.2 of BS 5228 – 1 (BSI 2009 +A1 2014a) calls for the designation of a noise sensitive location into a specific category (A, B or C) based on the existing rounded ambient noise levels in the absence of construction noise. This then sets a threshold noise value that, if exceeded at this location, indicates a potential significant noise impact associated with the construction activities, depending on context.

Table 14-21 sets out the values which, when exceeded, signify a potential significant effect.

Table 14-21 BS 5228-1 Example of Thresholds of Potential Significant Effect

Assessment Category & Threshold Value Period (L_{Aeq})	Construction Noise Threshold (CNT) (dB)		
	Category A [A]	Category B [B]	Category C [C]
Daytime (07:00 – 19:00hrs) and Saturdays (07:00 – 13:00hrs)	65	70	75
Evenings & Weekends (19:00 – 23:00hrs weekdays) (13:00 - 23:00hrs Saturdays) (07:00 – 23:00hrs Sundays)	55	60	65
Night-time (23:00 to 07:00hrs)	45	50	55
Notes	Category A: threshold values to use when ambient noise levels (when rounded to the nearest 5 dB) are less than these values.	Category B: threshold values to use when ambient noise levels (when rounded to the nearest 5 dB) are the same as category A values.	Category C: threshold values to use when ambient noise levels (when rounded to the nearest 5 dB) are higher than category A values.

These thresholds have been applied to residential buildings.

In order to assist with interpretation of significance, Table 14-22 includes guidance as to the likely magnitude of noise impact associated with construction activities, relative to the construction noise level. This guidance is derived from Table 3.16 of DMRB Noise and Vibration (UKHA 2020) and adapted to include the relevant significance effects from the EPA Guidelines (EPA 2022).

In accordance with the DMRB Noise and Vibration (UKHA 2020), construction noise and construction traffic noise impacts shall constitute a significant effect where it is determined that a major or moderate magnitude of impact will occur for a duration exceeding:

- Ten or more days or nights in any 15 consecutive days or nights.
- A total number of days exceeding 40 in any six consecutive months.

Table 14-22 Construction Noise Significance Ratings

Range of Construction Noise level	Guidelines for Noise Impact Assessment Significance (DMRB)	EPA EIAR Significance Effects	Determination
Below or equal to baseline noise level	Negligible	Not Significant	Depending on CNT, duration & baseline noise level
Above baseline noise level and below or equal to CNT	Minor	Slight to Moderate	
Above CNT and below or equal to CNT +5 dB	Moderate	Moderate to Significant	
Above CNT +5 to +15 dB	Major	Significant, to Very Significant	
Above +15 dB		Very Significant to Profound	

The adapted DMRB Noise and Vibration (UKHA 2020) guidance outlined is used to assess the predicted construction noise levels at NSLs and comment on the likely impacts during the construction stages.

14.5.3.4 Criteria for Rating Construction Vibration Impacts

Vibration standards come in two varieties: those dealing with human comfort and those dealing with cosmetic or structural damage to buildings. For airborne vibration impacts associated with surface construction activities, in both instances, it is appropriate to consider the magnitude of vibration in terms of Peak Particle Velocity (PPV).

14.5.3.4.1 Building Response Criteria

BS 7385 - 2 (BSI 1993) gives guidance regarding acceptable vibration in order to avoid damage to buildings. BS 5228 – 2 (BSI 2014b) reproduces these same guidance values.

These standards differentiate between transient and continuous vibration. Surface construction activities are transient because they occur for a limited period of time at a given location. Both documents recommend that, for soundly constructed residential property and similar light framed structures that are generally in good repair, a threshold for minor or cosmetic damage (i.e. non-structural damage) should be taken as a PPV (in frequency range of predominant pulse) of 15 mm/s at 4 Hertz (Hz) increasing to 20 mm/s at 15Hz and 50 mm/s at 40Hz and above. The standard also notes that below 12.5 mm/s PPV the risk of damage tends to be zero. Where the dynamic loading caused by continuous vibration is such as to give rise to dynamic magnification due to resonance, especially at the lower frequencies where lower guide values apply, then the guide values in BS 5228 – 2 (BSI 2014b) Table B.2 might need to be reduced by up to 50%. On a cautious basis, therefore, continuous vibration limits are set as 50% of those for transient vibration across all frequency ranges. Historically important buildings that are difficult to repair might require special consideration on a case by case basis, but buildings of historical importance should not be assumed to be more sensitive unless they are structurally unsound.

If a building is in an unstable state, then it will tend to be more vulnerable to the possibility of damage arising from vibration or any other ground borne disturbance. The vibration limit range for protected and historical buildings are equal to or up to 50% of those for light framed buildings, depending on their structural integrity. Where no structural defects are noted, the same limit to those for light framed buildings apply. For other structures and buildings that are determined to be potentially vulnerable to vibration due to significant structural defects, a more stringent criterion has been applied for transient vibration. It is assumed that known buildings and structures of this kind, will be subject to condition surveys well in advance of the works, and any defects identified repaired. The results of conditions surveys will determine whether a building or structure is classed as “vulnerable”.

Table 14-23 sets out the limits as they apply to vibration frequencies at 4Hz where the most conservative limits are required. At higher frequencies, the relevant limit values for transient vibration within Table B.2 and Figure B.1 of BS5228-2 (BSI 2014b) will apply, with similar reductions applied for continuous vibration and those for protected structures. For line 2 of Figure B.1 at frequencies below 4Hz, a maximum displacement of 0.6mm (zero to peak) should not be exceeded. Taking the above into consideration the vibration criteria for building response is set out in Table 14-23.

Table 14-23 Recommended Construction Vibration Thresholds for Buildings

Vibration Limits for Buildings (PPV) at the closest part of building to the source of vibration, at a frequency of 4Hz		
Building Type	**Transient Vibration**	**Continuous Vibration**
Reinforced or framed structures. Industrial and heavy commercial buildings	50 mm/s	25 mm/s
Unreinforced or light framed structures. Residential or light commercial-type buildings	15 mm/s	7.5 mm/s
Protected and Historic Buildings *Note 1	6 mm/s – 15 mm/s	3 mm/s – 7 mm/s
Identified Potentially Vulnerable Structures and Buildings with Low Vibration Threshold	3 mm/s	

Note 1 The relevant threshold value to be determined on a case by case basis. Where sufficient structural information is unavailable at the time of assessment, the lower values within the range will be used, depending on the specific vibration frequency.

14.5.3.4.2 Human Response Criteria

Humans are sensitive to vibration stimuli, and perception of vibration at high magnitudes may cause concern to building occupants. BS 5228 – 2 (BSI 2009 +A1 2014b) notes that vibration typically becomes perceptible at around 0.15 mm/s to 0.3 mm/s and may become disturbing or annoying at higher magnitudes. During construction works associated with breaking of ground, piling and excavation, depending on the methodologies

involved the vibration limits set within Table 14-24 would be clearly perceptible to building occupants and would have the potential to cause subjective effects.

Higher levels of vibration are however 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, piling can typically be tolerated at vibration levels up to 2.5 mm/s during the daytime and the evening if those affected are aware of the time-frame and origin of the vibration, and if they have been informed about the limit values relating to the structural integrity of neighbouring properties. Table 14-24 presents the significance table relating to potential impacts to building occupants during construction based on guidance from BS 5228 – 2 (BSI 2009 +A1 2014b).

Table 14-24 Human Response Vibration Significance Ratings

Criteria	Impact Magnitude	Significance Rating
≥10 mm/s PPV	Very High	Very Significant
≥1 mm/s PPV	High	Moderate to Significant
≥0.3 mm/s PPV	Medium	Slight to Moderate
≥0.14 mm/s PPV	Low	Not significant to Slight
Less than 0.14 mm/s PPV	Very Low	Imperceptible to Not significant

Luas Line Vibration

As some construction works will take place close to the Luas tracks it is appropriate to set vibration criteria during construction work at the Luas line. TII provides the Code of engineering practice for works on, near, or adjacent to the Luas light rail system (TII 2016), which details maximum allowable vibration values on the line to prevent damage, these are reproduced in Table 14-25.

Table 14-25 Vibration guidance values for avoidance of damage to the Luas line.

Frequency	Allowable vibration (in terms of peak particle velocity) at the Luas Line		
	Level 1	Level 2	Level 3
> 50 Hz	10mm/s	12mm/s	15mm/s
≤ 50 Hz	10mm/s	10mm/s	10mm/s

The document describes the following actions to be taken at each level:

> *"(i) Vibration readings below trigger level 1*
>
> *As long as measured vibrations are below level 1, works can continue as applied.*
>
> *(ii) Vibration readings between trigger levels 1 and 2*
>
> *In the case when measured vibration results exceed level 1, the relevant party shall initiate a review of his techniques and propose alterations to his methods including measures for reduction of vibration. These measures shall consider the works techniques, the geological conditions and other relevant factors. Any such measures shall be tested, applied and carefully monitored by the relevant party.*
>
> *(iii) Vibration readings between trigger levels 2 and 3*
>
> *In the event of vibration readings exceeding trigger level 2 or when damage to the light railway has been suspected, the associated works shall cease and the relevant party shall initiate a review of his techniques. The relevant party shall submit details of his proposed modifications to the works to ensure that vibrations do not exceed trigger level 1. The modifications shall be identified in a document submitted to TII. Works shall not recommence without the consent of TII.*

(iv) Vibration readings above trigger level 3

In the event of vibration readings exceeding level 3 in a discrete event, the procedure as described in (iii) shall apply."

14.5.3.5 Construction Noise & Vibration Impact Assessment

The following sections discuss the potential noise and vibration impacts/effects during construction across the six (6) zones defined for the project.

Table 14-26 summarises the approach adopted to construction noise and vibration sources which have been assessed as part of the construction phase.

Table 14-26 Overview of Construction Phase Noise and Vibration Assessment Procedures

Source	Prediction Method	Key Considerations	Impact/Effect Assessment
Construction noise at fixed sites & linear sections of cut & cover/ retained cuts/ track laying	SoftNoise Predictor Version 2021 (BS 5228-1Methodology (BSI 2009 +A1 2014a))	Model enables detailed plant and site layout information to calculate noise levels for varying work phases at multiple locations per site.	Results compared against construction noise significance thresholds (CNTs), baseline noise levels and mitigation trigger values for noise insulation (NI) or temporary rehousing (TRH) dependent on duration of impacts, magnitude and sensitivity.
Utility Diversions	Construction spreadsheet calculations for distances from work segments (BS 5228-1Methodology (BSI 2009 +A1 2014a))	Calculations provided per distance from source	Results compared against CNLs to determine compliance with criteria
Construction Vibration	Methodology from BS 5228-2 (BSI 2009 +A1 2014b) Review of empirical and measured data	Proximity of sensitive buildings/ structures/ construction methodologies and published data and monitored data from comparable works	Comparison against building construction thresholds and human response to vibration to categorize significant effects
Construction Traffic	Methodology from CRTN (UK Department of Transport 1998) Noise & acoustic principals	Changes in noise level with and without Metrolink construction phase - Calculated relating to volume flow changes in AADT (car, LGV and HGV fleet). Sensitive analysis allows magnitude of change to be determined	Significance of impact dependent on change in traffic noise level

Note that Softnoise Predictor version 2021 is a proprietary noise calculation package for computing noise levels. Calculations are based on BS 5228:2009+2014. This method has the scope to take into account a range of factors affecting the sound propagation, including:

- the magnitude of the noise source in terms of sound power.
- 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.
- the hardness of the ground between the source and receiver.

Calculations have been performed in octave bands from 63Hz to 8kHz as well as in overall dB(A) terms. Noise source data has been taken from BS5228 – 2009+A1(2014): Code of practice for noise and vibration control on construction and open sites Part 1 – Noise where available based on plant and equipment lists provided by the project team. Appendix A14.3 Construction Noise Source Data in Volume 4 of this EIAR details the noise levels associated with each item of plant.

Construction noise has been predicted both without and with mitigation measures in place. Not all mitigation measures are expected to reduce overall noise levels, for instance mitigation measures such as the use broadband reverse alarms rather than tonal alarms are expected to reduce annoyance at sensitive receptors rather absolute noise levels. Therefore, the noise model cannot capture all elements of mitigation, in this respect the model concentrates on the use of barriers as a mitigation method.

14.5.3.5.1 All Zones

There are certain construction works that will occur across all zones. The following section discusses these works.

Construction Traffic

During the construction phase the addition of construction related traffic has the potential to generate noise impacts on the existing road network. The traffic flows with and without construction traffic have been assessed to determine the likely change in noise level on each link provided as a result of the construction phase. Traffic flow data in terms of the Annual Average Daily Traffic (AADT) figures has been assessed with and without construction traffic and diverted traffic and the calculated change in noise levels are summarised in Table 14-27.

Table 14-27 Change in Traffic Noise Levels During Construction

Link Number	Name	Without Construction		With Construction		Change in Noise Level (dB)
		Total AADT	% Heavy Vehicles	Total AADT	% Heavy Vehicles	
1	R148	5,010	3%	5,637	13.27%	+0.5
2	Jackson's Bridge	2,617	2%	2,866	6.45%	+0.4
3	R148	7,012	3%	7,325	6.57%	+0.2
4	Pike Bridge	3,195	8%	3,423	14.31%	+0.3
5	R148 West	10,035	10%	10,107	10.31%	0.0
6	R148 East	10,219	7%	10,291	7.99%	0.0
7	R148 Leixlip	14,446	5%	14,674	5.84%	+0.1
8	Deey Bridge	189	1%	345	11.59%	+2.6
9	Louisa Bridge	7,769	7%	7,841	7.66%	+0.0
10	R149 Leixlip Confey	9,708	1%	9,947	3.02%	+0.1
11	Collins Rail Bridge	9,930	5%	10,188	6.70%	+0.1
12	R108 South of Whitworth Rd	17,919	9%	17,919	8.94%	0.0
13	R108 North of Whitworth Rd	25,438	13%	25,635	13.95%	0.0
14	Binns Bridge South of Whitworth Rd	31,323	13%	31,323	13.19%	0.0
15	Druncondra Stop	25,111	10%	25,111	10.45%	0.0
16	Clonliffe Rail Bridge	6,835	6%	6,835	5.78%	0.0
17	Clark's Rail Bridge	25,764	3%	25,764	3.31%	0.0
18	Newcomen Rail Bridge - Strand Rd	25,215	11%	27,976	10.75%	+0.5
19	Sheriff Street	12,012	2%	Closed during construction		
20	Seville Place	15,167	10%	20,247	8.22%	+1.3
21	Guild St	22,675	8%	20,247	8.22%	-0.5
22	Mayor St	2,830	13%	3,899	6.82%	+1.4
23	Guild St	25,598	8%	24,242	8.13%	-0.2

Link Number	Name	Without Construction		With Construction		Change in Noise Level (dB)
		Total AADT	% Heavy Vehicles	Total AADT	% Heavy Vehicles	
24	North Wall Quay West	11,980	29%	14,271	22.89%	+0.8
25	Samuel Beckett Bridge	24,884	9%	23,488	9.79%	-0.3
26	North Wall Quay East	10,606	28%	12,915	21.58%	+0.9
27	Sheriff Street Upper between 2168 and 2314	6,365	6%	2,150	29.07%	-4.7
28	Sheriff Street Upper between 2314 and 2584	5,929	10%	3,359	24.77%	-2.5
29	Sheriff Street Upper between 2584 and 2323	5,972	15%	3,612	30.87%	-2.2
30	E Wall Rd between 2323 and 2254	30,385	27%	28,446	29.74%	-0.3
31	E Wall Rd between 2254 and 2338	29,247	29%	27,505	31.32%	-0.3
32	M50 Port tunnel	27,169	33%	25,577	35.56%	-0.3
33	E Wall Rd between 2323 and 2253	24,981	30%	26,013	28.22%	+0.2
34	E Wall Rd between 2253 and 2104	26,482	29%	27,538	26.79%	+0.2
35	E Link Toll Bridge	18,886	28%	20,119	26.52%	+0.3
36	New Wapping St between 2168 and 2164	2,269	37%	3,932	17.09%	+2.4
37	N Wall Quay between 2164 and 2392	10,292	26%	12,326	20.35%	+0.8

The predicted increase in traffic noise levels associated with the construction of the development is less than 3dB. Reference to Table 14-35 confirms that the likely increase is *not significant*. Note that there are some locations where a *minor* to *moderate positive* effect will occur as a result of closing some roads during construction.

Overhead Line Equipment (OHLE) Installation

The installation of the catenary system is described in detail in Chapter 5 in Volume 2 of this EIAR. The works will be carried out in a linear fashion during night-time 4 hour shifts. The process is summarised as follows:

- Utility diversions to move utilities that are directly below the foundations for the catenary structure. Some of this work can take place during the day where there is a safe working zone available, however, it may also require night-works.
- Foundations are required every 40 – 50 m along the entire length of the proposed development both sides of the track. The majority of foundations will be constructed using concrete bored piles, however, where ground conditions differ it may be necessary to use driven steel piles. All foundation work on live tracks will take place at night during temporary closures.
- Mast and cantilever installation will take place once the concrete foundations have cured. Mast and cantilever installation will occur at night in separate processes with the masts first installed along the length of the works followed by the cantilevers.
- Cable installation will take place at night with messenger and contact wire laid in separate processes.
- Final OHLE adjustments will be carried out over night shifts as required to ensure the OHLE system cabling is in the correct position.

The noise impact of the catenary system installation will likely be significant at individual properties close to the tracks for periods of brief duration (i.e. up to 4 hours) while the works are occurring. Works that occur within 300 m of a property that is located along the track with a direct line of sight to the works, have the potential to cause a significant impact. However, as the works progress, the likely effects will become less significant at that property and the effects will follow the work progress linearly along the track. The specific

noise level generated by the work will depend on the type of piling adopted. It is noted that while bored piling has a lower noise output compared to steel driven piles, the installation of steel driven piles is faster and will result in the works being completed more quickly.

Mitigation measures are limited for these works due to the nature of the sites being temporary worksites for a 4-hour period each night and the plant involved is difficult to mitigate. Therefore, it may not be practical to install site hoarding or permanent noise barriers to the work site. However, measures that can be implemented are discussed in Section 14.6.1. Furthermore, it is recommended that in densely populated areas consideration be given to the use of multiple piling rigs per location as the additional noise impact is minor, however, the works will be completed more quickly, thus reducing the overall impact.

New Fencing

The installation of the railway fencing is described in Chapter 5 in Volume 2 of the EIAR. Generally, the installation of the fencing is expected to take place during the daytime working hours as set out in Chapter 5, however, in locations where the fencing runs particularly close to the rail tracks it may be necessary to carry out works during night-time possessions or full weekend closures.

Works that take place during daytime working hours have the potential to cause *moderate* effects at the closest properties. Works that take place during night periods have the potential to cause significant effects s at the closest properties. Mitigation measures are limited for these works due to the nature of the sites being temporary. Therefore, it is not practical to install site hoarding or permanent noise barriers to the work site. However, measures that may be implemented are discussed in Section 14.6.1.

Parapets

Parapet heightening for existing parapets and the installation of new parapets on new bridges will take place across the proposed development.

For parapet heightening the works will be undertaken during daytime working hours. The most impactful element of the works is expected to be due to cutting rebar. This element of the works is likely to cause brief, *moderate* to *significant* effects at nearby receptors, however, in general the works will likely cause a *slight* to *moderate* effect.

For parapets on bridges above the railway line, the works will take place during night time possessions. Given the sensitivity of the time period it is predicted that these works will likely cause a significant effect at nearby receptors. However, the likely effect will be *temporary* as the works will be undertaken over a two week duration on each bridge.

Construction Compounds

The construction compounds will be utilised as delivery and storage spaces for construction vehicles and materials. They will be designed in such a way that noise and vibration impacts/effects are minimised at nearby receptors, mainly by way of installation of barriers between receptors and compound, but also, where practicable, by locating internal routes and working areas far as possible from the most sensitive receptors. Mitigation measures will be implemented so that the criteria defined Section 14.5.2.3 are achieved. Measures that can be implemented are discussed in Section 14.6.1.

Construction Vibration

The range of activities with the greatest potential to generate vibration will be at level crossing closures, track lowering and linear work areas during piling for OHLE installation. Vibration levels generated during such activities have been compiled from a variety of sources including BS 5228 -2, (BSI 2009 +A1 2014b) and measurements made adjacent to items of specific plant by AWN Consulting.

The piling methodology to be employed for DART+ West project involves a combination of rotary bored piling, secant piles and impact piling.

Review of measured data from BS 5228-2 (BSI 2009 +A1 2014b) pertaining to rotary or auger driven piles, confirm that at distance of 3.5 m to 7 m, piling activities (including auguring, driving and hammer hitting base of hole) do not result in any significant vibration levels (i.e. typically of the order of <1 to 3 mm/s PPV) and are below the criteria set for this scheme for significant effects to people within buildings or to protected or vulnerable structures. These values are also in line with measured results from other construction projects conducted by AWN Consulting.

Vibration levels associated with driven piles are assessed in order to determine potential worst case impacts. BS 5228-2 (BSI 2009 +A1 2014b) includes measured magnitude of vibration associated with different piling types. Table 14-28 reproduces those associated with steel sheet piling.

Table 14-28: Vibration Magnitudes Associated with Sheet Steel Piling

Soil Condition	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 provided)	U-shaped piles	7.1	0.3 – 0.7
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 14-28 indicate that at distances beyond 20 m, vibration magnitudes are significantly reduced to well below those associated with any form of cosmetic damage to protected and historic buildings. At distances up to 20 m, the low vibration threshold for identified vulnerable buildings is likely to just be exceeded. A *negative moderate* to *significant* effect is likely for people within buildings within 20m of this activity.

During breaking activity at ground level, there is also potential for vibration to be generated through the ground. Empirical data for this activity is not provided in the BS 5228- 2:2009+A1:2014 standard, however the likely levels of vibration from this activity is expected to be significantly below the vibration criteria for building damage on experience from other sites. At distances of 20 m from this activity vibration magnitudes are expected to be well below those associated with any form of cosmetic damage to protected, historic and identified vulnerable buildings. A *negative* moderate impact is likely for people in buildings within 20 m of this activity. At increasing distances towards 50 m and beyond impacts to structures and people are likely *not significant* from this type of 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 discussed above.

Notwithstanding the information above, any activities undertaken at the construction sites will be required to operate below the vibration limits set out within Table 14-23.

Note that there will be several properties in the vicinity of the works that would be considered to be vulnerable to vibration impacts, including

- Lock-keeper's cottage at North Strand Road/Newcomen Bridge.
- Ashtown lock-keeper's cottage.
- Ashtown Oil Mill.
- Porterstown schoolhouse.

- Crossing-keeper's house at Porterstown Road.
- Former Leixlip railway station.
- Former Coldblow & Lucan railway station, east of Collins Bridge, Westmanstown.
- Station Master's house, Maynooth.

Refer to Chapter 21 in Volume 2 of the EIAR for further detail on these properties. Where these properties are in close proximity to construction activity, the lower vibration thresholds defined in Section 14.5.3.4.1 will apply. In addition, the mitigation measures outlined in Section 14.6.1 will be applied in particular, monitoring of vibration levels to avoid significant impacts occurring.

14.5.3.5.2 Zone A

The construction works specific to Zone A can be summarised as follows:

- Modifications in Connolly station.
- Track lowering and parapets heightening below OBO11.
- Construction of a new traction substation at Glasnevin.

Modifications to Connolly Station

The construction approach planned for this work is described in Chapter 5 in Volume 2 of this EIAR. The overall duration of the works is expected to be approx. 18 months with the majority of the work completed during daytime working hours. There will be some exceptions to this when night-time work will be needed for short periods to allow for the operation of installing temporary structural supports below the canopy and then reinstating the original structural supports. These works are programmed to be undertaken over two separate approx. 12 night periods.

The majority of the closest receptors to the works at Connolly Station are commercial in nature and as many of the construction activities will take place internally at vault level typically there is not expected to be significant construction noise impacts at this location. However, during the night periods there is the potential of significant impacts at any nearby dwellings to the works, the likely effects will be *negative, temporary and significant*.

Track lowering below OBO11

Track lowering works at this location will take place over an approx. 6 week period to lower the track by up to 325 mm along approximately 330 m of track. The works will be carried out over the course of weekend closures at this location and works will take place during daytime and night-time periods of each weekend closure between 01:00 Saturday to 05:00 Monday.

The works will likely generate significant noise impacts when occurring. Mitigation options will be limited, however, closest buildings to this work site are commercial in nature and therefore less sensitive to noise impacts.

Construction of a new substation at Glasnevin

The substation works will take place over an approx. 7 month period, with the main civil works which entails the majority of noisy works taking approx. 4 months. The majority of construction works will be carried out within daytime working hours. During these periods the primary source of noise will be as a result of piling and concreting works. Predictions indicate that the likely noise impact from the works will typically be *moderate* at the closest dwellings, however the piling works have the potential to cause a *temporary*, *significant* effect at the closest dwellings located in the Claremont Lawn and Clareville Court estates. Night time / weekend possessions will also be required for some construction activities, such as electrical connections. The site can implement typical mitigation measures such as a solid hoarding for the duration of the works. The majority of works will take place during daytime working hours and will be scheduled to occur during the summer months to avoid disruption to the playing pitches nearby.

14.5.3.5.3 Zone B

The construction works within Zone B can be summarised as follows:

- General MGWR track lowering.
- Spencer Dock station construction.
- OBD228 Sheriff Street Bridge reconstruction.
- Access ramp into Docklands' compound.
- New slab track configuration at Spencer Dock-Docklands-East Wall area.
- Track lowering and structural intervention at OBO36 Ossory Road Bridge.

MGWR Track Lowering

Track lowering works across the MGWR line will take place over an approx. 10 week period of full track possession. An additional approx. 2 month closure for the section between Structure C (chainage 20+309 and 20+470) at Spencer Dock Permanent Way and OBD227. During these possessions works will take place 24/7 along the length of track. Works that occur within 200 m of a property that is located along the track have the potential to cause a *temporary*, *significant* effect , however, as the works progress the effects will likely become less significant at that property and the effects will follow the work progress linearly along the track. Given the density of the urban building and infrastructure design, as well as the screening currently in place along much of the rail line, much of the work will be occluded from sensitive receptors as the works progresses along the track and therefore noise levels may be further reduced at these locations.

Mitigation measures are limited for these works due to the non-static nature of the sites and the plant involved. Works should be scheduled so that, where practicable, works undertaken close to residential properties are scheduled to occur during daytime working hours. Measures that can be implemented are discussed in Section 14.6.1.

Spencer Dock Station & OBD228 Sherriff Street Bridge Reconstruction

The construction of Spencer Dock Station and OBD228 reconstruction will be carried out during daytime hours over an approx. 39 month and an approx. 80 week (1.5 year) period respectively. Construction of the station is similar in methodology to many other large commercial construction projects in Dublin City with the following construction phases envisaged:

- Enabling works including demolition of existing structures approx. 4 week duration daytime works.
- Installation of secant pile wall using rotary bored piles approx. 15 weeks duration daytime works.
- Excavation, note some excavated material is to be transported via road to other work sites of the proposed development approx. 16 weeks daytime works.
- Concrete works approx. 32 weeks daytime works.
- Construction of the steel structure incl. the installation of the roof steel truss approx. 26 weeks duration daytime works.
- Architectural finishes and landscaping approx. 68 weeks daytime works.
- OBD228 reconstruction approx. 80 weeks daytime works;

The work site is overlooked by residential apartment buildings and as a result there will be some phases of the construction period, e.g. demolition, piling and excavation, where the construction noise levels are expected to be significant at these locations. Table 14-29 describes the potential noise and vibration impacts/effects for each stage of work without any mitigation in place.

Table 14-29 Description of Mitigated Noise Effects s at Spencer Dock Station

Work Stage	Duration (Approx)	Potential Impacts/Effects
Demolition of existing structures, including ODB228	4 weeks	Moderate to significant noise effects for periods during the daytime works when in close proximity to sensitive locations, particularly at properties close to OBD228. Note: night work not required.
Piling	15 weeks	Moderate to significant noise effects for periods during the daytime works when in close proximity to sensitive locations. Note: night work not required.
Excavation	16 weeks	Moderate to significant noise effects for periods during the daytime works when in close proximity to sensitive locations. Note: night work not required.
Concrete Works	32 weeks	Moderate to significant noise effects for periods during the daytime works when in close proximity to sensitive locations. Note: night work not required.
Steel Structure	26 weeks	Potentially moderate noise effects for periods during the daytime works when in close proximity to sensitive locations. Note: night work not required.
Architectural Finishes and Landscaping	68 weeks	No significant effects. Note: night work not required.
ODB228 Reconstruction	80 weeks	Depending on activity the noise impact generally ranges from not significant to moderate. Note: night work not required.

There are some phases where a significant noise or vibration effects may occur at sensitive locations. Mitigation measures that can be implemented to reduce the effects are discussed in Section 14.6.1.

There will also be some diversions of traffic during the course of the works as OBD228 will be closed completely during the construction period. This has been assessed in the construction traffic assessment in Section 14.5.3.5.1.

Access Ramp to Docklands Compound

The access ramp will allow construction vehicles to enter the compound from Sherriff St when other access is blocked due to other works. The ramp construction will involve excavation and earth moving to and from the ramp followed by drainage works, pavement laying and installation of guard rails. Typical plant to be used during these works are bulldozers, backhoes, cranes, concrete trucks, compactors, asphalt pavers and trucks. Works will be carried out over an approx. 4 month period during daytime working hours.

Generally, the works are not expected to generate significant noise levels for prolonged periods and the site can implement typical mitigation measures such as a solid hoarding for the duration of the works. It's expected that the pavement laying has the potential to cause brief significant effects whilst undertaken in close proximity to dwellings within the locality.

Spencer Dock-Docklands-East Wall Permanent Way Installation

The permanent way works will involve the construction of new ballast and track slab and retaining walls in order to prevent flotation and minimise the impact on adjacent tracks. Track works in Spencer Dock, including inside the station, will not start until the U- structure (bottom slab and retaining walls) is finished. These works will start at the station end of the track and will continue to the north (outwards) along the affected lines.

The principal construction elements at Docklands Permanent Way consist of:

- On-site offices and welfare facilities.
- North Wall permanent facilities demolition.
- Earthworks and piling.
- Slabs and cantilever Walls.

- Spencer Docks track.
- Connections track.

Considering all the constraints in this area, the design has been grouped into 4 different types of structural solutions as noted in Figure 14-7 below:

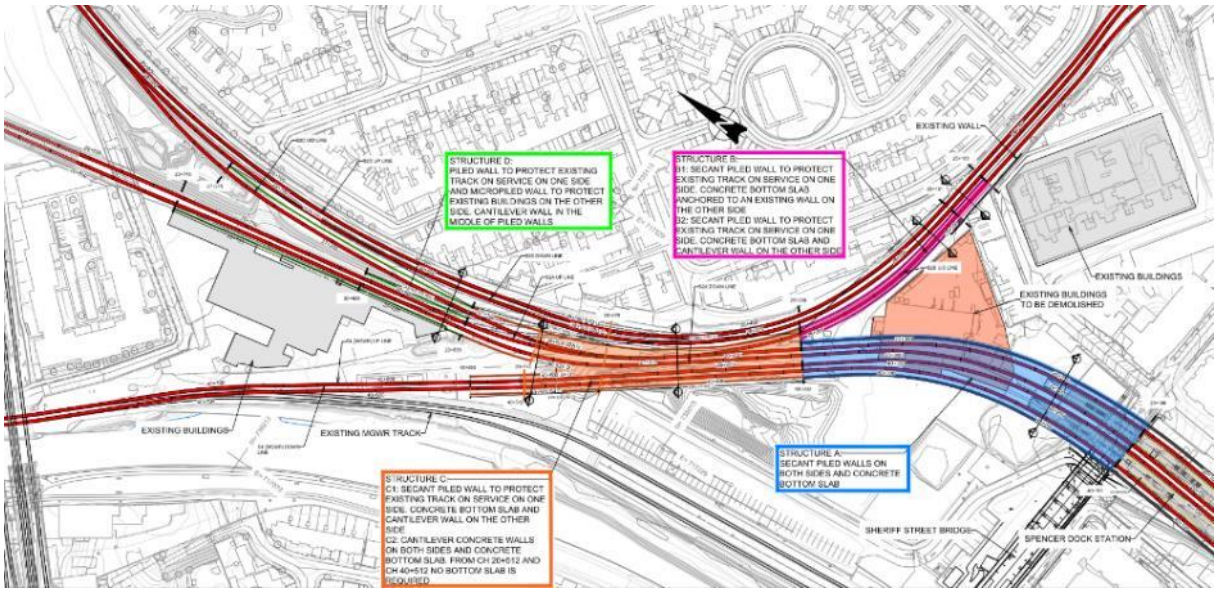


Figure 14-7 Spencer Dock proposed walls and protection slabs with the final track alignment

For Structure A, a 158 m length secant piled wall is required on each side of the tracks (in total, 316 m). Structure A will be constructed before the overbridge OBO228 is reconstructed as the supports(columns) load path will be into Structure A.

For Structure B, the secant piled wall is required for a total length of around 145 m parallel to East Wall Branch tracks to protect the on-service tracks.

For Structure C, the secant piled wall is required for a total length of around 165 m parallel to East Wall Branch tracks to protect the on-service tracks.

For Structure D, the secant piled wall is required for a total length of around 165 m parallel to East Wall Branch tracks to protect the on-service tracks, and a micro-piled wall with a total length of around 190 m on the Westside S2A Down Track Line to protect the existing buildings.

The total construction duration for all the piled wall is estimated to be approx. 11 months allowing for daytime working.

The total construction duration for all the cantilever walls and bottom slabs is estimated to be approx. 7 months allowing for daytime working.

There will be periods of work that will likely generate significant noise effects during daytime hours. It is understood that night-time works will be required for approx. 2.5 weeks with a further night possession at the end of the works. Given the duration of the night works and the additional night works for the OHLE installation there is the potential for *temporary*, *profound* effects on nearby properties. The severity of the effects is dependent on the number of consecutive nights where each receptor will be impacted (i.e. without respite the works will cause a profound impact, with respite nights scheduled then the impact could be significant). The potential noise effects is highest for Structure B and Structure D given the closer proximity of the works to dwellings.

Mitigation measures that can be implemented to reduce the impact are discussed in Section 14.6.1.

Construction of a new substation and attenuation tank at Spencer Dock

The substation works will take place over an approx. 32 week period, with the main civil works which entails the majority of noisy works taking an approx. 18 week period. The construction of the attenuation tank is expected to take place across an approx. 52 week period. The majority of construction works will be carried out within daytime working hours. During these periods the primary source of noise will be as a result of piling and concreting works. Night time / weekend possessions will also be required for some construction activities, such as electrical connections. Predictions indicate that the noise effects from the works will be *moderate* at the closest dwellings on Abercorn Road.

14.5.3.5.4 Zone C

The construction works within Zone C can be summarised as follows:

- OBG6D, OBG6C and OBG7A track lowering.
- OBG5 and OBG11 Arch deck reconstruction.
- OBG9 flat deck bridge modification.
- Ashtown, Coolmine and Castleknock substations.
- Level crossing closures in Porterstown, Clonsilla, Ashtown and Coolmine.
- Ashtown and Coolmine stations.
- Clonsilla siding installation.

Track lowering

OBG6D, OBG6C, and OBG7A are all located on the Navan Road interchange in Blanchardstown that connects Navan Road (N3) to the M50. The works will be carried out over the course of weekend closures at this location and works will take place during daytime and night-time periods of each weekend closure between 01:00 Saturday to 05:00 Monday. The works are located away from sensitive locations and noise impacts are not expected to be significant during the works.

OBG5 Broombridge Arch Deck Reconstruction

Most works will be performed during regular daytime working hours over the approx. 40 week construction period. Soil improvement behind existing walls and foundation strengthening will be performed during two railway full weekend possessions. Deconstruction of the existing arch will be performed during 1 week of day and night work on the railway. Demolition of the inner part of existing arch, placement of the new precast arch, and backfill to bed stone behind the walls, restoration work, and placement of parapets will be performed during approx. 4 weeks of night possessions and 11 weekend possessions of the railway.

The nearest sensitive locations to the works are the residential properties on Bannow Rd ~100m to the south. The distance between these residences and the works will reduce noise impacts and the majority of activities are not expected to generate significant impacts. However, some noisy activity may likely generate a *short term significant* effect particularly when taking place at night. There will be periods of disturbance during certain periods, particularly night works, however the overall effect is *temporary* and *moderate* to *significant*.

OBG11 Castleknock Bridge Modification

Most works will be performed during regular daytime working hours. Soil improvement behind existing walls and foundation strengthening will be performed during railway full weekend possessions. Deconstruction of the existing arch will be performed during 1 week of day and night work on the railway. Demolition of the inner part of existing arch, placement of the new precast arch, and backfill to bed stone behind the walls, restoration work, and placement of parapets will be performed during multiple weeks of night possessions on the railway.

There are several dwellings located nearby to the works and as a result there is a potential for significant noise impacts to occur during certain phases of the work. In particular the night-works are likely to result in *significant*, *temporary* noise effects.

Mitigation measures are limited for these works due to the nature of the sites being temporary worksites for a 4 hour period each night. Therefore, it is not practical to install site hoarding or permanent noise barriers to the work site. However, measures that can be implemented are discussed in Section 14.6.1.

OBG9 Old Navan Road Bridge Modification

Most works will be performed during daytime working hours. Foundation strengthening, placement of temporary steel frame and deck jacking will be performed during railway weekend possessions. The total construction duration for this bridgework is estimated at approx. 42 weeks, including 1 full weekend of possession and 6 weeks of night closure working on the railway. Note that the night works are not anticipated to occur continuously and the night works will be spread across the construction programme to accommodate the works above the track. There are several dwellings located nearby to the works and as a result there is a potential for significant noise effects to occur during certain phases of the work. In particular the night-works are likely to result in *significant*, *temporary* noise effects.

Mitigation measures are limited for these works due to the nature of the sites being temporary worksites for a 4 hour period each night. Therefore, it is not practical to install site hoarding or permanent noise barriers to the work site. However, measures that can be implemented are discussed in Section 14.6.1.

Construction of a Substations at Ashtown, Coolmine and Castleknock

The substation works at each location will take place over an approx. 30 week period, with the main civil works which entails the majority of noisy works taking an approx. 18 week period. The majority of construction works will be carried out within daytime working hours. During these periods the primary source of noise will be as a result of piling and concreting works. Night time / weekend possessions will also be required for some construction activities, such as electrical connections. Predictions indicate that the noise effects from the works will be *moderate* at the closest dwellings to the construction sites with the implementation of typical mitigation measures such as perimeter hoarding around the site.

Ashtown Station

The current pedestrian bridge at Ashtown station will be replaced with a new one in order to deal with the pedestrian flow increase due to the proposed traffic changes. The works are expected to take place across a 5 month period with the majority of the works taking place during the night and weekend possessions, due to the proximity to the live rail tracks. In particular dismantling of the existing bridge; platform widening; piling on the northern platform; and cutting piles and installing the pile caps will be undertaken during night periods. These night works will likely generate *significant*, *temporary* noise effects at nearby receptors.

During the day period, *moderate* to *significant temporary* noise effects are likely to occur at the nearest receptors, in particular at the Rathborne Village building which directly overlooks the works and the Station House dwelling. Mitigation measures that can be implemented are discussed in Section 14.6.1.

Ashtown Level Crossing

An underpass is proposed for access across the rail track and canal near to Ashtown Station. The works will take approx. 2 years to complete with approximately two thirds of the work taking place during the day period. However, there will be night possession work where work is taking place close to the rail track, these works will include piling, excavation and concreting. Night works are likely to cause a significant effect at surrounding receptors, and in particular at the Station House located adjacent to the rail tracks. During the day period, the likely effects from the works will range from *moderate* to *significant* dependent on the activities undertaken.

The site can implement typical mitigation measures such as a solid hoarding for the duration of the works and typical mitigation measures can be implemented, these are discussed in Section 14.6.1.

Coolmine Level Crossing

The Coolmine level crossing will be closed to vehicular traffic and replaced with a new pedestrian and cyclist crossing point. The majority of construction work will take place during the daytime, however, some night works will be required during works on or close to the tracks or when lifting precast elements into place. The duration of the night works is limited to 1 or 2 nights per activity over the course of up to a 5 month construction period.

At the closest dwellings located on Riverwood Hall there is the potential for *moderate* to *significant effects* during the day works. At dwellings located further from the works, there will likely be a *moderate* noise effects.

When night works occur the noise effects will be brief but significant at surrounding dwellings.

In addition, junction upgrade works will be required as part of the Coolmine level crossing replacement works at the following locations,

- Diswellstown Road Junction.
- Porterstown Road Junction.
- Clonsilla Road Junction.
- Castleknock Road Junction.

The majority of construction work will take place during the daytime, however, some night works will be required during works on or close to the tracks or when lifting precast elements into place. The duration of the night works is limited to 1 or 2 nights per activity over the course of up to an approx. 12 months construction period. The works may require breaking out roadways and footways. If breaking out is required at any location then a brief, significant effect is likely to occur at the closest dwellings to the works. However, mitigation measures will be employed, in particular temporary localised screens may be utilised to reduce potential effects from breaking works. Mitigation measures that can be implemented are discussed in Section 14.6.1.

Porterstown Level Crossing

The Porterstown level crossing will be closed to vehicular traffic and replaced with a new pedestrian and cyclist crossing point. The majority of construction work will take place during the daytime, however, some night works will be required during works on or close to the tracks or when lifting precast elements into place. The duration of the night works is limited to 1 or 2 nights per activity over the course of up to an approx. 14 month construction period.

At the closest dwelling, Abbey Cottage, there is the potential for *moderate* to *significant* effects during the day works.

When night works occur the noise effect will be brief but *significant* at surrounding receptors. Mitigation measures that can be implemented are discussed in Section 14.6.1.

Clonsilla Level Crossing

The Clonsilla level crossing will be closed to vehicular traffic and replaced with a new pedestrian and cyclist crossing point. The majority of construction work at will take place during the daytime, however, some night works will be required during works on or close to the tracks or when lifting precast elements into place. The duration of the night works are limited to 1 or 2 nights per activity over the course of up to an approx. 14 month construction period.

At the closest dwellings, 10 – 12 Larch Grove and Churchview Cottage, there is the potential for *significant* effects during the day works.

When night works occur the noise effect will be brief but *significant* at surrounding receptors. Mitigation measures that can be implemented are discussed in Section 14.6.1.

Clonsilla Siding

The existing siding at Clonsilla will be extended in length as part of the proposed development. The works will need to take place at night and over weekend possessions and are expected to last approx. 1.5 months. Some aspects of the work are likely to generate significant noise effects at the nearest dwellings located along the R121, some 60m from the work site. The most intrusive noise will be works of relatively short duration such as rail cutting and then welding and stressing as well as ballast compaction and tamping. Effects at this location are likely to be *negative, temporary and moderate to significant*.

14.5.3.5.5 Zone D

The construction works within Zone D can be summarised as follows,

- Hansfield, Dunboyne and M3 Parkway substations.
- OBCN286 and OBCN290 track lowering.
- M3 Parkway sidings.

Track lowering at OBCN286 & OBCN290

OBCN286 is located at Barnhill and to facilitate clearance for the catenary system and OHLE the tracks will be lowered by up to 357 mm for a distance of 325 m. The works will be carried out over the course of weekend closures at this location over the course of 4 weeks in total and works will take place during daytime and night-time periods of each weekend closure between 01:00 Saturday to 05:00 Monday. The works will likely generate significant noise effects when occurring, in particular at the two closest cottages that are located to the north and south of the rail track. Mitigation options will be limited, however, the most intrusive activities are expected to be of short duration.

OBCN290 is located at Dunboyne Station and to facilitate clearance for the catenary system and OHLE the tracks will be lowered by up to 395 mm for a distance of 215 m. The works will be carried out over the course of weekend closures at this location over the course of 3 weeks and works will take place during daytime and night-time periods of each weekend closure between 01:00 Saturday to 05:00 Monday. Whilst they will be protected by permanent noise barriers located between the track and the nearby dwellings, significant effects are still predicted for dwellings within the Larchfield estate that bound the rail track. However, the most intrusive activities are expected to be of short duration.

Construction of a Substations at Hansfield, Dunboyne and M3 Parkway

The substation works will take place over an approx. 30 week period, with the main civil works which entails the majority of noisy works taking an 18 week period. The majority of construction works will be carried out within daytime working hours. During these periods the primary source of noise will be as a result of piling and concreting works. Night time / weekend possessions will also be required for some construction activities, such as electrical connections. Predictions indicate that the noise effects from the works will typically be moderate at the closest dwellings, however for the M3 Parkway substation the piling works will likely have the potential to cause a *temporary, significant* effects at the cottage located at the end of Navan Road. The site can implement typical mitigation measures such as a solid hoarding for the duration of the works.

M3 Parkway Siding

The existing siding at M3 Parkway will be extended by constructing a new siding parallel to the existing as part of the project. The works will take place during daytime working hours, however, transportation of material to and from the compound will take place at night. Noise effects of this work are not expected to be significant given the distance of the works from sensitive locations and the daytime working hours.

Night-time traffic movements to the compound are also expected to be minor in terms of their noise impact due to the haul route via the already heavily trafficked M3 motorway. Therefore, small numbers of additional

night-time traffic movements will not change the existing noise climate. Likely effects at this location will be *negative, temporary and slight*.

14.5.3.5.6 Zone E

The construction works specific to Zone E can be summarised as follows:

- Leixlip Confey and Blakestown substation.
- Barberstown and Blakestown level crossings.
- OBG 13 and OBG18 track lowering.
- OBG 14 Cope Bridge reconstruction & widening.
- OBG16 Louisa Bridge reconstruction.

Construction of a Substations at Leixlip Confey and Blakestown

The substation works will take place over am approx. 32 week period, with the main civil works which entails the majority of noisy works taking an approx. 18 week period. The majority of construction works will be carried out within daytime working hours. During these periods the primary source of noise will be as a result of piling and concreting works. Night time / weekend possessions will also be required for some construction activities, such as electrical connections. Predictions indicate that the noise effect from the works will typically be moderate at the closest dwellings, however for the Leixlip Confey substation the piling works have the potential to cause *temporary*, *significant* effects at the closest dwellings located in the Glendale and River Forest estates. The site can implement typical mitigation measures such as a solid hoarding for the duration of the works.

Barberstown Level Crossing

The proposed works at Barberstown Level Crossing include the construction of a new road bridge with pedestrian and cycle facilities crossing the Dublin to Sligo railway and the Royal Canal approximately 200 m west of the existing level crossing. The proposals include for the construction of approach roads on raised embankment which will tie into the separately proposed Barnhill to Ongar road scheme to the north and to the existing road network south of the railway.

The majority of the works will take place during daytime hours over the course of a 1 to 2 year construction period, however, night work will be required for the following stages of construction,

- Piling – approx. 6 nights.
- Lifting new bridge deck – approx. 2 nights.
- Decommissioning existing level crossing – approx. 20 nights.

The works are located in a rural location with relatively few dwellings nearby, however, for those dwellings that are close to the works, i.e., 1 & 2 Barberstown Cottages, there will be periods of the construction work which generate significant noise levels during the nights. In particular the decommissioning of the existing level crossing is likely to cause *significant* to *very significant* effects. However, day works are expected to cause only *slight* to *moderate* effects at the closest receptors.

Track lowering at OBG13 & OBG18

OBG13 is located between Leixlip Confey and Clonsilla stations and to facilitate clearance for the catenary system and OHLE the tracks will be lowered. The works will be carried out over the course of weekend closures at this location over the course of 9 weeks and works will take place during daytime and night-time periods of each weekend closure between 01:00 Saturday to 05:00 Monday. The works will likely generate significant noise effects when occurring. Mitigation options will be limited, however, the most intrusive activities are expected to be of short duration.

OBG18 is located approx. 2.2 km from the Maynooth Station towards Dublin and to facilitate clearance for the catenary system and OHLE the tracks will be lowered. The works will be carried out over the course of

weekend closures at this location over the course of an approx. 11 weeks and works will take place during daytime and night-time periods of each weekend closure between 01:00 Saturday to 05:00 Monday. The works will likely generate significant noise effects when occurring. Mitigation options will be limited, however, the most intrusive activities are expected to be of short duration.

OBG14 Cope Bridge Deck Reconstruction and Widening

The works will consist of the precast arch deck reconstruction to increase the height of the bridge, as well as a new build of two footbridges either side of the existing arch bridge. The construction duration is approx. 46 weeks per footbridge of which the majority will be undertaken during the day time working hours, however some activities are required to be undertaken during the night due to the close proximity of the rail tracks. Night works will include 2 weekends of piling, 2 weekends of excavation, 2 weekends of installing the pilecaps as well as 2 weeks of night works to construct the top slab and 2 weeks of parapets work. Deck reconstruction will take place over the course of approx. 40 weeks, of which will be 5 weeks of night works and 11 weekend possessions.

The majority of day time construction works will likely cause *moderate*, *temporary* effects at surrounding properties, however some works such as piling have the potential to cause *temporary significant* effects although it is not expected that these impacts will be of relatively short duration.

During the night period predictions indicate that the construction works will cause a *temporary, negative*, *significant* effect at nearby dwellings. In particular this will be during the two periods of two week long night possessions.

OBG16 Louisa Bridge Modification

Most works will be performed during regular daytime working hours. Foundation strengthening, placement of temporary steel frame and deck jacking will be performed during railway weekend possessions. The total construction duration for this bridgework is estimated at approx. 42 weeks, including 1 full weekend of possession and 6 weeks of night closure working on the railway. Note that the night works are not anticipated to occur continuously and the night works will be spread across the construction programme to accommodate the works above the track. There are several dwellings located nearby to the works and as a result there is a potential for significant noise effects to occur during certain phases of the work. In particular the night-works are likely to result in *significant, temporary* noise effects.

Mitigation measures are limited for these works due to the nature of the sites being temporary worksites for a 4 hour period each night. Therefore, it is not practical to install site hoarding or permanent noise barriers to the work site. However, measures that can be implemented are discussed in Section 14.6.1.

Blakestown Level Crossing

No significant construction works will occur at Blakestown and therefore there will be no noise effects as a result of this crossing being closed.

14.5.3.5.7 Zone F

The construction works specific to Zone F can be summarised as follows,

- Modifications to the Maynooth Station.
- Modifications to the existing siding at Maynooth Station.
- Construction of the new Maynooth Substation.
- Track doubling from Maynooth Station to the new depot.
- Construction of the new UBG22A, UBG22B, UBG22C & OBG23A structures.
- Construction of the new depot Access Road.
- Construction of the new depot.

Modifications to Maynooth Station and the Existing Siding

Modification to the platforms is required at Maynooth Station to allow for the track realignment works. The demolition of the platforms is expected to cause the most effects at nearby receptors. The effects are likely to be *negative, significant and temporary*, in particular at the dwellings within the Silken Vale estate that back on to the railway.

The existing siding at Maynooth Station will be upgraded to meet the operational needs and electrification requirements. The works will take place over an approx. 6 week duration and will take place during daytime working hours. Noise effects from some elements of this work, in particular the extension and compaction of the subgrade, sub-ballast layer and first ballast layer, have the potential to be temporarily significant at the closest dwellings that bound the railway line, in particular the dwellings within the Silken Vale estate that back on to the railway. Other elements of the work will likely have *negative, moderate and temporary* effects at the closest receptors.

Construction of a Substation at Maynooth

The substation works will take place over an approx. 32 week period, with the main civil works which entails the majority of noisy works taking an approx. 18 week period. The majority of construction works will be carried out within daytime working hours. During these periods the primary source of noise will be as a result of piling and concreting works. Night time / weekend possessions will also be required for some construction activities, such as electrical connections. Predictions indicate that the noise impact from the works will typically be *moderate* at the closest dwellings, however the piling works have the potential to cause a *temporary, significant* effect at the closest dwellings located in the Silken Vale estate. The site can implement typical mitigation measures such as a solid hoarding for the duration of the works.

Track Doubling from Maynooth Station to Depot

It will be required to upgrade the single-track line to a twin-track configuration between Maynooth and the proposed depot. The works to be undertaken will depend on the current configuration of the track over various sections, however, as an overview it will include conversion of sidings to mainline, replacement of track and construction of new mainline, diversion of double track, track realignment and track slewing. It will be necessary for the vast majority of the works to be undertaken during night and weekend possessions over the course of a 60 week duration.

Given the duration and methodology of the works, as well as the sensitive night period in which the majority of the works will be undertaken, it is predicted the properties nearby to the rail line will likely experience *negative, significant to profound, temporary* effects.

Mitigation measures are limited for these works due to the nature of the sites being temporary worksites for a 4-hour period each night. Therefore, it is not practical to install site hoarding or permanent noise barriers to the work site. However, measures that can be implemented are discussed in Section 14.6.1.

Construction of the new UBG22A & UBG22B underbridges

New underbridge structures will be constructed during the daytime working hours over the course of an approx. 42 week period for UBG22A and an approx. 36 week period for UBG22B. The closest receptors are approximately 100 m from the site. Given the distance to the site and the period of the day that the works will be undertaken in there are no significant effects predicted for these works.

Construction of the new OBG23A overbridge

A new precast overbridge structure will mainly be constructed over an approx. 47 week period during daytime working hours with an additional 2 weeks of night possessions and 2 weekend possessions to tie into existing road network. The works include piling, excavation concreting and lifting and placement of precast concrete elements.

The closest receptors are located approximately 200 m from the bulk of the work. Given the distances there will be no significant effects during the day period. When works take place during the night period there is the potential for *temporary, moderate to significant* effects at the closest receptors.

Construction of the new Depot Access Road

The construction of the depot access road will take place over approx. 5 month in duration. The works will be undertaken during the daytime working hours and will consist of:

1. Utilities diversion.
2. Site clearance and excavation to remove vegetation and topsoil.
3. Soil compaction to the required level.
4. Fine grading.
5. Lay aggregate base for the road.
6. Lay the pavement and finishes.

The closest residential receptors are located approximately 100 m from the bulk of the works. Given that the working hours will be during the day period and the distance to the receptors will typically be 100 m or more from the works the effects are likely to be *negative, slight and temporary*.

Construction of the Depot

The following phases of construction and durations are anticipated for an approx. 120 week (3 year) construction period for the depot:

- Depot 30 months
- Depot PW Maintenance Compound 12 months
- Compensatory Storage areas 6 months

The possession strategy is to utilise daytime working hours as much as possible because most of the activities are offline from the railway line. There is minimum effect on the railway where the connections to mainline are after the double tracking works are complete. For the OBG24 demolition a full weekend closure is needed.

The work site is located a significant distance from nearby residential buildings and as a result the noise and vibration effects are not expected to be significant. Table 14-30 describes the potential noise and vibration effects for each stage of work without any mitigation in place.

Table 14-30 Description of Unmitigated Noise Effects at Depot Site

Work Stage	Duration	Potential Effects
Demolition of ODG24	1 week, 1 night and 1 weekend possession	Noise effects are not significant given the distance from sensitive locations.
Site Clearance, Earthworks and Utilities Diversions	12 weeks	Noise & vibration effects not significant.
Track installation	10 Months	Potentially significant noise effect for periods during the daytime works when in close proximity to northern boundary and sensitive properties. Tamping activity is the noisiest activity.
Workshop Building Structure	48 weeks	Noise & vibration effects not significant.
Workshop Building Installations	24 weeks	Noise & vibration effects not significant.
Equipment Installation and Commissioning	32 weeks	Noise & vibration effects not significant.
SET Installation	9 Months	Moderate noise effects during OHLE installation.

There are some phases where a significant noise or vibration effect may occur at sensitive locations. Mitigation measures that can be implemented to reduce the negative effects are discussed in Section 14.6.1.

14.5.4 Potential Operational Impacts

14.5.4.1 Operational Rail Noise

There is no applicable national guidance specifying airborne noise limits from rail operations, therefore precedence from other rail projects has been used. A review of relevant criteria relating to operational train noise has been undertaken for several large scale urban rail projects, namely Dublin Luas, MetroLink, Channel Tunnel Rail Link-London and Cross Rail-London in addition to guidance documents relating to environmental noise.

Table 14-31 proposes airborne noise operational rail criteria.

Table 14-31 Operational Rail Noise Threshold

Sensitive Locations	Noise Criteria during Operational Phase
Locations that are highly sensitive during day and night-time periods • All residential buildings; • Health care facilities (hospitals, nursing homes) • Hotels, student accommodation, hostels etc.	Daytime: 55 dB $L_{Aeq,16hr}$ (07:00 – 23:00hrs) Night-time: 45dB $L_{Aeq,8hr}$ (23:00 – 07:00hrs)

Where operational rail noise is calculated to be below the threshold values in

Table **14-31**, the effect is determined to be not significant. Where operational rail noise levels are above these threshold levels, the effects rating is dependent on the magnitude above the threshold value and the increase above the baseline noise environment.

Where pre-existing noise levels are already high (well above the threshold value), a small change in noise levels will not be noticeable and a larger change may cause disturbance and be significant. The scale of the impact will depend on the degree of noise change. If the ambient noise is level is currently low (below the threshold), then the scale of impact is dependent on the extent to which the predicted noise levels exceed the thresholds. The change criteria and associated effects ratings are summarised in Table 14-32.

Table 14-32 Impact magnitude and significance rating

Calculated noise level above threshold or baseline	Impact Magnitude	Significance Rating
>10 dB	Very High	Very Significant
5 – 10 dB	High	Significant
3 – 5 dB	Medium	Moderate
1 – 3 dB	Low	Slight
Less than 1 dB	Very Low	Not Significant

14.5.4.2 WHO Environmental Noise Guidelines for the European Region

The World Health Organisation (WHO) have published in October 2018 Environmental Noise Guidelines for the European Region. The objective of these guidelines is to provide recommendations for protecting human health from exposure to environmental noise from transportation, wind farm and leisure sources of noise. The guidelines present recommendations for each noise source type in terms of L_{den} and L_{night} levels above which there is risk of adverse health risks.

However, it should be noted that the WHO guideline values referred to here are recommended to serve as the basis for a policy-making process to allow evidence based public health orientated recommendations. They

are not intended to be noise limits and the WHO document states the following regarding the implementation of the guidelines:

> *"The WHO guideline values are evidence-based public health-oriented recommendations. As such, they are recommended to serve as the basis for a policy-making process in which policy options are considered. In the policy decisions on reference values, such as noise limits for a possible standard or legislation, additional considerations – such as feasibility, costs, preferences and so on – feature in and can influence the ultimate value chosen as a noise limit. WHO acknowledges that implementing the guideline recommendations will require coordinate d effort from ministries, public and private sectors and nongovernmental organizations, as well as possible input from international development and finance organizations. WHO will work with Member States and support the implementation process through its regional and country offices."*

It is therefore not intended to refer to the WHO guidelines in an absolute sense as part of this assessment and it will be a decision for national and local policy makers to adopt the WHO guidelines and propose noise limits for use. Notwithstanding this the following recommendations are noted from the WHO guidelines:

- For average noise exposure, the WHO strongly recommends reducing noise levels produced by railway traffic below 54 dB L_{den}, as railway noise above this level is associated with adverse health effects.
- For night noise exposure, the WHO strongly recommends reducing noise levels produced by railway traffic during night time below 44 dB L_{night}, as night-time railway noise above this level is associated with adverse effects on sleep.

The recommended noise exposure levels are similar to the absolute levels proposed in Table 14-31 however as this proposed development is an existing track already exposed to rail noise it is not practical to achieve these absolute levels in many areas.

As the WHO guidelines are intended to allow policy makers make health-orientated recommendations further commentary will be presented in this chapter on the health effects of the calculated noise levels in terms of prevalence of highly annoyed population using the percentage highly annoyed (%HA) metric and sleep disturbance using the percentage highly sleep disturbed (%HSD) metric based on the community response studies for rail noise on which the WHO datasets are based.

14.5.4.3 Fixed Plant Noise

Once a development of this nature becomes fully operational, a variety of electrical and mechanical plant will be required to service the proposed development at various locations. Most of this plant will be capable of generating noise to some degree. Some of this plant may operate 24 hours a day, and hence would be most noticeable during quiet periods (i.e. overnight). Noisy plant with a direct line-of-sight to noise sensitive properties would potentially have the greatest effects. Plant contained within plantrooms has the least potential for effects.

BS 8233:2014 Guidance on Sound Insulation and Noise Reduction for Buildings (BSI 2014c) provides guideline values for internal noise levels within residential dwellings. The following guideline values for indoor noise levels are presented in the standard:

Table 14-33 BS 8233:2014 Indoor Noise Levels

Activity	Location	Daytime	Night-time
Resting	Living room	35 dB $L_{Aeq, 16hour}$	-
Dining	Dining room/area	40 dB $L_{Aeq, 16hour}$	-
Sleeping (daytime resting)	Bedroom	35 dB $L_{Aeq, 16hour}$	30 dB $L_{Aeq, 8hour}$
Notes: Daytime assessment period – 07:00 to 23:00 hrs Night-time assessment period – 23:00 to 07:00 hrs			

The BS 8233:2014 (BSI 2014c) values are broadly in-line with the values as presented in the WHO Guidelines for Community Noise (WHO 1999), which are presented in Table 14-34.

Table 14-34 WHO Indoor Noise Levels

Specific Environment	Critical Health Effect(s)	dB $L_{Aeq, T}$	Time Base (House)	dB $L_{Amax, F}$
Dwelling indoors	Speech intelligibility and moderate annoyance, daytime and evening	35	16	-
Inside bedrooms	Sleep disturbance, night-time	30	8	45

The L_{AFmax} is the instantaneous fast time weighted maximum sound level, measured during the sample period, and the 45 dB L_{AFmax} criterion applies to 'single sound events' within bedrooms at night. This guideline is generally interpreted as the value that individual noise events should not normally exceed.

Referring to the BS 8233:2014 (BSI 2014c) and WHO Guidelines for Community Noise (WHO 1999) documents, the following daytime and night-time internal noise thresholds have been identified for residential dwellings in the vicinity of Operational Phase plant items:

- 35 dB $L_{Aeq, 16\ hr}$ within living rooms and dining rooms during daytime periods (07:00hrs to 23:00hrs).
- 30 dB $L_{Aeq, 8\ hr}$ within bedrooms during the night-time period (23:00hrs to 07:00hrs).

It is appropriate to derive external noise limits based on the internal guidance set out in Table 14-33. This is done by factoring in the degree of noise reduction afforded by a partially open window. Annex G in BS 8233:2014 (BSI 2014c) comments that, '…*If partially open windows were relied upon for background ventilation, the insulation would be reduced to approximately 15 dB*…' although it is also acknowledged that the level difference through a window partially open for ventilation can vary depending on window type and this is nominally deemed to fall in the range of 10 to 15 dB. Therefore, to provide a worst-case assessment, an inside to outside level difference of 10 dB assuming an open window has been used. In summary, therefore the following external noise criteria are proposed for residential properties in the vicinity of the proposed development:

- Daytime (07:00hrs to 23:00hrs): 45 dB $L_{Aeq, 16hr}$.
- Night-time (23:00hrs to 07:00hrs): 40 dB $L_{Aeq, 8hr}$.

In areas where background noise levels (expressed using the L_{A90} parameter) are below the fixed noise limits above, there is potential for the operation of a new noise sources at this level to be audible and to generate potential significant effects, depending on the magnitude above the background noise level. Therefore, when considering the potential impact of the noise emissions from operational plant associated with the proposed development consideration will also be given to the British Standard BS 4142:2014+A1:2019: Methods for rating and assessing industrial and commercial sound.

BS 4142:2014+A1:2019: Methods for rating and assessing industrial and commercial sound is the industry standard method for analysing building services plant sound emissions to residential receptors. BS 4142 describes methods for rating and assessing sound of an industrial and/or commercial nature. The methods described in this British Standard use outdoor sound levels to assess the likely effects of sound on people who might be inside or outside a dwelling or premises used for residential purposes upon which sound is incident.

For an appropriate BS 4142 assessment it is necessary to compare the measured external background sound level (i.e. the $L_{A90,T}$ level measured in the absence of plant items) to the rating level ($L_{Ar,T}$) of the various plant items, when operational. Where sound emissions are found to be tonal, impulsive, intermittent or to have other sound characteristics that are readily distinctive against the residual acoustic environment, BS 4142 advises that penalties be applied to the specific level to arrive at the rating level.

The subjective method for applying a penalty for tonal sound characteristics outlined in BS 4142 recommends the application of a 2 dB penalty for a tone which is just perceptible at the receptor, 4 dB where it is clearly

perceptible, and 6 dB where it is highly perceptible. In relation to intermittency, BS 4142 recommends that if the intermittency is readily distinguishable against the residual acoustic environment, a penalty of 3 dB can be applied. The following definitions as discussed in BS 4142 as summarised below:

"ambient sound level, $L_{Aeq,T}$" equivalent continuous A-weighted sound pressure level of the totally encompassing sound in a given situation at any given time, usually from many sources near and far, at the assessment location over a given time interval, T".

"residual sound level, $L_{Aeq,T}$" equivalent continuous A-weighted sound pressure level of the residual sound (i.e. ambient sound remaining at the assessment location when the specific sound source is suppressed to such a degree that it does not contribute to the ambient sound) at the assessment location over a given time interval, T".

"specific sound level, $L_{Aeq,T}$" equivalent continuous A-weighted sound pressure level produced by the specific sound source at the assessment location over a given reference time interval, Tr".

"rating level, $L_{Ar,T}$" specific sound level plus any adjustment for the characteristic features of the sound".

"background sound level, $L_{A90,T}$" A-weighted sound pressure level that is exceeded by the residual sound at the assessment location for 90% of a given time interval, T, measured using time weighting F and quoted to the nearest whole number of decibels".

In order to establish an initial estimate of impact, BS 4142 states the following:

"*Obtain an initial estimate of the impact of the specific sound by subtracting the measured background sound level from the rating level and consider the following.*

a. Typically, the greater this difference, the greater the magnitude of the impact.

b. A difference of around +10 dB or more is likely to be an indication of a significant adverse impact, depending on the context.

c. A difference of around +5 dB is likely to be an indication of an adverse impact, depending on the context.

d. The lower the rating level is relative to the measured background sound level, the less likely it is that the specific sound source will have an adverse impact or a significant adverse impact. Where the rating level does not exceed the background sound level, this is an indication of the specific sound source having a low impact, depending on the context."

Adverse impacts include, but are not limited to, annoyance and sleep disturbance. Not all adverse impacts will lead to complaints and not every complaint is proof of an adverse impact.

The assessment methodology (i.e. comparison of rated sound level to background sound level) is quoted in BS 4142 as representing a methodology to 'obtain an initial estimate' of impact. It is important to note that BS 4142 also comments that 'Where the initial estimate of the impact needs to be modified due to the context, take all pertinent factors into consideration'. BS 4142 provides a list of potential pertinent factors that can influence the 'initial estimate'.

For night time the design target for operational plant items at the nearest NSL shall be limited to no greater than 5 dB above the background sound level. Depending on the context, it may be acceptable for plant noise emissions to be greater than 5 dB above the background provided guideline values for internal noise levels within residential dwellings from BS 8233:2014 (BSI 2014c) are not exceeded.

Noise from public address (PA) systems would not normally be considered using this guidance given its nature and frequency. In this instance, best practice guidance has been set out for this source which will be implemented during detail design of the stations.

14.5.4.4 Changes in Road Traffic Noise

In the absence of any Irish guidelines or standards relating to describing the effects associated with changes in road traffic noise levels, reference has been made to the DMRB Noise and Vibration document (UKHA 2020). This document provides magnitude rating tables relating to changes in road traffic noise. The document suggests that during the year of opening (the short-term period), the magnitude of impacts between the Do-Nothing and the Do-Something scenarios are likely to be greater compared to the longer-term period when people become more habituated to the change.

For the proposed development, the initial significance criteria are determined based on the magnitude of change for the 'short-term' period, i.e. the year of opening. For this assessment year, a 1 dB change between the Do-Nothing and Do-Something scenarios is the smallest that is considered perceptible. Table 14-35 summarises the potential impact associated with defined changes in traffic noise level during the year of opening, 2028.

Table 14-35 Significance of Change Criteria – Short-Term

Change in Noise Level, dB	Short Term Magnitude	Initial Significance Rating
Greater than or equal to 5.0	Major	Significant
3.0 to 4.9	Moderate	Significant
1.0 to 2.9	Minor	Not Significant
Less than 1.0	Negligible	Not Significant

Where changes in traffic noise levels in the short-term are less than 3 dB, the impact is deemed not significant. Where changes in traffic noise levels are greater than 3 dB, the impact is deemed to be potentially significant.

Further consideration of the magnitude of change in noise levels are determined for the long-term period (i.e. between the Do Nothing and Do Something scenarios for future assessment year 2043). For this assessment year (design year 2043), a 3 dB change is the smallest that is considered perceptible.

Table 14-36 summarises the likely impact associated with defined changes in traffic noise level between the Do-Nothing and Do-Something scenarios during the long-term period.

Table 14-36 Significance of Change Criteria – Long-Term

Long-Term Magnitude	Change in Noise Level, dB	Initial Significance Rating
Major	Greater than or equal to 10.0	Significant
Moderate	5 to 9.9	Significant
Minor	3.0 to 4.9	Not Significant
Negligible	Less than 3.0	Not Significant

14.5.4.5 Vibration

Once operational, there is potential for operational vibration impacts associated with the above ground sections of railway at adjacent sensitive buildings. Reference is made to BS 6472 – 1 (BSI 2008) which provides the following Vibration Dose Value (VDV) ranges which result in various probabilities of adverse comment resulting from exposure to vibration within buildings. An adverse comment is an unfavourable human reaction or response.

Table 14-37 Vibration during operation - threshold of significant effects on building occupants

BS 6472-1 2008 Rating	In the Absence of Appreciable Existing Levels of Vibration (1), (2)	
	VDV ms-1.75 Daytime (07:00-23:00)	VDV ms-1.75 Night-time (23:00-07:00)
Adverse Comment not expected	≤ 0.2	≤ 0.1
Low probability of adverse comment	> 0.2 – 0.4	> 0.1 – 0.2
Adverse comment possible	> 0.4 – 0.8	> 0.2 – 0.4
Adverse comment probable	> 0.8 – 1.6	> 0.4 – 0.8
	> 1.6	> 0.8

(1) Highest impact category used, daytime or night-time.

(2) Where there is an appreciable existing level of vibration and daytime and night-time vibration dose values (VDVs) exceed 0.22 ms-1.75 and 0.13 ms-1.75

Table 14-38 details the significance rating applied to operation phase vibration impacts. Note that for locations exposed to a measured level of vibration in the baseline environment, which will be the case for most locations assessed as part of this proposed development, the rating is determined based on the change in vibration level.

Table 14-38 Operational Vibration Significance Rating Scale

Impact Classification	In the Absence of Appreciable Existing Levels of Vibration		Appreciable Existing Levels of Vibration	Significance Rating
	VDV ms-1.75 Daytime (07:00-23:00)	VDV ms-1.75 Night-time (23:00-07:00)	% Increase in VDV	
Negligible	≥0.2	≥0.1	≤25	Not Significant
Slight	> 0.2 – 0.4	> 0.1 – 0.2	25 – 40%	Significant impact
Moderate	> 0.4 – 0.8	> 0.2 – 0.4	> 40 – 100%	
Substantial	> 0.9 – 1.6	> 0.4 – 0.8	> 100 –185%	
Severe	> 0.62	> 0.8	> 185%	

14.5.4.6 Operational Rail Noise & Vibration Impact Assessment

The proposed development will facilitate the operation of an enhanced rail service between Dublin and Maynooth and M3 Parkway. An increase in operational services has the potential to pose effects to noise and vibration at the closest properties along the length of the proposed development.

An assessment of the likely increase in operational noise levels has been undertaken at the unattended baseline survey locations. The methodology used to calculate rail noise levels was in accordance with the RMR method which is the Dutch calculation methodology adopted for the assessment of rail noise by Iarnród Éireann. The calculations have been performed taking into account the following information:

- Train categories in operation along the line.
- train numbers and speeds.
- distance attenuation.
- air absorption.
- ground factors (absorbent and reflecting surfaces).
- ground height differences (cuttings/embankments).
- screening effects (boundary treatments, buildings, retaining walls etc).
- meteorological conditions.
- angle of view of the receiver.
- the number of rail sections within the considered area.

14.5.4.6.1 Noise Model

A computer-based prediction model has been prepared in order to quantify the traffic noise level associated with the operational phase of the development. This section discusses the methodology behind the noise modelling process and presents the results of the modelling exercise.

SoftNoise Predictor

Proprietary noise calculation software was used for the purposes of this impact assessment. The selected software, SoftNoise Predictor Version 2021, calculates rail noise levels in accordance with the RMR methodology.

Input to the Noise Model

The noise model was prepared using 3D rail alignment drawings, topographical data, Ordnance Survey mapping and train numbers. Table 14-39 and Table 14-40 summarise the train numbers and train types used in the assessment. Note that existing Diesel Multiple Units (DMU) and freight movements, where present, are not changing as a result of this proposal. The train numbers are presented in terms of a typical weekday day, evening and night period for DMU and Electric Multiple Units (EMU) traffic. Note that freight movements are not included in the assessment as the information provided indicates there will be no change to freight movements currently in operation. Furthermore, the frequency of freight movements is insignificant in the context of the Commuter and DART service.

Table 14-39 Do Nothing Train Numbers

Do-Nothing Summary Table		Number of trains																	
Section/direction		Daytime (7.00 - 19.00)						Evening (19.00 - 23.00)						Night (23.00 - 7.00)					
		EMU Trains			DMU Trains			EMU			DMU			EMU			DMU		
From	To	Passenger	Technical	Total Trains	Passenger	Technical	Total Trains	Passenger	Technical	Total Trains	Passenger	Technical	Total Trains	Passenger	Technical	Total Trains	Passenger	Technical	Total Trains
Connolly	East Wall Jct.	4 (4-car) 39 (6-car) 27 (8-car)	3 (4-car)	73	1 (3-car) 9 (4-car) 1 (7-car) 11 (8-car) 6 Belfast	2 (4-car) 1 (8-car) 2 (7-car)	27	1 (4-car) 10 (6-car) 8 (8-car)	2 (4-car) 1 (6-car)	22	2 (7-car) 3 (8-car) 2 Belfast	0	5	5 (6-car) 2 (8-car)	3 (4-car) 3 (6-car) 2 (8-car)	15	1 (7-car)	0	1
East Wall Jct.	Connolly	4 (4-car) 40 (6-car) 27 (8-car)	3 (4-car)	74	1 (3-car) 10 (4-car) 3 (7-car) 11 (8-car) 6 Belfast	1 (4-car) 1 (7-car)	27	2 (4-car) 10 (6-car) 6 (8-car)	1 (8-car)	19	3 (8-car) 3 Belfast	0	3	4 (6-car) 5 (8-car)	1 (6-car) 4 (8-car)	14	2 (8-car)	0	2
Connolly	Newcomen Jct	0	0	0	1 (7-car)	0	1	0	0	0	0	0	0	0	0	0	0	0	0
Newcomen Jct	Connolly	0	0	0	0	1 (4-car)	1	0	0	0	0	0	0	0	0	0	0	0	0
Connolly	North Strand Jct.	0	0	0	6 (3-car) 30 (4-car) 2 (7-car) 15 (8-car)	1 (5-car)	54	0	0	0	4 (3-car) 6 (4-car) 1 (7-car) 1 (8-car)	0	12	0	0	0	1 (3-car) 2 (4-car) 1 (7-car) 2 (8-car)	1 (3-car) 3 (4-car) 1 (8-car)	11
North Strand Jct.	Glasnevin	0	0	0	6 (3-car) 31 (4-car) 2 (7-car) 15 (8-car)	1 (5-car)	55	0	0	0	4 (3-car) 6 (4-car) 1 (7-car) 1 (8-car)	0	12	0	0	0	1 (3-car) 1 (4-car) 1 (7-car) 2 (8-car)	1 (3-car) 3 (4-car) 1 (8-car)	10
Glasnevin	Islandbridge Jct.	0	0	0	5 (3-car) 12 (4-car)	1 (5-car)	18	0	0	0	4 (3-car) 1 (4-car)	0	5	0	0	0	1 (3-car)	0	1
Islandbridge Jct.	Glasnevin	0	0	0	5 (3-car) 12 (4-car) 1 (5-car)	1 (7-car)	19	0	0	0	4 (3-car)	0	4	0	0	0	1 (3-car)	0	1
Glasnevin	North Strand Jct.	0	0	0	6 (3-car) 29 (4-car) 1 (5-car) 3 (7-car) 14 (8-car)	1 (7-car)	54	0	0	0	5 (3-car) 8 (4-car) 4 (8-car)	0	17	0	0	0	1 (3-car) 2 (4-car) 1 (8-car)	1 (3-car) 1 (4-car) 1 (7-car)	7
North Strand Jct.	Connolly	0	0	0	6 (3-car) 28 (4-car) 1 (5-car) 3 (7-car) 14 (8-car)	1 (7-car)	53	0	0	0	5 (3-car) 8 (4-car) 4 (8-car)	0	17	0	0	0	1 (3-car) 2 (4-car) 1 (8-car)	0	4
Docklands	Glasnevin	0	0	0	6 (3-car) 4 (4-car)	2 (4-car)	12	0	0	0	1 (3-car) 1 (4-car)	0	2	0	0	0	0	0	0
Glasnevin	Clonsilla	0	0	0	7 (3-car) 21 (4-car) 2 (7-car) 15 (8-car)	3 (4-car)	48	0	0	0	1 (3-car) 6 (4-car) 1 (7-car) 1 (8-car)	0	9	0	0	0	1 (4-car) 2 (8-car) 1 (7-car)	1 (3-car) 2 (4-car) 1 (8-car)	8
Clonsilla	Glasnevin	0	0	0	7 (3-car) 23 (4-car) 3 (7-car) 14 (8-car)	0	47	0	0	0	1 (3-car) 7 (4-car) 3 (8-car)	0	11	0	0	0	2 (4-car) 2 (8-car)	1 (3-car) 1 (4-car) 1 (7-car)	7
Glasnevin	Docklands	0	0	0	(5 3-car) (6 4-car)	1 (7-car)	12	0	0	0	1 (3-car)	0	1	0	0	0	0	0	0

Do-Nothing Summary Table		Number of trains																	
Section/direction		Daytime (7.00 - 19.00)						Evening (19.00 - 23.00)						Night (23.00 - 7.00)					
		EMU Trains			DMU Trains			EMU			DMU			EMU			DMU		
From	To	Passenger	Technical	Total Trains	Passenger	Technical	Total Trains	Passenger	Technical	Total Trains	Passenger	Technical	Total Trains	Passenger	Technical	Total Trains	Passenger	Technical	Total Trains
Connolly	Pearse	4 (4-car) 40 (6-car) 27 (8-car)	1 (4-car)	72	6 (3-car) 19 (4-car) 1 (5-car) 3 (7-car) 17 (8-car)	1 (7-car) 1 (8-car)	48	2 (4-car) 10 (6-car) 6 (8-car)	0	18	4 (3-car) 5 (4-car) 1 (7-car) 5 (8-car)	0	15	2 (6-car) 3 (8-car)	1 (6-car) 2 (8-car)	8	1 (3-car)	1 (4-car) 1 (7-car)	3
Pearse	Connolly	4 (4-car) 40 (6-car) 26 (8-car)	2 (4-car)	72	5 (3-car) 22 (4-car) 2 (7-car) 14 (8-car)	2 (4-car) 1 (5-car) 1 (7-car) 2 (8-car)	49	1 (4-car) 10 (6-car) 8 (8-car)	1 (4-car)	20	5 (3-car) 5 (4-car) 2 (7-car) 4 (8-car)	0	16	5 (6-car) 2 (8-car)		7	1 (3-car) 1 (4-car) 1 (7-car)	0	3
Glasnevin	Clonsilla	0	0	0	7 (3-car) 21 (4-car) 2 (7-car) 15 (8-car)	3 (4-car)	48	0	0	0	1 (3-car) 6 (4-car) 1 (7-car) 1 (8-car)	0	9	0	0	0	1 (4-car) 2 (8-car) 1 (7-car)	1 (3-car) 2 (4-car) 1 (8-car)	8
Clonsilla	Maynooth	0	0	0	1 (3-car) 18 (4-car) 2 (7-car) 14 (8-car)	1 (4-car)	36	0	0	0	5 (4-car) 1 (7-car) 2 (8-car)	0	8	0	0	0	1 (4-car) 2 (8-car) 1 (7-car)	2 (4-car) 1 (8-car)	7
Maynooth	Kilcock	0	0	0	7 (4-car) 1 (7-car) 2 (8-car)	0	10	0	0	0	1 (4-car) 1 (7-car)	0	2	0	0	0	0	0	0
Kilcock	Maynooth	0	0	0	5 (4-car) 1 (7-car) 1 (8-car)	0	7	0	0	0	2 (4-car)	1 (7-car)	3	0	0	0	1 (4-car)	0	1
Maynooth	Clonsilla	0	0	0	1 (3-car) 15 (4-car) 3 (7-car) 14 (8-car)	0	33	0	0	0	6 (4-car) 3 (8-car)	0	9	0	0	0	3 (4-car) 2 (8-car)	1 (4-car) 1 (7-car)	7
Clonsilla	Glasnevin	0	0	0	7 (3-car) 23 (4-car) 3 (7-car) 14 (8-car)	0	47	0	0	0	1 (3-car) 7 (4-car) 3 (8-car)	0	11	0	0	0	2 (4-car) 2 (8-car)	1 (3-car) 1 (4-car) 1 (7-car)	7
Clonsilla	M3 Parkway	0	0	0	11 (3-car) 4 (4-car)	1 (4-car)	16	0	0	0	4 (3-car) 1 (4-car)	0	5	0	0	0	1 (3-car)	1 (3-car)	2
M3 Parkway	Clonsilla	0	0	0	11 (3-car) 6 (4-car)	0	17	0	0	0	4 (3-car) 1 (4-car)	0	5	0	0	0	1 (3-car) 1 (4-car)	1 (3-car)	3

Table 14-40 Do Something Train Numbers

Do-Something Summary Table		Number of Trains																	
Section/direction		Daytime (7.00 - 19.00)						Evening (19.00 - 23.00)						Night (23.00 - 7.00)					
		EMU			DMU			EMU			DMU			EMU			DMU		
From	To	Passenger	Technical	Total Trains	Passenger	Technical	Total Trains	Passenger	Technical	Total Trains	Passenger	Technical	Total Trains	Passenger	Technical	Total Trains	Passenger	Technical	Total Trains
Connolly	East Wall Jct.	89	4	93	33	0	33	24	2	26	10	0	10	6	9	15	4	0	4
East Wall Jct.	Connolly	88	5	93	34	0	34	26	1	27	10	0	10	7	9	16	3	0	3
Connolly	North Strand Jct.	67	0	67	21	0	21	20	7	27	6	0	6	11	4	15	2	0	2
North Strand Jct.	Glasnevin	110	0	110	21	0	21	36	7	43	6	0	6	18	6	24	2	0	2
Glasnevin	Islandbridge Jct.	71	0	71	0	0	0	25	0	25	0	0	0	14	3	17	0	0	0
Islandbridge Jct.	Glasnevin	72	0	72	0	0	0	27	0	27	0	0	0	10	0	10	0	0	0
Glasnevin	North Strand Jct.	110	0	110	21	0	21	35	0	35	6	0	6	12	10	22	2	0	2
North Strand Jct.	Connolly	67	0	67	21	0	21	19	0	19	6	0	6	8	10	18	2	0	2
Spencer Dock	Glasnevin	71	0	71	0	0	0	26	0	26	0	0	0	12	8	20	0	0	0
Glasnevin	Clonsilla	104	0	104	21	0	21	38	7	45	6	0	6	18	11	29	2	0	2
Clonsilla	Maynooth	67	0	67	21	0	21	23	7	30	6	0	6	12	10	22	2	0	2
Maynooth	Maynooth Depot	0	35	35	21	0	21	0	17	17	6	0	6	0	13	13	2	0	2
Maynooth Depot	Maynooth	0	35	35	21	0	21	0	0	0	6	0	6	0	27	27	2	0	2
Maynooth	Clonsilla	67	0	67	21	0	21	19	0	19	6	0	6	9	21	30	2	0	2
Clonsilla	Glasnevin	104	0	104	21	0	21	35	0	35	6	0	6	14	20	34	2	0	2
Glasnevin	Spencer Dock	71	0	71	0	0	0	27	0	27	0	0	0	11	10	21	0	0	0
Clonsilla	M3 Parkway	37	0	37	0	0	0	15	0	15	0	0	0	4	3	7	0	0	0
M3 Parkway	Clonsilla	37	0	37	0	0	0	16	0	16	0	0	0	4	0	4	0	0	0
Connolly	Pearse	165	0	165	0	0	0	45	0	45	0	0	0	18	9	27	1	0	1
Pearse	Connolly	160	0	160	0	0	0	50	2	52	0	0	0	19	3	22	1	0	1
Spencer Dock	East Wall Jct.	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0
East Wall Jct.	Spencer Dock	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Spencer Dock	North Strand Jct.	43	0	43	0	0	0	16	0	16	0	0	0	8	2	10	0	0	0
North Strand Jct.	Spencer Dock	43	0	43	0	0	0	16	0	16	0	0	0	4	0	4	0	0	0

The relevant mapping, train numbers, speeds and rail categories have been supplied by IDOM, Iarnród Éireann and Roughan & O'Donovan.

14.5.4.6.2 Noise Model Validation

The impact assessment for the proposed development will concentrate on the noise levels predicted from future DART EMU's and the relevant change in rail noise as a result of the proposed development. However, as that will require a noise model to be developed it is important in the first instance to validate the noise model methodology. To do this a noise model was developed of the current situation with respect to train numbers and types between Dublin and Maynooth/M3 Parkway and the resultant noise levels compared to the measured baseline levels at each of the unattended noise monitoring locations.

The noise model is validated by ensuring that the calculated noise level is within an acceptable margin of error of the measured noise level. Note that the model validation process is only possible at locations where rail noise is the dominant noise source. At locations where other noise sources such as road traffic or other urban noise source are also significant contributors, it is not expected that the rail noise model will calculate a similar noise level to the baseline measurement.

For the validation model the train number and types as outlined in Table 14-39 have been modelled. The daytime period has been used for the purposes of model validation as during this period there are more frequent rail movements allowing for a more accurate comparison of predicted and measured rail noise. Table 14-41 presents the results of the model validation. The following inputs have been used for the model,

- RMR Rail Category: Category 8 for EMU and Category 6 for DMU.
- Support Correction: Concrete sleepers on ballast.
- Track Correction: Joined rails.
- Operational Speed: as provided by IDOM.

Table 14-41 Results of Noise Model Validation

Zone	Location	Measured L_{day} dB	Predicted L_{day} dB
B	N01	53	44
	N04	50	43
A	N07	61	64
B	N08	54	50
A	N09	53	53
	N10	55	54
	N11	59	61
	N13	54	57
C	N15	60	60
	N18	56	58
	N19	58	60
	N20	60	63
	N21	62	64
	N22	57	57
	N24	66	66
	N25	58	56
	N26	66	62
	N28	54	54
E	N29	54	48
	N30	63	66
	N31	61	64

Zone	Location	Measured L_{day} dB	Predicted L_{day} dB
	N33	59	63
	N34	56	60
	N35	60	62
	N37	63	65
	N39	57	61
F	N41	59	63
	N42	54	56
D	N46	53	48
	N48	58	60
	N49	57	56
	N50	57	58
	N51	56	54

At all locations where rail noise is dominant the predicted results are within ± 3 dB of the measured values with the majority of locations where rail noise is dominant being within ± 1 dB indicating a high degree of accuracy from the noise model. As a result, the noise model validated and will be used to predict future rail noise levels from DART EMU vehicles.

14.5.4.6.3 Operational Rail Noise Levels with DART+ West project

The validated noise model discussed in Section 14.5.4.6.2 was updated to reflect the change in rail fleet as a result of the proposed development. The majority of DMU's on the network will be replaced with DART EMU type trains as part of the proposed development. In accordance with the RMR methodology the closest category match to the proposed DART EMU train is Category 8. Note the RMR categories are defined as follows,

1. Block braked passenger trains.
2. Disc braked and block braked passenger trains.
3. Disc braked passenger trains.
4. Block braked freight trains.
5. Block braked diesel trains.
6. Diesel trains with disc brakes.
7. Disc braked urban subway and rapid tram trains.
8. Disc braked InterCity and slow trains.
9. Disc braked and block braked high speed trains.
10. Light rail.
11. Block braked freight trains (silent).

For the operational model, the train number and types as outlined in Table 14-40 have been modelled, with a scaling applied to account for the number of axels of the proposed ten carriage DART EMU's versus the reference RMR trains. Table 14-42 presents the calculated rail noise levels for each time period at each assessment location.

Table 14-42 Rail Noise Levels with DART+ West

Zone	Location	Predicted $L_{Aeq,16hr}$ dB	Predicted L_{day} dB	Predicted $L_{evening}$ dB	Predicted L_{night} dB	Predicted L_{den} dB
A	N02	36	36	36	30	38
	N05	49	49	48	42	51
	N06	50	50	50	44	53

Zone	Location	Predicted $L_{Aeq,16hr}$ dB	Predicted L_{day} dB	Predicted $L_{evening}$ dB	Predicted L_{night} dB	Predicted L_{den} dB
	N07	61	61	61	54	63
	N09	52	52	52	46	55
	N11	62	62	62	56	65
	N13	55	55	55	49	58
B	N01	45	45	45	40	48
	N03	59	59	59	54	62
	N04	49	49	49	45	53
	N08	54	53	54	50	57
	N10	58	58	58	54	62
	N12	47	46	47	42	50
C	N15	60	60	60	54	62
	N16	57	57	57	52	60
	N18	57	57	57	52	60
	N19	58	58	58	54	62
	N20	63	63	63	59	67
	N21	64	64	64	59	67
	N22	56	56	56	52	60
	N23	62	62	62	57	65
	N24	68	68	68	62	71
	N25	56	56	56	51	59
	N26	63	63	63	57	65
	N28	55	55	55	49	57
D	N46	45	44	45	38	47
	N47	54	53	54	47	56
	N48	58	57	58	51	60
	N49	54	53	54	46	56
	N50	56	55	56	49	58
	N51	51	50	51	44	53
E	N29	48	48	47	42	50
	N30	65	65	65	60	68
	N31	64	64	63	58	67
	N32	62	62	62	57	65
	N33	62	62	62	57	65
	N34	59	59	59	54	62
	N35	62	62	61	56	65
	N36	61	61	60	56	64
	N37	65	65	65	60	68
	N38	61	61	60	55	64
	N39	60	60	60	55	63
	N40	57	57	57	52	60
F	N41	63	63	63	58	66

Zone	Location	Predicted $L_{Aeq,16hr}$ dB	Predicted L_{day} dB	Predicted $L_{evening}$ dB	Predicted L_{night} dB	Predicted L_{den} dB
	N42	56	56	55	51	59

To assess the potential rail noise effects the following criteria have been applied,

- Daytime ($L_{Aeq,16hr}$) levels ≤55 dB and Night-time (L_{night}) levels ≤45 dB = No significant effects
- For noise levels above these thresholds the degree of effect is determined based on the change in noise level relative to the baseline. Table 14-32 details the scale used.

In this instance, locations N01, N02, N04, N05, N06, N12, N29, N46 and N51 have rail noise levels with DART+ West in operation that are below the day and night thresholds of significance.

All other locations have rail noise levels that exceed the absolute thresholds and for those locations Table 14-43 compares the day and night noise levels to the calculated Do Nothing rail noise levels to determine the degree of significance of the effects.

Table 14-43 Comparison of Rail Noise with DART+ West Do Nothing vs Do Something

Zone	Location	Do Nothing $L_{Aeq,16hr}$ dB	Do Something $L_{Aeq,16hr}$ dB	Difference between Do Nothing and Do Something, dB	Significance of Effects	Do Nothing L_{night} dB	Do Something L_{night} dB	Difference between Do Nothing and Do Something, dB	Significance of Effects
A	N07	63	61	-2	Positive - Slight	57	54	-3	Positive - Slight
	N09	52	52	0	Neutral	47	46	-1	Positive - Slight
	N11	60	62	2	Negative - Slight	55	56	1	Negative - Slight
	N13	56	55	-1	Positive - Slight	50	49	-1	Positive - Slight
B	N03	55	59	4	Negative - Moderate	46	54	8	Negative - Significant
	N08	49	54	5	Negative - Moderate	33	50	17	Negative - Significant
	N10	52	58	6	Negative - Moderate	27	54	27	Negative - Significant
C	N15	60	60	0	Neutral	54	54	0	Neutral
	N16	58	57	-1	Positive - Slight	53	52	-1	Positive - Slight
	N18	57	57	0	Neutral	52	52	0	Neutral
	N19	59	58	-1	Positive - Slight	54	54	0	Neutral
	N20	62	63	1	Negative - Slight	57	59	2	Negative - Slight
	N21	63	64	1	Negative - Slight	58	59	1	Negative - Slight
	N22	56	56	0	Neutral	51	52	1	Negative - Slight
	N23	61	62	1	Negative - Slight	56	57	1	Negative - Slight
	N24	65	68	3	Negative - Slight	61	62	1	Negative - Slight
	N25	55	56	1	Negative - Slight	50	51	1	Negative - Slight
	N26	61	63	2	Negative - Slight	56	57	1	Negative - Slight
	N28	53	55	2	Negative - Slight	48	49	1	Negative - Slight
D	N47	56	54	-2	Positive - Slight	50	47	-3	Positive - Slight
	N48	60	58	-2	Positive - Slight	54	51	-3	Positive - Slight
	N49	56	54	-2	Positive - Slight	50	46	-4	Positive - Moderate
	N50	58	56	-2	Positive - Slight	52	49	-3	Positive - Slight
E	N30	65	65	0	Neutral	61	60	-1	Positive - Slight
	N31	63	64	1	Negative - Slight	59	58	-1	Positive - Slight

Zone	Location	Do Nothing $L_{Aeq,16hr}$ dB	Do Something $L_{Aeq,16hr}$ dB	Difference between Do Nothing and Do Something, dB	Significance of Effects	Do Nothing L_{night} dB	Do Something L_{night} dB	Difference between Do Nothing and Do Something, dB	Significance of Effects
	N32	62	62	0	Neutral	57	57	0	Neutral
	N33	62	62	0	Neutral	58	57	-1	Positive - Slight
	N34	59	59	0	Neutral	55	54	-1	Positive - Slight
	N35	62	62	0	Neutral	57	56	-1	Positive - Slight
	N36	61	61	0	Neutral	57	56	-1	Positive - Slight
	N37	65	65	0	Neutral	60	60	0	Neutral
	N38	60	61	1	Negative - Slight	56	55	-1	Positive - Slight
	N39	60	60	0	Neutral	56	55	-1	Positive - Slight
	N40	57	57	0	Neutral	53	52	-1	Positive - Slight
F	N41	63	63	0	Neutral	58	58	0	Neutral
	N42	56	56	0	Neutral	45	51	6	Negative - Moderate

The likely effects can be summarised per Zone as follows,

- Zone A – Negative, Neutral and Positive, slight, long term effect.
- Zone B – Negative, moderate to significant, long term effect.
- Zone C – Negative, Neutral and Positive, slight, long term effect.
- Zone D – Positive, slight to moderate, long term effect.
- Zone E – Negative, Neutral and Positive, slight, long term effect.
- Zone F – Neutral to Negative, moderate, long term effect.

The majority of locations show a slight change in rail noise levels as a result of DART+ West, with some areas experiencing a neutral or positive change. However, there are NSLs where the effects rating is determined as negative and moderate to significant within sections of Zone B on the MGWR line between Spencer Dock and Glasnevin and in Zone F which is between Maynooth and the proposed depot.

Both Zones will experience a negative effects as there will be a more significant increase in rail activity on these sections of the track when compared to the Do Nothing scenario. Mitigation measures to reduce this effect is discussed in Section 14.6.

14.5.4.6.4 Technical Movement Rail Noise Levels with DART+West project

In addition to the timetabled activity there will also be technical movements to and from the depot associated with the development. These movements are to allow DART EMU's to be stabled at the depot following the completion of service and also to deploy stabled DART EMU's to the network prior to the beginning of service.

While the assessment in Section 14.5.4.6.3 includes the technical movements it is also appropriate to examine the peak hour noise effect for technical movements. The peak period for technical movements will be the early morning deployment of DART EMU's prior to service beginning. This will occur between 5am and 6am where 20 DART EMU's will depart the depot and travel to the eastern end of the network. To assess the potential noise effects of this activity the noise model was developed to calculate the rail noise level due to the 20 DART EMU's travelling from the depot. The calculated rail noise level was then compared to the measured noise level of the same 1hr period in the early morning at each assessment location. Table 14-44 presents the result of this assessment.

Table 14-44 Rail Noise Levels of Technical Movements for DART+ West

Zone	Location	Predicted $L_{Aeq,1hr}$ dB 5am to 6am	Measured $L_{Aeq,1hr}$ dB 5am to 6am	Change in Noise Level, dB	Significance of Effects
B	N01	47	48	1	Slight
	N04	49	49	0	Not Significant
A	N07	59	56	-3	Not Significant
B	N08	53	49	-4	Not Significant
A	N09	49	48	-1	Not Significant
	N10	56	55	-1	Not Significant
	N11	58	51	-7	Not Significant
	N13	53	49	-4	Not Significant
C	N15	58	55	-3	Not Significant
	N18	53	54	-1	Not Significant
	N19	53	58	-5	Not Significant
	N20	60	60	-1	Not Significant
	N21	61	63	-2	Not Significant
	N22	53	56	-4	Not Significant

Zone	Location	Predicted $L_{Aeq,1hr}$ dB 5am to 6am	Measured $L_{Aeq,1hr}$ dB 5am to 6am	Change in Noise Level, dB	Significance of Effects
	N24	65	64	1	Not Significant
	N25	52	60	-8	Not Significant
	N26	58	59	-1	Not Significant
	N28	49	52	-3	Not Significant
E	N29	51	49	2	Slight
	N30	66	64	2	Slight
	N31	64	61	3	Slight
	N33	58	61	-3	Not Significant
	N34	57	54	3	Slight
	N35	57	61	-4	Not Significant
	N37	63	61	2	Slight
	N39	58	56	2	Slight
F	N41	59	50	9	Moderate
	N42	55	50	5	Moderate
D	N46	No technical movements during the night period are expected in Zone D			
	N48				
	N49				
	N50				
	N51				

The majority of locations show a not significant or slight effects as a result of DART+ West. However, there are two locations where the impact rating is moderate. They are N41 and N42 both located in Zone F which is between Maynooth and the proposed depot. This Zone will experience a moderate effect as there will be a more significant increase in rail activity on this section of the track due to technical movements between Maynooth and the depot. Mitigation measures to reduce this effect is discussed in Section 14.6.

14.5.4.6.5 Rail Vibration Levels with DART+ West project

Vibration caused by the dynamic forces between the train wheels and track is a potential source of impact during the operational phase. The degree of vibration that will be experienced at locations close to the tracks will be determined by the track profile at that location, the ground conditions and the train operation (e.g. speed, frequency etc). In this instance as there is already an operational rail line in place and the proposed development will replace existing DMU's with EMU's, the adopted methodology in terms of vibration is to examine the baseline vibration levels measured for typical DMU pass-bys, scale the vibration level to account for an increase in rail movements with the proposed development and comment on the resultant vibration level. This methodology assumes a similar level of vibration will be generated by both DMU's and EMU's.

The vibration levels associated with individual train movements were used to calculate an overall estimated VDV figure for the daytime period of 07:00hrs to 23:00hrs and night-time period 23:00hrs to 07:00hrs. The VDV figure is based on the Do Something train movements listed in Table 14-40. Using these train numbers, the VDV value expected is listed in Table 14-45 for each survey location.

Table 14-45 Rail Vibration Levels for DART+ West

Zone	Location	Calculated $VDV_{b,day}$ ($m/s^{1.75}$)	Calculated $VDV_{b,night}$ ($m/s^{1.75}$)	Significance of Impact
B	N01	0.00	0.00	Not Significant
	N04	0.05	0.03	Not Significant
A	N07	0.03	0.02	Not Significant
B	N08	0.03	0.02	Not Significant
A	N09	0.03	0.02	Not Significant
	N10	0.03	0.02	Not Significant
	N11	0.03	0.02	Not Significant
	N13	0.02	0.01	Not Significant
C	N15	0.03	0.02	Not Significant
	N18	0.03	0.02	Not Significant
	N19	0.01	0.01	Not Significant
	N20	0.02	0.01	Not Significant
	N21	0.05	0.04	Not Significant
	N22	Vibration not perceptible during survey		Not Significant
	N24	0.06	0.04	Not Significant
	N25	0.01	0.01	Not Significant
	N26	0.01	0.00	Not Significant
	N28	0.02	0.01	Not Significant
E	N29	Vibration not perceptible during survey		Not Significant
	N30	0.03	0.02	Not Significant
	N31	0.04	0.03	Not Significant
	N33	0.01	0.01	Not Significant
	N34	0.02	0.01	Not Significant
	N35	0.02	0.01	Not Significant
	N37	0.03	0.02	Not Significant
	N39	0.03	0.02	Not Significant
F	N41	0.01	0.00	Not Significant
	N42	0.01	0.01	Not Significant
D	N46	Vibration not perceptible during survey		Not Significant
	N48	0.02	0.01	Not Significant
	N49	0.02	0.01	Not Significant
	N50	0.01	0.01	Not Significant
	N51	0.01	0.01	Not Significant

The calculated VDV level is several orders of magnitude lower than the adopted limit values to avoid adverse impacts as per Section 14.5.4.5.

Therefore, in accordance with the guidance in BS 6472-1 there is a low probability of adverse impact due to vibration during the operation of the proposed development and the likely effects are rated as being *long-term, negative and not significant*.

14.5.4.6.6 Noise Impact of Changes to Traffic on Road Network

For the operational phase, two areas are deemed to have the potential for noise effects due to traffic redistribution associated with the proposed development. Impact scenarios have been modelled representing the worst-case traffic impacts at these areas, as advised by the proposed development traffic consultants. The two areas of potential effects are:

- Operational phase effects in proximity to road network affected by the Ashtown level crossing changes.
- Operational phase effects in proximity to the road network affected by the Coolmine and Clonsilla level crossing changes.

The road links (a road link is a segment of road between two junctions) modelled are shown in Figure 14-8 and Figure 14-9 for Ashtown and Coolmine/Clonsilla respectively.

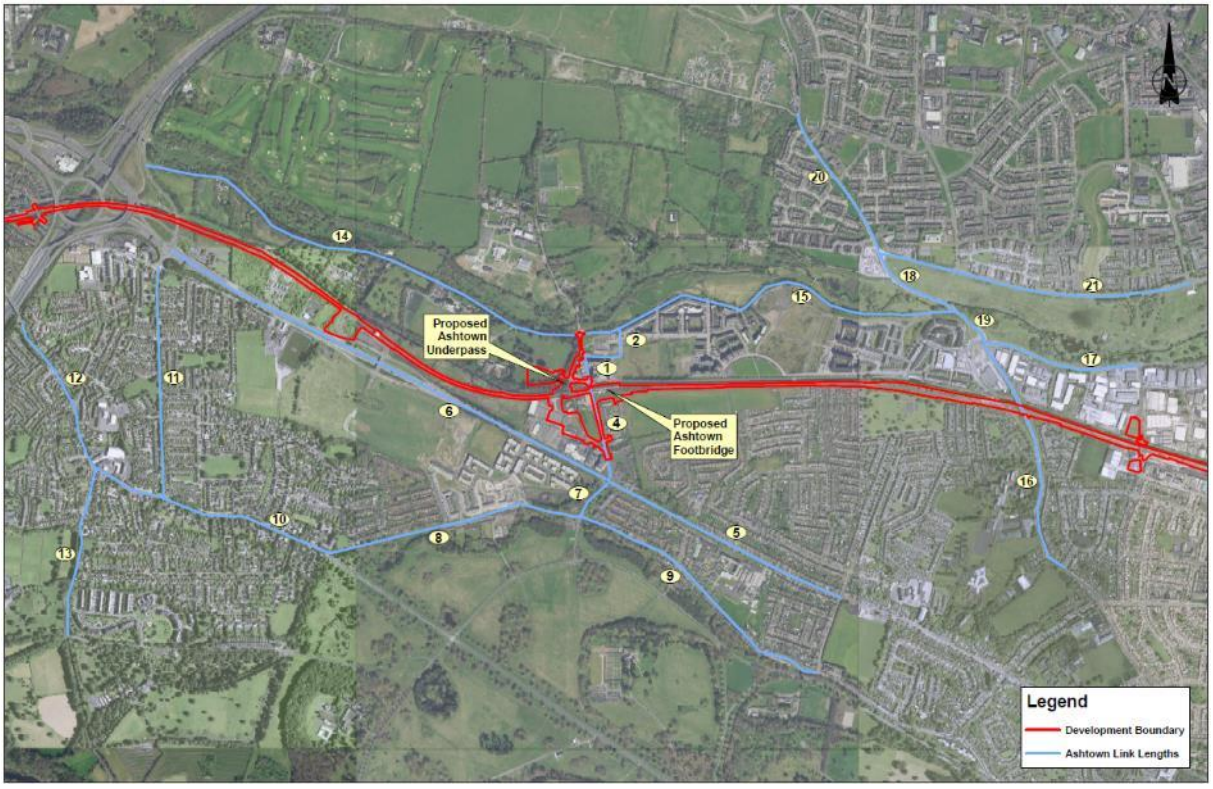


Figure 14-8 Ashtown Road Links Included in Assessment

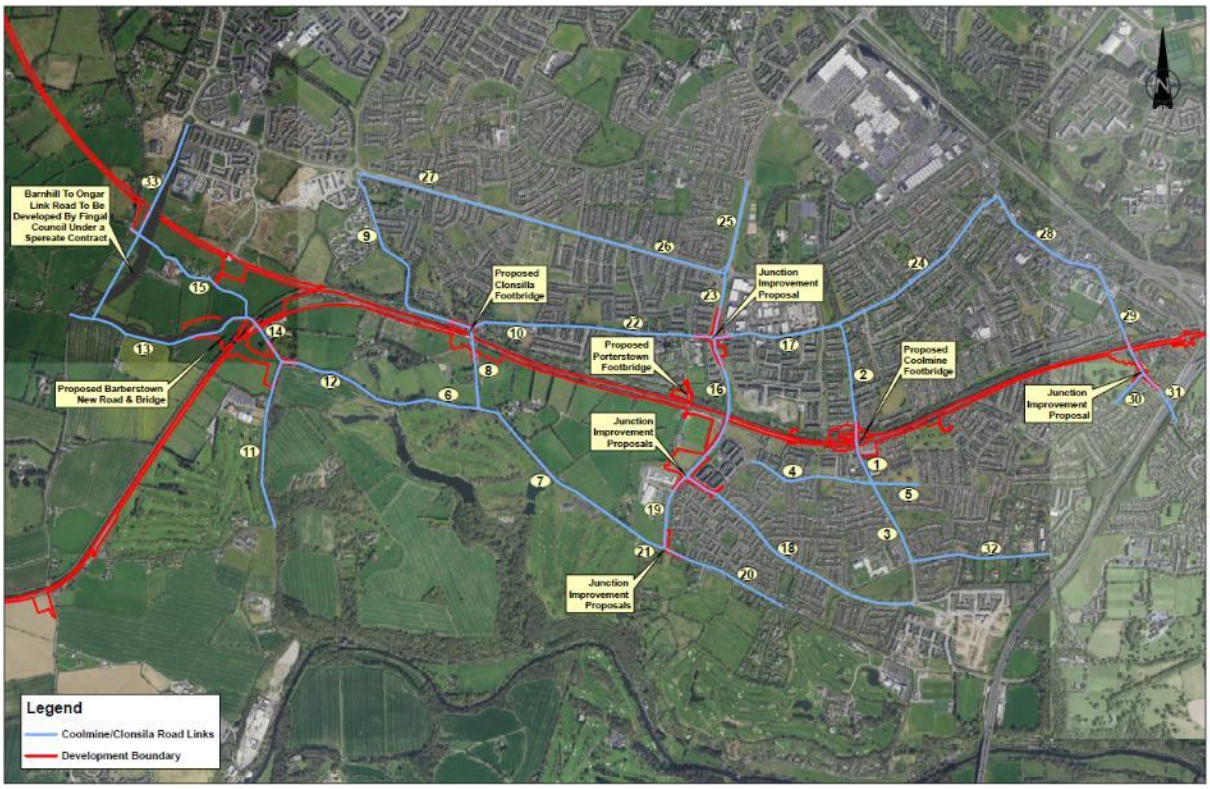


Figure 14-9 Coolmine/Clonsilla Road Links Included in Assessment

The traffic flows have been assessed to determine the likely change in noise level on each link as a result of the proposed development for both the opening year and design years. Traffic flow data in terms of the Annual Average Daily Traffic (AADT) figures has been assessed and the calculated change in noise levels during these two periods are summarised in Table 14-46 .

Table 14-46 Change in Traffic Noise Levels with Proposed Development - Ashtown

Link Number	Opening Year 2028			Design Year 2043		
	Do Nothing AADT	Do Something AADT	Change in Noise Level (dB)	Do Nothing AADT	Do Something AADT	Change in Noise Level (dB)
1	3,213	6,272	+2.9	3,519	6,542	+2.7
2	4,555	4,315	-0.2	5,064	4,518	-0.5
4	7,768	10,587	+1.3	8,583	11,059	+1.1
5	26,180	26,635	+0.1	26,249	26,356	0.0
6	26,138	26,366	0.0	25,065	25,678	+0.1
7	17,339	17,608	+0.1	17,648	17,176	-0.1
8	11,465	11,844	+0.1	12,783	12,412	-0.1
9	8,149	8,816	+0.3	8,446	9,464	+0.5
10	15,590	16,020	+0.1	17,319	16,891	-0.1
11	8,509	8,595	0.0	9,202	9,555	+0.2
12	12,015	11,402	-0.2	13,100	11,369	-0.6
13	10,813	10,776	-0.0	10,980	11,362	+0.1
14	9,052	7,942	-0.6	9,223	7,979	-0.6
15	7,079	8,553	+0.8	6,367	7,593	+0.8
16	16,196	14,967	-0.3	16,955	15,209	-0.5

Link Number	Opening Year 2028			Design Year 2043		
	Do Nothing AADT	Do Something AADT	Change in Noise Level (dB)	Do Nothing AADT	Do Something AADT	Change in Noise Level (dB)
17	15,040	14,781	-0.1	14,718	12,333	-0.8
18	21,158	21,242	0.0	22,301	22,035	-0.1
19	19,220	18,209	-0.2	19,124	17,558	-0.4
20	16,986	17,233	+0.1	17,347	17,268	-0.0
21	5,943	6,306	+0.3	7,236	9,050	+1.0

Note: Link 3 removed by traffic consultant – no data available

Table 14-47 Change in Traffic Noise Levels with Proposed Development - Coolmine/Clonsilla

Link Number	Opening Year 2028			Design Year 2043		
	Do Nothing AADT	Do Something AADT	Change in Noise Level (dB)	Do Nothing AADT	Do Something AADT	Change in Noise Level (dB)
1	5,652	0	-37.5	5,214	0	-37.2
2	9,283	8,562	-0.4	11,066	8,867	-1.0
3	10,642	8,784	-0.8	11,303	9,842	-0.6
4	7,726	7,225	-0.3	10,050	8,707	-0.6
5	8,852	8,143	-0.4	11,145	8,826	-1.0
6	10,518	10,598	0.0	12,094	11,865	-0.1
7	10,935	10,536	-0.2	12,401	11,796	-0.2
8	3,882	0	-35.9	4,461	0	-36.5
9	6,028	8,145	+1.3	7,494	9,476	+1.0
10	7,252	9,574	+1.2	9,249	10,817	+0.7
11	9,624	8,915	-0.3	10,731	9,363	-0.6
12	10,518	10,598	0.0	12,094	11,865	-0.1
13	1,041	1,910	+2.6	1,524	2,836	+2.7
14	1,388	2,192	+2.0	1,870	3,122	+2.2
15	1,039	1,026	-0.1	1,107	1,102	-0.0
16	20,251	26,105	+1.1	22,665	28,652	+1.0
17	8,149	9,277	+0.6	8,862	9,949	+0.5
18	10,829	11,584	+0.3	10,757	12,267	+0.6
19	12,852	15,077	+0.7	13,828	15,947	0.6
20	869	921	+0.2	2,223	2,210	-0.0
21	869	879	+0.0	1,400	1,564	+0.5
22	18,359	18,191	-0.0	18,419	18,390	-0.0
23	16,566	15,833	-0.2	16,818	18,681	+0.5
24	12,210	10,973	-0.5	11,355	10,442	-0.4
25	16,566	15,833	-0.2	16,818	18,681	+0.5
26	18,550	18,544	-0.0	18,049	19,155	+0.3
27	20,565	19,379	-0.3	20,660	19,671	-0.2
28	7,397	7,461	0.0	8,513	9,531	+0.5

Link Number	Opening Year 2028			Design Year 2043		
	Do Nothing AADT	Do Something AADT	Change in Noise Level (dB)	Do Nothing AADT	Do Something AADT	Change in Noise Level (dB)
29	17,338	19,851	+0.6	17,458	17,544	0.0
30	11,429	13,881	+0.8	12,131	13,016	+0.3
31	18,324	19,108	0.2	18,582	16,316	-0.6
32	9,460	9,147	-0.1	10,217	10,286	0.0
33	12,530	13,990	+0.5	13,591	15,073	+0.4

The predicted increase in traffic noise levels associated with the development is less than 3dB for both the opening and design years. Reference to Table 14-35 and Table 14-36 confirms that this increase is not significant. Note that there are some locations where a major positive effect will occur as a result of closing the level crossings. These positive effects will likely occur close to the level crossing locations where traffic will be removed from the network.

In addition to the areas discussed above there will be road realignment works at the following locations.

- Barberstown.
- L5041 diversion and OBG23A.

To assess the potential for traffic flow on these realigned sections of road, the traffic noise impact associated with these new alignments have been reviewed with respect to their proximity to nearby sensitive locations.

Barberstown

The proposed works at Barberstown Level Crossing include the construction of a new road bridge with pedestrian and cycle facilities which crosses the Dublin to Sligo railway and the Royal canal approximately 200m west of the existing level crossing. The proposals include for the construction of approach roads on raised embankment which tie into the proposed Barnhill to Ongar Road scheme to the north and to the existing road network south of the railway.

General arrangement of the proposed level crossing replacement works is provided in Chapter 5 of Volume 2 of this EIAR.

With respect to noise effects this proposal will move traffic currently using the existing level crossing away from a small number of dwellings that are situated close to the existing level crossing. This will have a positive effect and reduce the noise levels experienced by these properties due to road traffic in this area. Note that the proposed realigned section of road will be elevated to the rear of the nearest residential properties, however, the realigned road is a further distance, approximately 83 m, from the rear of these properties compared to the existing road network which is located approximately 13 m from the front of these properties. The attenuation of noise over distance will ensure that noise effects to the rear of the property, even when elevation is considered, is lower than the noise levels currently experienced to the front of the properties. Overall, the likely noise effects are considered to be *long-term, neutral and not significant* at this location.

L5041 Diversion and OBG23A

A new bridge, OBG23A, will be constructed to access the depot crossing the Royal Canal from the R148 Kilcock Road. This new OBG23A provides separate road access to the depot and connects to the existing road network (R148 and L5041). General arrangement of the proposed level crossing replacement works is provided in Chapter 5 of Volume 2 of this EIAR.

The proposed realigned L5041 and OBG23A are located over 200m from any residential properties. However, realigning the road will introduce additional noise to the environment at this location and the resultant likely

noise effects will be negative. Overall once attenuation due to distance is taken into account the magnitude of the impact is considered to be slight and mitigation is not necessary.

Summary

In summary, the predicted increase in noise levels associated with vehicles at the majority of road junctions and realignments in the vicinity of the proposed development are likely to have *long-term, negative to neutral and not significant to slight* effects. At some locations close to the level crossings being closed the effects are likely to be *long-term, positive and significant*.

14.5.4.6.7 Fixed Plant Noise Impacts

The primary source of fixed plant noise associated with the development are the substations located along the network. The substation buildings will contain several rooms of which the transformer rooms are the most significant sources of noise. The transformers will be 38 kV oil-based and to ensure noise effects are controlled at the nearest dwellings will be selected to ensure noise output when measured at 2 m from any point of the substation building does not exceed 55 dB(A). Furthermore, selections will be made to ensure that there is no significant tonal noise audible at the nearest sensitive locations.

Noise calculations have been carried out based on the location and position of each substation proposed across the network and the resultant noise level at the nearest sensitive locations is presented in Table 14-48.

Table 14-48 Calculated Noise from Substations at Nearest Dwelling to Substation

Location	Predicted Noise Level, dB(A)
Spencer Dock	37
Glasnevin	31
Ashtown	37
Castleknock	30
Coolmine	35
Hansfield	30
Leixlip Confey	30
Blakestown	37
Maynooth	43
Dunboyne	33

Note that at Maynooth the predicted noise level of 43dB(A) is above the absolute threshold of 40dB(A) specified, however, resultant noise effects are *not significant* when the baseline noise level of 48dB L_{Aeq} at night is considered.

14.5.4.6.8 Depot Operation Noise Impacts

The depot operation has the potential to generate noise effects during the day and night-time periods. The depot will be in operation 24/7 and will be used to stable and maintain DART EMU's from across the network. To assess the noise effect of the operation the following noise sources have been considered:

- Maintenance building activity – note this building is fully enclosed and noise internal to the building will be largely contained within the building.
- Substation and mechanical plant serving the depot.
- Automatic Train Wash (ATW).
- Stabling.

To inform the assessment AWN measured the noise levels generated by several workshop activities at the current Fairview and Inchicore depots. Train wash activity was also measured at the Fairview depot. The following noise levels have been measured during these surveys,

- General maintenance activity – 74dB(A) internally within the building.
- Wheel Lathe – 80dB(A) internally within the building.
- Automatic Train Wash (ATW) – 61dB(A) at 12m for an open air ATW.
- Substation – as per Section 14.5.4.6.7.
- Roof mounted gas burners – 46dB(A) at 10m per unit (8 units assumed)

Note that when modelling the maintenance building a lightweight construction has been assumed such as an insulated cladding panel. The assumed sound insulation performance of this construction is 26 dB R_w which is readily achievable by such constructions available on the market. For the ATW the wash area is enclosed on two sides and above with openings either end for the trains to enter and exit.

In addition, the movement of DART EMU's within the depot has also been modelled. For the purposes of the assessment, the peak hour movements as discussed previously in Section 14.5.4.6.4 have been adopted as a worst-case. Figure 14-10 presents the combined noise contours from all the above activities operating together constantly. This represents a worst-case as the activity at the depot will vary in intensity across a typical day and it is not expected that all activity would occur simultaneously as modelled here. Note that this assessment takes into account the full development of the depot to accommodate both Phase 1 and Phase 2 of the sidings proposed.

Figure 14-10 Noise Contours for Peak Depot Activity

The outcome of the depot noise model is that the noise level beyond the boundary of the depot itself are expected to be less than 45 dB(A). The cumulative noise levels at the nearest individual dwellings have also been calculated and are indicated on Figure 14-11 below and are all ≤35 dB(A). This noise level is of a similar order of magnitude to the baseline background noise levels measured at these locations as outlined in Table 14-18 which indicates that there are likely to be *long-term, negative and slight* noise effects.

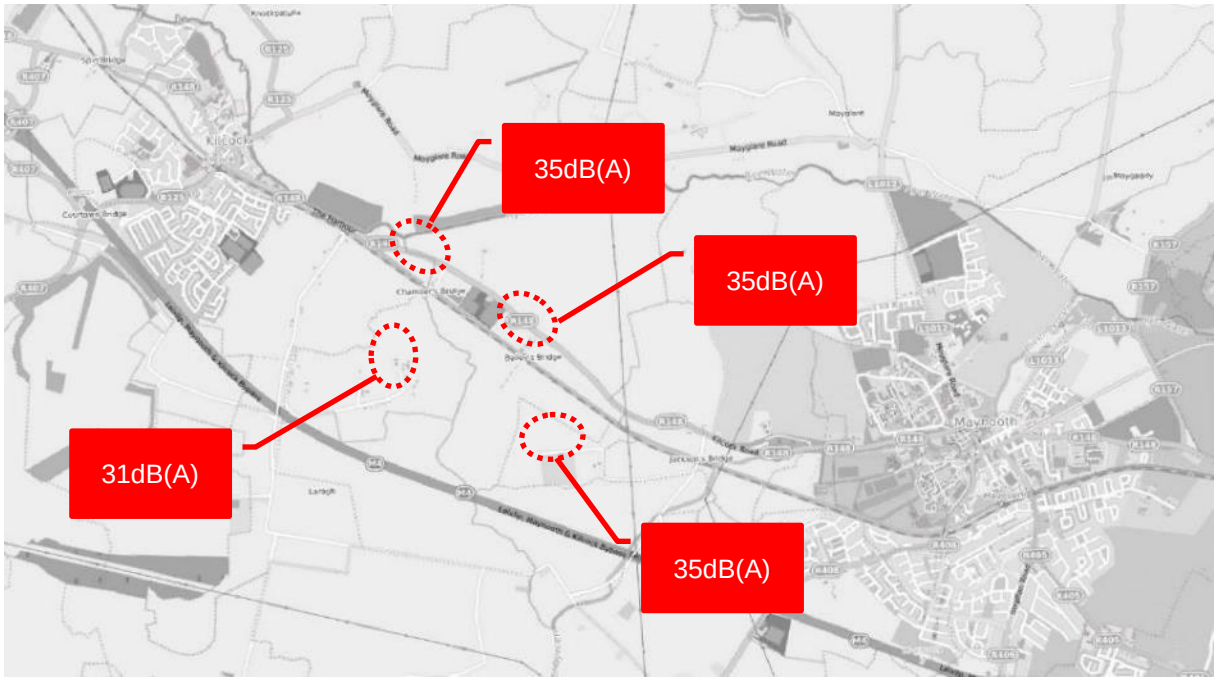


Figure 14-11 Depot Noise Levels at Nearest Dwellings

14.5.4.6.9 Permanent Compounds and Maintenance Work

During the operational phase of the proposed development there will be permanent compounds located at the following areas:

- Navan Road – including OHLE maintenance building.
- depot west of Maynooth– Chief Civil Engineering (CCE) compound.
- Docklands.

The compounds will primarily be storage areas for maintenance materials and equipment and will for the majority of the time be inactive. However, in support of maintenance activity on the track and to accept deliveries of new materials there will be periods of activity that could generate a noise impact.

The compounds at all locations are located in excess of 75 m from the nearest sensitive locations. Once attenuation due to distance is considered the noise effects of compound activity at these locations is not expected to be significant.

During the operation of DART+ West there will be periodic maintenance activities on the OHLE and rail to ensure the safe and efficient operation of the service. In order to maintain the service provision maintenance is carried out at night and as such there is a potential risk of noise disturbance during the activity. Following discussion with Iarnród Éireann it is understood that the frequency of common maintenance is generally as follows:

- Alignment and levelling of tracks – only occurs when inspections identify a track defect.
- Track Tamping – depending on the maintenance requirement will occur once a year to once every three years.
- Ballast track reprofiling – every two years.
- Rail and manhole cleaning – once every four months done by personnel walking the track.
- Switches cleaning – once a week.
- Track geometry inspection – once a year.

There is a risk of *brief and short term negative significant* noise effects at sensitive locations near the rail line during essential maintenance works. Section 14.6.2 outlines recommended mitigation measures to be

implemented during the operation of the proposed development to control noise effects during maintenance works.

14.5.4.6.10 PA Announcements

All stations will be provided with PA systems for critical technical and safety messages. There is a potential for the PA systems to generate a brief negative impact at nearby sensitive locations during announcements. However, noise effects at offsite locations will be controlled through the careful consideration of the PA system design. The primary method of ensuring that noise effects are controlled is to limit the volume level used in accordance with the existing ambient noise level. This will ensure the system is operating only at the volume level required to ensure audibility on the platform. Section 14.6.2.3 outlines recommended mitigation measures to be implemented during the detail design.

14.5.4.6.11 Spencer Dock Station

A new station is to be constructed at Spencer Dock as illustrated in Figure 14-12.

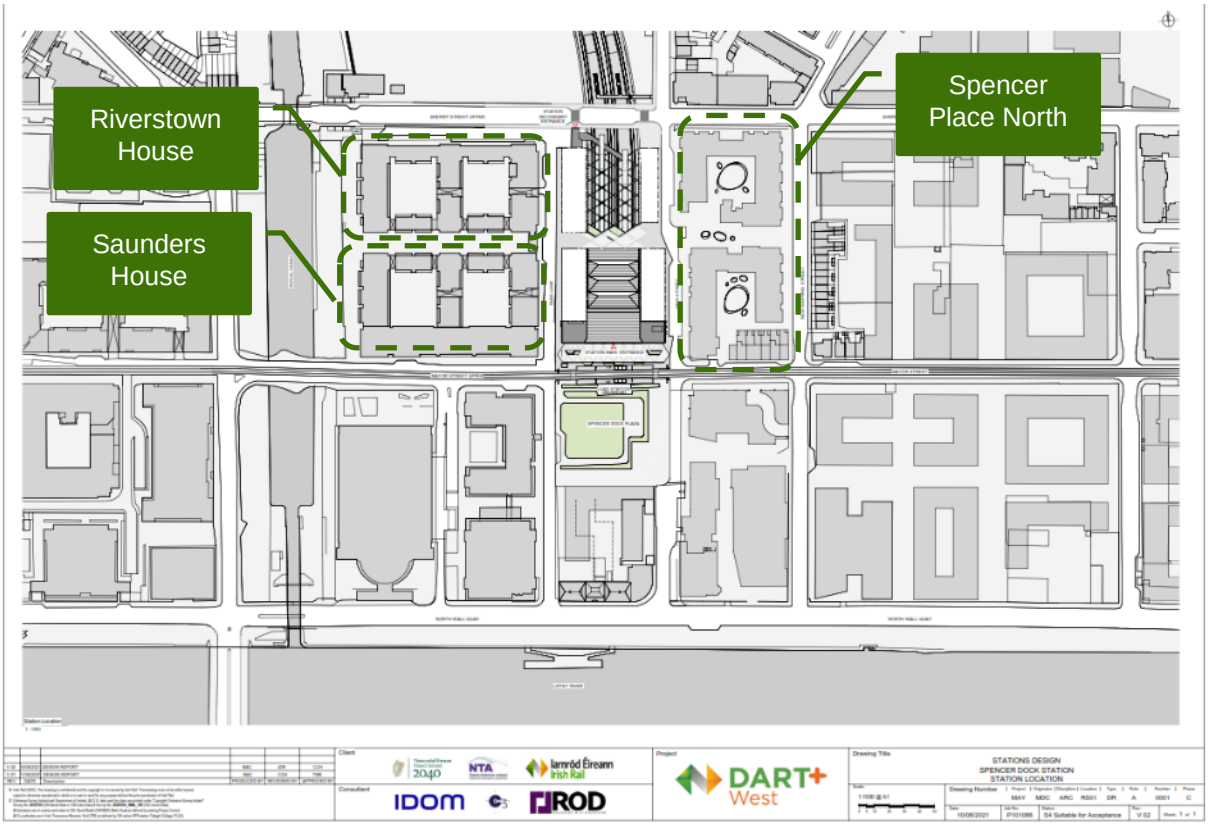


Figure 14-12 Spencer Dock Station Location

The station is overlooked on the eastern and western sides by residential developments which are located approximately 30 m from the partially covered platform. Noise sources associated with the station will be as follows,

- Rail movements.
- PA announcements.
- Fixed plant.

Operational rail movements to this station have been assessed using the noise model discussed previously in Section 14.5.4.6.1 and it has been determined that the rail noise levels during day and night respectively at the nearest apartment buildings of Riverstown House, Saunders House and Spencer Dock North are of the order of 60dB $L_{Aeq,16hr}$ and 55dB L_{night}.

Comparing this noise level to the measured baseline level at location N52 in Table 14-2 where daytime noise levels of 59dB $L_{Aeq,16hr}$ and night-time noise levels of 54dB L_{night} were measured it can be concluded that the noise effects from operational rail at this location will likely be *slight*.

For fixed plant sources serving the station the cumulative operational noise level from any plant and equipment will be controlled to not exceed the fixed noise levels set out in Section 14.5.4.3.

During the detailed design of the station plant and ventilation systems, the background noise level at the nearest and most exposed NSLs to each fixed item of plant will be determined for day and night-time periods. This data will be used to establish the absolute noise limits that will apply to fixed plant using the guidance from BS 4142 (BSI 2014 +A1 2019) discussed in Section 14.5.4.3. Based on the baseline data measured in the vicinity of the Spencer Dock station as part of this study, the background noise level varies from 49dB L_{A90} during the day to 45dB L_{A90} at night. Therefore, following the methodology outlined in Section 14.5.4.3 the cumulative fixed plant noise from Spencer Dock station will be controlled to not exceed the following noise levels,

- Daytime (07:00hrs to 23:00hrs): 45 dB $L_{Aeq, 16hr}$.
- Night-time (23:00hrs to 07:00hrs): 40 dB $L_{Aeq, 8hr}$.

Section 14.6.2.4 discusses mitigation measures that will be employed to ensure compliance with these limit values. Operating within the limit values presented here will ensure the noise effects of fixed plant serving the Spencer Dock station are likely to be *negative, not significant and long-term*.

Finally, PA announcements will be controlled through the careful consideration of the PA system design. The primary method of ensuring that noise effects are controlled is to limit the volume level used in accordance with the existing ambient noise level. This will ensure the system is operating only at the volume level required to ensure audibility on the platform. Section 14.6.2.3 outlines recommended mitigation measures to be implemented during the detailed design.

14.6 Mitigation measures

14.6.1 Construction Stage

During the course of construction the procedures outlined in Iarnród Éireann operation procedure CCE-QMS-008-002 Noise Management – CCE Activities will be implemented. This document outlines the following noise mitigation measures:

1. The Community Liaison Officer (or other nominated person) will notify affected residents in advance of any planned works commencing with a letter drop in the relevant area.
2. Where planned work occurs over a 72hr weekend shutdown there will be a noise management plan submitted to the local authority.
3. All attempts to avoid, prevent or reduce the harmful effects of exposure to environmental noise arising from work activities must be practical and appropriately risk assessed before implementation.
4. The following measures should be implemented where feasible during construction activities:
    a. Carry out as much preparatory work in daylight as possible (sawing or drilling rails).
    b. Inspect the worksite in daylight if possible and look for the best location to position generators.
    c. Position generators and lighting away from residential dwellings.
    d. Take advantage of natural barriers such as vegetation, walls or embankments that can offer noise screening to adjacent neighbours.
    e. Where necessary, use noise attenuation screens. The screens must be located as close to the receiver or source as possible.
    f. Consider using additional supply cables and structures so that the generators can be positioned as far away from housing as practicable.

g. Where possible, use low-noise plant. Any unsuitable plant should be replaced by higher quality low noise plant, or contained by the use of mufflers/silencers.
h. Do not leave equipment or vehicles running/idling unnecessarily.
i. Do not shout work instructions when working in residential areas at night unless absolutely necessary.
j. Plan effectively to ensure timely deliveries of materials.

The following sections outline additional detail with regards noise and vibration mitigation during construction.

14.6.1.1 Communication with Neighbours

The Contractor should be proactive in engaging with the occupants of neighbouring properties and should notify them of any works forecast to generate appreciable levels of noise, explaining the nature and duration of the works.

A designated noise liaison should be appointed by the contractor for the duration of the construction works. This person should log any issues and follow up in a prompt fashion.

Night-works in particular have the potential to generate the most significant noise effects. All affected sensitive locations should be notified of planned works in advance of the works progressing. The notification should include a description of the works, the expected duration and details of how to contact the contractor to log complaints.

14.6.1.2 Noise & Vibration Monitoring

The following ongoing noise monitoring programme is recommended for the site in relation to demolition and construction activities.

Noise Monitoring Terminals (NMT), number and locations to be agreed, to be installed with the following specifications (or similar approved):

- Logging of two concurrent periods, e.g. 15-minute & hourly.
- Daily CIC automated calibrations.
- E-mail alert on threshold exceedance.
- E-mail alert on low battery and low memory.
- Remote access to measured data.
- Live display of noise levels.

Vibration monitoring stations should continually log vibration levels using the Peak Particle Velocity parameter (PPV, mm/s) in the X, Y and Z directions, in accordance with BS ISO 4866: 2010: Mechanical vibration and shock – Vibration of fixed structures – Guidelines for the measurement of vibrations and evaluation of their effects on structures.

The mounting of the transducer to the vibrating structure will need to comply with BS ISO 5348: 1998: Mechanical vibration and shock – Mechanical mounting of accelerometers. In summary, the following ideal mounting conditions apply:

- The transducer and its mountings should be as rigid as possible.
- The mounting surfaces should be as clean and flat as possible.
- Simple symmetric mountings are best.
- The mass of the mounting should be small in comparison to that of the structure under test.
- The monitoring equipment should be set to monitor vibration in 5 minute periods.
- E-mail alert on threshold exceedance.
- E-mail alert on low battery and low memory.
- Remote access to measured data.
- Live display of vibration levels.

In addition, it is recommended that spot check noise & vibration measurements are conducted on a monthly basis. These spot checks can be organized to coincide with works that have potential to generate high levels of noise or vibration on site in order to confirm the potential extent of effects.

A monthly noise and vibration monitoring report should be prepared by the contractor. Reports should identify any exceedances above nominal limit values and attempts to clarify the causes etc. Where remedial measures are required and identifiable, these should also be clearly stated.

14.6.1.3 Noise Control Audits

It is recommended that noise control audits be conducted at regular intervals throughout the construction programme.

The purpose of the audits will be to ensure that all appropriate steps are being taken to control construction noise emissions. To this end, consideration should be given to issues such as the following (note that this list is not intended to be exhaustive):

- Hours of operation being correctly observed.
- Opportunities for noise control “at source”.
- Optimum siting of plant items.
- Plant items being left to run unnecessarily.
- Correct use of proprietary noise control measures.
- Materials handling.
- Poor maintenance.
- Correct use of screening provided and opportunities for provision of additional screening.

14.6.1.4 Hours of Work

In order to maintain services during the day, the majority of on track construction works along the railway line itself will take place at night. Works outside of the live railway corridor can progress during the day (i.e., construction of bridges associated with level crossing replacements, the construction of the depot, substations, construction compounds). Every effort will be made to avoid, reduce, and/or mitigate negative effect s, however, there is likely to be some disturbance experienced for those in close proximity to the railway line caused by noise, lighting or fencing/hoarding erected associated with the construction activities.

Consideration should be given to the scheduling of activities in a manner that reflects the location of the site and the nature of neighbouring properties. Each potentially noisy event/activity should be considered on its individual merits and scheduled according to its noise level, proximity to sensitive locations and possible options for noise control.

Depending on the noise emission levels experienced and associated noise effects, the contractor should be flexible and able to conduct certain works at hours which reflect periods when the neighbouring properties have lower sensitivities to noise. Furthermore, every effort will be made to schedule the noisiest works to take place during the less sensitive daytime working hours.

14.6.1.5 Selection of Quiet Plant

Careful consideration must be given to the noise emission levels of plant items when they are being considered for use on the site. This practice is recommended in relation to sites with static plant such as compressors and generators. It is recommended that these units be supplied with manufacturers’ proprietary acoustic enclosures where possible. 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 should be selected wherever possible. Should a particular item of plant already on the site be found to generate high noise levels, the first action should be to identify whether or not said item can be replaced with a quieter alternative.

14.6.1.6 Control of Noise Sources

If the use of low noise plant or replacing a noisy item of plant are not viable or practicable options, consideration should 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, often in consultation with the supplier. For example, resonance effects in panel work or cover plates can be reduced through stiffening or application of damping compounds; rattling and grinding noises can often be controlled by fixing resilient materials in between the surfaces in contact.

BS5228 states that *"as far as reasonably practicable sources of significant noise should be enclosed"*. In applying this guidance, constraints such as mobility, ventilation, access and safety must be taken into account. Items suitable for enclosure include pumps and generators. Demountable enclosures that could be moved around site as necessary may also be used to screen operatives using hand tools such as angle grinders.

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" (BAT).

BAT is defined as follows in EC Directive 96/61:

> *'"...the most effective and advanced stage in the development of an activity and its methods of operation which indicate the practical suitability of particular techniques for providing, in principle, the basis for emission limit values designed to prevent or eliminate or, where that is not practicable, generally to reduce an emission and its impact on the environment as a whole."*

In this context "best" means *"the most effective in achieving a high general level of protection of the environment as a whole"*.

The expression "available techniques" means *"those techniques developed on a scale which allows implementation…., under economically and technically viable conditions, taking into consideration the costs and advantages, whether or not the techniques are used or produced within the State, as long as they are reasonably accessible to the operator carrying on the activity"*.

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

In specifying or otherwise determining BAT, consideration should be given to a specified list of considerations and also to *"the likely costs and advantages of measures"* as well as *"the principles of precaution and prevention"*.

Thus, the concept of BAT requires a degree of balance between the attainment of environmental benefits and the likely cost implications. In the identification of BAT, regard should be had to a wide range of factors, however, emphasis should be given to "practical suitability" and the need "to reduce an emission and its impact on the environment as a whole".

Proposed techniques should also be evaluated in light of their potential effect on occupational health and safety.

BS5228 makes a number of recommendations in relation to "use and siting of equipment". These are relevant and hence are reproduced below. These recommendations should be implemented on the site.

> *"Plant should always be used in accordance with manufacturers' instructions. Care should be taken to site equipment away from noise-sensitive areas. Where possible, loading and unloading should also be carried out away from such areas.*
>
> *Circumstances can arise when night-time working is unavoidable. Bearing in mind the special constraints under which such work has to be carried out, steps should be taken to minimise disturbance to occupants of nearby premises.*

Machines such as cranes that may be in intermittent use should be shut down between work periods or should be throttled down to a minimum. Machines should not be left running unnecessarily, as this can be noisy and waste energy.

Plant known to emit noise strongly in one direction should, when possible, be orientated so that the noise is directed away from noise-sensitive areas. Attendant operators of the plant can also benefit from this acoustical phenomenon by sheltering, when possible, in the area with reduced noise levels.

Acoustic covers to engines should be kept closed when the engines are in use and idling. The use of compressors that have effective acoustic enclosures and are designed to operate when their access panels are closed is recommended.

Materials should be lowered whenever practicable and should not be dropped. The surfaces on to which the materials are being moved could be covered by resilient material."

The following outline guidance in relation to specific considerations id provided below:

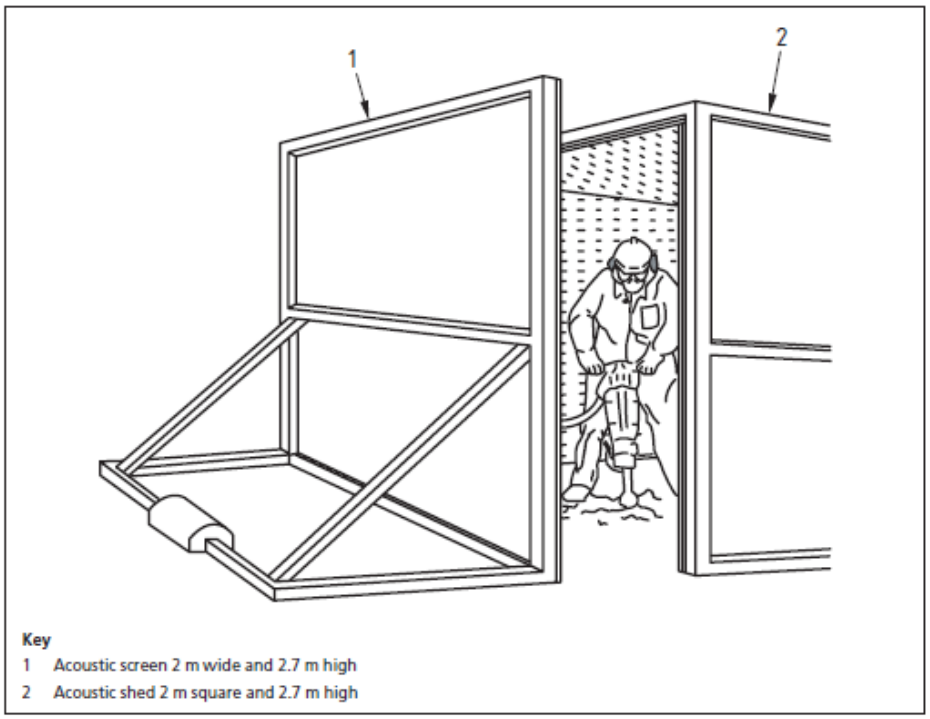
- For mobile plant items such as cranes, dump trucks, excavators and loaders, the installation of an acoustic exhaust and/or maintaining enclosure panels closed during operation can reduce noise levels by up to 10 dB. Mobile plant should be switched off when not in use and not left idling.
- For piling 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 may be 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. Erect localised screens around breaker or drill bit when in operation in close proximity to noise sensitive boundaries.
- For all materials handling ensure that materials are not dropped from excessive heights and drop chutes/dump trucks are lined with resilient materials.
- For compressors, generators and pumps, these can be surrounded by acoustic lagging or enclosed within acoustic enclosures providing air ventilation.
- Demountable enclosures can also be used to screen operatives using hand tools and may be moved around site as necessary.
- All items of plant should 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.
- Where practicable, metal on metal or rock on metal impacts should be avoided during night works. This can be achieved through the use of rubber mallets or impact linings etc. on site.
- White noise reverse alarms should be utilised on vehicles where practicable to reduce potential annoyance of tonal noise emissions from site.

14.6.1.7 Screening

The use of screens can be effective in reducing the noise level at a receiver location and should be employed as a complementary measure to all other forms of noise control. The effectiveness of a noise screen will depend on the height and length of the screen and its position relative to both the source and receiver. The height and length of any screen should, where practicable, be such that there is no direct line of sight between the source and the receiver.

BS5228 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 screen should 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 barrier rather than the transmission through the barrier itself. Screens constructed of materials with a surface mass greater than 10kg/m typically offer adequate sound insulation performance.

Annex B of BS5228 (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. BS5228 Figure B2 is included here for information purposes.



Key
1 Acoustic screen 2 m wide and 2.7 m high
2 Acoustic shed 2 m square and 2.7 m high

Table B.4 **Measured sound reduction given by types of partial enclosure**

Type of enclosure (see Figure B.3)	Reduction dB(A)		
	Facing the opening(s)	Sideways	Facing rear of shed
Open-sided shed lined with absorbent material; no screen	1	9	14
Open-sided shed lined with absorbent material; with reflecting screen in front	10	6	8
Open-sided shed lined with absorbent material; with absorbent screen in front	10	10	10

Figure 14-13 Typical acoustic screen/shed detail

It is acknowledged that for some worksites it will not be practicable to install localised screens due to the constrained nature of the work area. However, where practicable screens will be installed by the contractor.

14.6.1.8 Vibration

The vibration from construction activities will be limited to the values set out within Section 14.5.3.4. It should be noted that these limits are not absolute, but provide guidance as to magnitudes of vibration that are very unlikely to cause cosmetic damage. Limit values have been provided for the following building types:

- Soundly constructed residential and commercial properties.
- Protected structures and sensitive buildings such as those with no or minimal foundations.

It is understood that bored piling is to be used in this instance which is a piling method which generates relatively low levels of vibration. Notwithstanding this, considerations should be given to the following methods to further mitigate the vibration levels:

- Minimise obstructions between the vibration source and the sensitive receiver, e.g. old basement floors, old foundations etc., which exacerbate the transmission of vibration.
- Reduce the resistance to bored piles by “mudding in”. This technique involves lubricating the borehole with a small amount of bentonite slurry.

14.6.1.9 Piling

Piling programmes should be arranged so as to control the amount of disturbance in noise and vibration sensitive areas at times that are considered of greatest sensitivity.

During the construction planning stage the contractor and engineer, as well as the client, should be made aware of the proposed method of working of the piling contractor. The piling contractor should in turn have evaluated any practicable and more acceptable alternatives that would economically achieve, in the given ground conditions, equivalent structural results.

It should be remembered that a decision regarding the type of pile to be used on a site will normally be governed by such criteria as loads to be carried, strata to be penetrated and the economics of the system, for example the time it will take to complete the installation and other associated operations such as soil removal. It may not be possible for technical reasons to replace a noisy process by one of the 'quieter piling' alternatives. Even if it is possible, the adoption of a quieter method may prolong the piling operation; the net result being that the overall disturbance to the community will not necessarily be reduced.

On typical piling 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 works is usually short in relation to the length of construction work as a whole, and the amount of time spent working near to noise sensitive areas can represent only a part of the piling period.

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 may be 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.

Screening by barriers and hoardings is less effective than total enclosure but can be a useful adjunct to other noise control measures. For maximum benefit, screens should be close either to the source of noise (as with stationary plant) or to the listener. Removal of a direct line of sight between source and listener can be advantageous both physically and psychologically. In certain types of piling works there will be ancillary mechanical plant and equipment that may be stationary, in which case, care should be taken in location, having due regard also for access routes. When appropriate, screens or enclosures should be provided for such equipment.

Contributions to the total site noise can also be anticipated from mobile ancillary equipment, such as handling cranes, dumpers, front end loaders etc. These machines may only have to work intermittently, and when safety permits, their engines should be switched off (or during short breaks from duty reduced to idling speed) when not in use.

All mechanical plant should be well maintained throughout the duration of the piling works.

14.6.2 Operational Stage

14.6.2.1 Noise Barriers

Noise barriers are required to reduce the noise effects at the most impacted properties. Table 14-49 details the extent of the barriers.

Table 14-49 Noise Barrier Extents

Location	Height	Start Chainage	End Chainage	Total Length
Ossory Road (MGWR Up Track Side)	3 m	40+840	41+015	175 m
Ardilaun Square (MGWR Up Track Side)	3 m	41+465	41+515	50 m
Drumcondra Park (MGWR Up Track Side)	3 m	41+820	41+930	110 m
		41+960	42+090	130 m

Location	Height	Start Chainage	End Chainage	Total Length
Drumcondra Park/Portland Lock (MGWR Down Track Side)	3 m	41+900	42+185	285 m
Maynooth	3.5 m	90+180	91+440	1,260 m

Further information on the barriers are detailed in the following paragraphs and images:

- Ossory Road – 3 m high barrier relative to road surface height between OBD 227A and OBD226 on the MGWR up track side as shown on Figure 14-14.

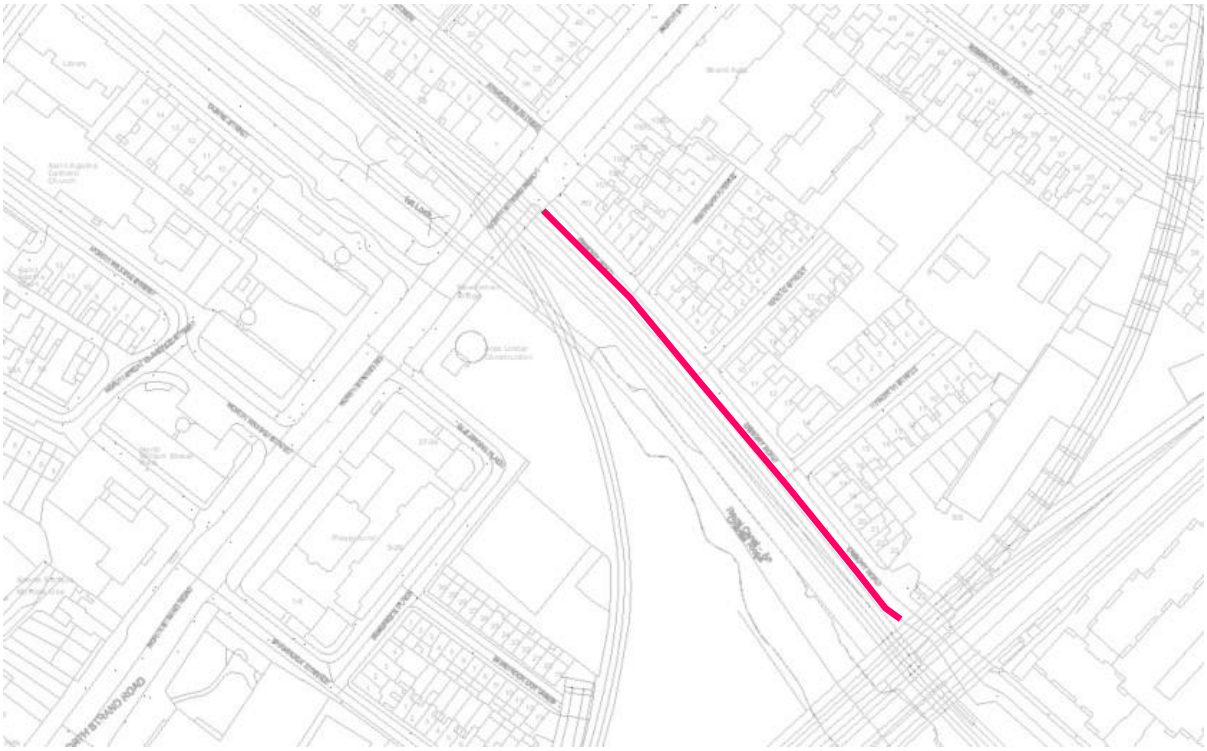


Figure 14-14 Ossory Road Noise Barrier Extent

- Ardilaun Square – 3 m high noise barrier relative to road surface height on the MGWR up track side as shown in Figure 14-15.

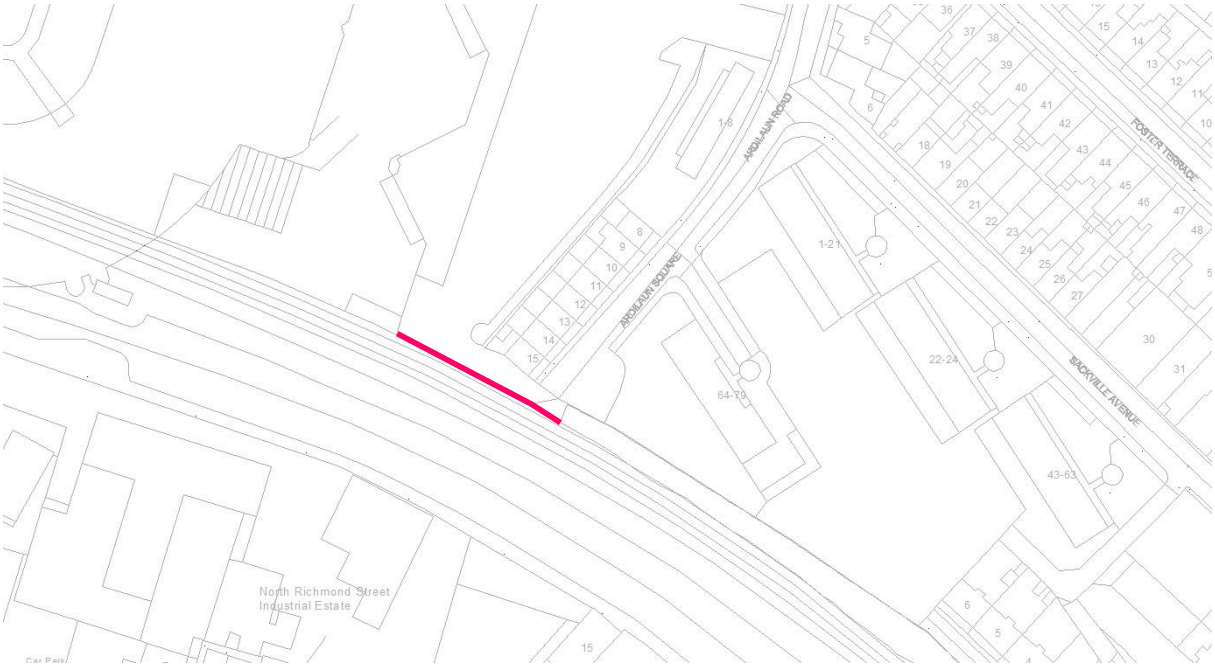


Figure 14-15 Ardilaun Square Noise Barrier Extent

- Drumcondra Park/Portland Lock – 3 m high barrier from OBD224 to OBD223 on both up and down sides of the track. Note that as these barriers are parallel to one another each should be specified to have an absorptive face on the rail side to avoid reflecting noise back towards the opposite side as shown in Figure 14-16.

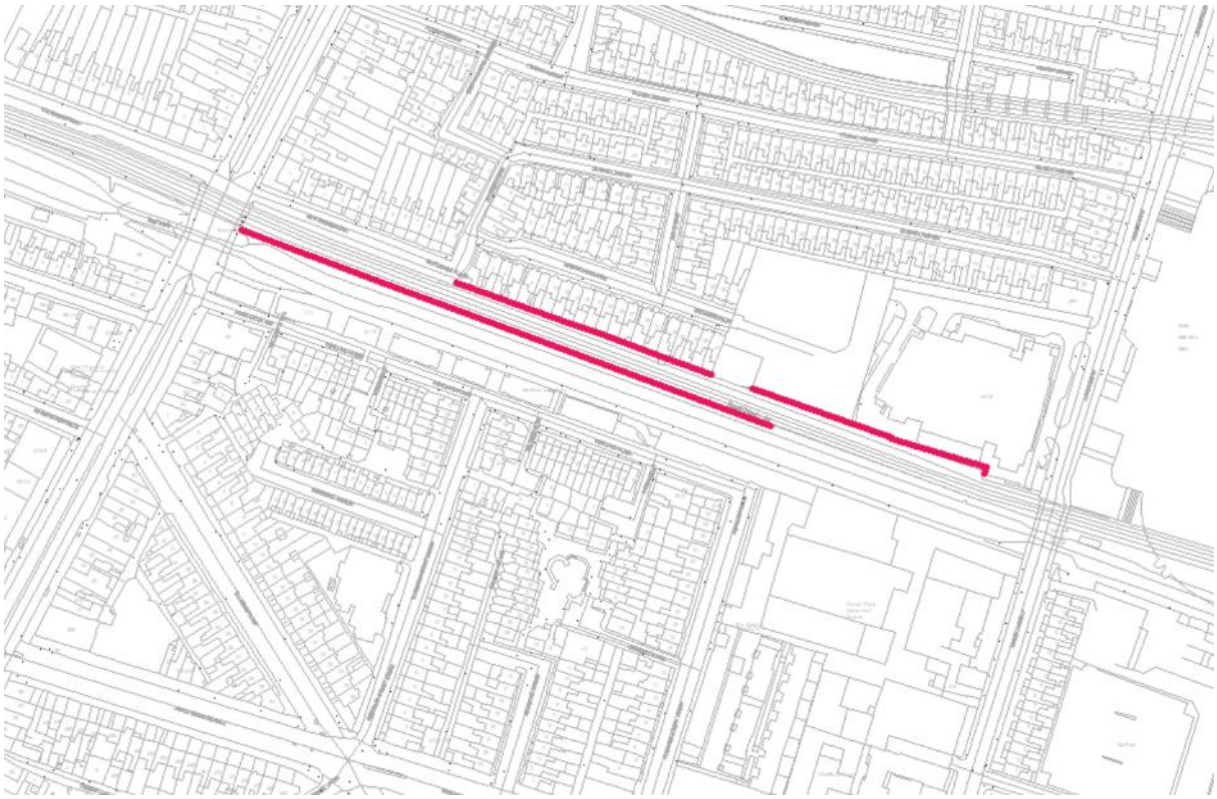


Figure 14-16 Drumcondra Park / Portland Lock Noise Barrier Extent

- Maynooth to Maynooth Depot - 3.5 m high barrier along the fence line between OBG21 and chainage 91+500 on the westbound track edge as shown on Figure 14-17.

Figure 14-17 Maynooth Noise Barrier Extent

Barriers will be specified to achieve a noise reduction class B4 when tested in accordance with EN 16272-2: 2012 Railway Applications - Track - Noise Barriers and Related Devices Acting on Airborne Sound Propagation - Test Method for Determining the Acoustic Performance - Part 2: Intrinsic Characteristics - Airborne Sound Insulation in the Laboratory Under Diffuse Sound Field Conditions.

The barriers at Drumcondra Park/Portland Lock will be specified to also achieve a noise absorption rating to avoid reflections.

14.6.2.2 Ongoing Maintenance

During the course of ongoing maintenance the procedures outlines in Iarnród Éireann operation procedure CCE-QMS-008-002 Noise Management – CCE Activities will be implemented. This document outlines the following noise mitigation measures:

- The Community Liaison Officer (or other nominated person) will notify affected residents in advance of any planned works commencing with a letter drop in the relevant area.
- Where planned work occurs over a 72 hr weekend shutdown there will be a noise management plan submitted to the local authority.
- All attempts to avoid, prevent or reduce the harmful effects of exposure to environmental noise arising from CCE work activities must be practical and appropriately risk assessed before implementation.
- The following measures should be implemented where feasible during maintenance activities:
  - Carry out as much preparatory work in daylight as possible (sawing or drilling rails).
  - Inspect the worksite in daylight if possible and look for the best location to position generators.
  - Position generators and lighting away from residential dwellings.
  - Take advantage of natural barriers such as vegetation, walls or embankments that can offer noise screening to adjacent neighbours.
  - Where necessary, use noise attenuation screens. The screens must be located as close to the receiver or source as possible.
  - Consider using additional supply cables and structures so that the generators can be positioned as far away from housing as practicable.

- Where possible, use low-noise plant. Any unsuitable plant should be replaced by higher quality low noise plant, or contained by the use of mufflers/silencers.
- Do not leave equipment or vehicles running/idling unnecessarily.
- Do not shout work instructions when working in residential areas at night unless absolutely necessary.
- Plan effectively to ensure timely deliveries of materials.

14.6.2.3 PA Systems

In this instance, Iarnród Éireann (IÉ) have a standard procedure for the design of station services which includes a procedure for the design of PA systems. Section 5 of Iarnród Éireann Standard I-TEL-3930 Station Services – Design, Install and Commission details the following measures with regards to the noise emission from PA systems,

- 1 Ambient Noise Sensor (ANS) must be located per platform
- The PA system must be commissioned, tested, and certified to current TSI standards by an external nominated body prior to handover to IÉ for acceptance testing.
- dB(A) background sound level reading must be recorded at each platform between 2 pairs of speakers. This must be recorded during normal operating hours but without a train in the station.
- Recorded test announcement must be played from the outstation and the volume levels on the amplifiers must be adjusted until the normal output volume is an average of 10dB(A) above recorded background levels.
- Microphone, MRA and VOIP levels must be adjusted to correspond to normal volume levels.
- Reduced volume must be adjusted to ensure the output volume does not exceed recorded background levels.
- The system must not exceed an average SPL over 8 hours of 85dB(A) and a maximum of 90dB(A).
- The system must have a minimum 0.5 STI indoors and a 0.045 STI outdoors.
- GA CAD drawing to show all speakers in the station and labelled as per zone must be provided and include cable routes. TSI test locations must also be noted on the drawing.

These measures will be implemented throughout the DART+ West project to minimise any noise effects from PA systems.

14.6.2.4 Substations & Fixed Plant

Substations should be selected and designed to ensure no tonal noise emissions are audible at the nearest sensitive locations and overall noise emissions do not exceed 55dB(A) when measured 2 m from any point around the substation building. For all other fixed plant serving the development the assessment outlined previously has specified noise limits at the nearest noise sensitive properties that must be achieved in order to ensure the impact is acceptable. To achieve these noise limits consideration will be given, at the detailed design stage, to a variety of mitigation measures and forms of noise control techniques. Some examples of these measures are as follows:

- duct mounted attenuators on the atmosphere side of air moving plant.
- splitter attenuators or acoustic louvres providing free ventilation to internal plant areas.
- solid barriers screening any external plant.
- anti-vibration mounts on reciprocating plant.

In addition to the above, IÉ will adopt the following measures to minimise potential noise disturbance for neighbours.

- All mechanical plant items e.g. motors, pumps etc. shall be regularly maintained to ensure that excessive noise generated by any worn or rattling components is minimised.
- Any new or replacement mechanical plant items, including plant located inside new or existing buildings, shall be designed so that all noise emissions from site do not exceed the noise limits outlined in this document.

14.7 Residual effects

14.7.1 Construction Phase

14.7.1.1 Construction Noise

The effects per Zone are as follows.

Zone A

Zone A works will include new fencing, parapets, track lowering, SET installation and construction of a new traction substation at Glasnevin. During the day period the majority of the works are expected to cause moderate effects, however the piling for the substation is expected to cause a significant effect at the closest receptors. During night works the noise effect is expected to be significant. The resultant residual effects for Zone A will likely be *negative, moderate to significant and temporary to short-term*.

Zone B

Zone B works will include new fencing, parapets, track lowering, SET installation, Sheriff Bridge reconstruction, Spencer Dock permanent way construction and construction of a new station at Spencer Dock. During the day period the majority of the works are expected to cause a moderate to significant effect depending on the activities taking place. For Spencer Dock station there are expected to be some temporary significant effects, however for the majority of the works for the new station the effect will be moderate. During night works the noise effect is expected to be significant within Zone B. The resultant residual effects for Zone B will likely be *negative, moderate to significant and temporary to short-term*.

Zone C

Zone C works will include new fencing, parapets, track lowering, SET installation, bridge deck modifications, substation constructions, level crossing closures and construction of replacement infrastructure, station construction works and sidings. The majority of day works are expected to cause a moderate effect, however depending on the receptor distance to the work and the activity being undertaken there will be some significant effects during the day. During night works the noise impact is expected to be significant within Zone C. The resultant residual effects for Zone C will likely be *negative, moderate to significant and temporary to short-term*.

Zone D

Zone D works will include new fencing, parapets, track lowering, SET installation, substation constructions and sidings. The day works at the M3 Parkway sidings are expected to cause a temporary moderate effect. The substations at Hansfield, Dunboyne and M3 Parkway are expected to cause a temporary significant effect during the piling phase, but most works will typically result in a moderate effect at the closest receptors. During night works the noise effect is expected to be significant within Zone D. The resultant residual effects for Zone D will likely be *negative, moderate to significant* and *temporary to short-term*.

Zone E

Zone E works will include level crossing closures and construction of replacement infrastructure (where applicable), new fencing, parapets, track lowering, SET installation, bridge reconstruction and substation constructions. During the day period the majority of the works are expected to cause a moderate to significant effect depending on the activities taking place. During night works the noise effect is expected to be significant to very significant within Zone E. The resultant residual effects for Zone E will likely be *negative, moderate to very significant and temporary to short-term*.

Zone F

Zone F works will include level crossings, new fencing, parapets, track lowering, SET installation, bridge reconstruction, track doubling, station works, depot construction and substation constructions. During the day period the majority of the works are expected to cause a moderate to significant effect depending on the activities taking place, however depot construction works are expected to only cause a moderate noise impact. During night works the noise effect is expected to be potentially profound within parts of Zone F, this is due to the prolonged night works undertaken for the track doubling. The resultant residual effects for Zone F will likely be *negative, moderate to profound and temporary to short-term*.

14.7.1.2 Construction Vibration

The residual effects of vibration during construction will be *negative*, *slight* to *moderate* and *brief to temporary* depending on location. All construction activity will be carried out within the vibration thresholds specified, noting in particular the lower values that apply to more sensitive or protected structures.

14.7.1.3 Commentary on Health Affects during the Construction Phase

The construction phase is short-term and therefore any elevated levels of noise will be of limited duration and, as a result, are not expected to pose any risk to human health. In terms of the noise exposure of construction workers and potential hearing damage that may be caused due to exposure to high levels of noise, the Safety, Health and Welfare at Work (General Application) Regulations 2007 (Statutory Instrument No. 299 of 2007) provides guidance in terms of allowable workplace noise exposure levels for employees. The Regulations specify two noise Action Levels at which the employer is legally obliged to reduce the risk of exposure to noise. The appointed contractor will be required to comply with the Regulations and provide appropriate noise exposure mitigation measures where necessary.

14.7.2 Operational Phase

14.7.2.1 Rail Noise

With the mitigation measures outlined in Section 14.6.2.1 in place, the residual rail noise effect during the operation of the proposed development have been recalculated and Table 14-43 compares the day and night noise levels with mitigation in Zone B and Zone F to the calculated Do Nothing rail noise levels to determine the degree of significance of the effects.

Table 14-50 Comparison of Rail Noise with DART+ West Do Nothing vs Do Something With Mitigation

Zone	Location	Do Nothing $L_{Aeq,16hr}$ dB	Do Something $L_{Aeq,16hr}$ dB	Do Nothing L_{night} dB	Do Something L_{night} dB
B	N03	55	56	46	51
	N08	49	44	33	40
	N10	52	54	27	51
F	N41	63	56	58	49
	N42	56	54	45	51

Following mitigation, the residual effects are discussed in the following sections.

14.7.2.1.1 Zone B

Noise levels at Ardiluan Square (N08) have reduced below the absolute noise levels for day and night of 55dB $L_{Aeq,1hr}$ and 45dB L_{night} respectively and thereby noise effects are considered to be *not significant*.

Reductions of the order of 3 to 4dB have been noted at Ossory Road (N03), Drumcondra Park (N10) and Portland Lock. To determine the specific residual noise effect at these properties, the measured noise levels

during the baseline survey are compared against the mitigated Do Something levels. Table 14-51 presents this comparison where it is determined that the Do Something rail noise levels with mitigation are equivalent to or less than the prevailing ambient baseline which measures all noise sources in the environment.

Table 14-51 Zone B Comparison of Rail Noise with DART+ West Baseline vs Do Something With Mitigation

Zone	Location	Baseline $L_{Aeq,16hr}$ dB	Do Something $L_{Aeq,16hr}$ dB	Baseline L_{night} dB	Do Something L_{night} dB
B	N03	66	56	Note 1	51
	N08	53	44	52	40
	N10	55	54	51	51

Note 1 Night-time baseline data is not available for this location.

It is therefore concluded that the residual effects in Zone B is likely to be *negative, slight and long term*.

14.7.2.1.2 Zone F

Reductions of up to 11dB have been noted in Zone F at locations adjacent to the noise barrier. It is therefore concluded that the residual effects in Zone F are likely to be *negative, slight and long term*.

14.7.2.1.3 Commentary on Health Affects

As discussed in Section 14.5.4.2, the WHO Environmental Noise Guidelines (WHO 2018) document provides recommendations for assessing the health effects of absolute noise levels from various sources. For rail sources the association between exposure to railway noise and annoyance and sleep disturbance are provided by the WHO and reproduced in Table 14-52 and Table 14-53.

Table 14-52 The Association between Railway Noise (L_{den}) and Annoyance (%HA)

L_{den} (dB)	%HA
40	1.5
45	3.4
50	6.6
55	11.3
60	17.4
65	25.0
70	33.9
75	44.3
80	56.1

Table 14-53 The Association between Railway Noise (L_{night}) and Sleep Disturbance (%HSD)

L_{night} (dB)	%HSD
40	2.1
45	3.7
50	6.3
55	10.4
60	17.0
65	26.3

Taking the results presented previously in Sections 14.5.4.6.3 and 14.7.2 it is possible to comment on the absolute rail noise levels predicted and the health metrics above for each zone for both the Do Nothing and Do Something scenarios, including mitigation.

Table 14-54 WHO Health Metrics for L_{den} Do Nothing vs Do Something

Zone	Do Nothing		Do Something	
	Range of Predicted Rail Noise L_{den} dB	%HA	Range of Predicted Rail Noise L_{den} dB	%HA
A	40 - 66	1.5 - 25	38 - 65	1.5 - 25
B	42 - 57	1.5 - 11.3	48 - 61	3.4 - 17.4
C	56 - 69	11.3 - 33.9	57 - 71	11.3 - 33.9
D	50 - 62	6.6 - 17.4	47 - 60	3.4 - 17.4
E	51 - 68	6.6 - 25	50 - 68	6.6 - 25
F	57 - 66	11.3 - 25	57 - 59	10.4

Table 14-55 WHO Health Metrics for L_{night} Do Nothing vs Do Something

Zone	Do Nothing		Do Something	
	Range of Predicted Rail Noise L_{night} dB	%HSD	Range of Predicted Rail Noise L_{night} dB	%HSD
A	32 - 57	0 - 10.4	30 - 56	0 - 10.4
B	0 - 46	0 - 3.7	40 - 53	2.1 - 6.3
C	48 - 61	3.7 - 17	49 - 62	3.7 - 17
D	41 - 54	2.1 - 10.4	38 - 51	2.1 - 6.3
E	43 - 61	2.1 - 17	42 - 60	2.1 - 17
F	45 - 58	3.7 - 17	49 - 51	6.3

The analysis indicates that depending on the zone the risk of health effect varies. In this instance it is relevant to compare the health impact metrics of the Do Nothing scenario to the Do Something scenario. This would present the change in potential health impacts as a result of the proposed development. This comparison finds that there are small changes to the health effects in all zones and changes in noise level are *slight negative and positive* depending on the zone.

14.7.2.1.4 Summary

The effects can be summarised per Zone as follows,

- Zone A – Negative, Neutral and Positive, slight, long term effects.
- Zone B – Negative, slight, long term effects.
- Zone C – Negative, Neutral and Positive, slight, long term effects.
- Zone D – Positive, slight to moderate, long term effects.
- Zone E – Negative, Neutral and Positive, slight, long term effects.
- Zone F – Neutral to Negative, slight, long term effects.

14.7.2.2 Rail Vibration

The range of operational vibration levels have been found to be not significant. The residual effects are likely to be *negative, not significant and long-term*.

14.7.2.3 Fixed Plant Items

The range of operational noise levels from each fixed source will be controlled in accordance with best practice guidance to control significant noise impacts. The likely residual effects are *negative, slight and long-term*.

14.7.2.4 Changes to Road Traffic on the Local Road Network

Residual noise effects due to changes to road traffic on the local road network are at most locations are likely to be *long-term, neutral and not significant.* At some locations close to the level crossings being closed, the likely noise effects are *long-term, positive and significant*.

14.7.2.5 Depot Operation

Residual noise effects at the closest NSLs to the Maynooth depot are *negative, slight and long-term*.

14.7.2.6 Permanent Compounds and Maintenance Work

Residual noise effects at the closest NSLs to the permanent compounds and ongoing maintenance work are *negative, significant and brief and short-term*.

14.7.2.7 PA Announcements

Residual noise effects at the closest NSLs to the PA announcements are *negative, slight and brief*.

14.7.2.8 Spencer Dock Station

Residual noise effects at the closest NSLs to Spencer Dock Station are *negative, slight and long-term*.

14.8 Cumulative effects

In the context of noise and vibration effects the construction and operational phases are considered separately and there will be no cumulative noise or vibration effect on the environment.

During construction, cumulative effects will not be any greater than the residual effects described in Section 14.7.1. This is due to the nature of noise and vibration and the fact that the effects only occur while construction activity is ongoing. Once works stop, the effect stops and therefore cumulative effects of the phased approach to construction do not occur.

During operation, the main source of noise is rail noise which will continue to be the primary noise source for the nearest noise sensitive locations to the development. Other ancillary sources such as fixed plant, road traffic and maintenance works will not generate a cumulative effect either due to the relatively low noise level associated with them compared to rail noise, i.e., for fixed plant and road traffic, or due to the fact that rail movements are suspended during maintenance works and therefore the noise emissions occur separately and at different times and cannot generate a cumulative effect.

The cumulative assessment of relevant plans and projects is undertaken separately in Chapter 26 of this EIAR.

14.9 References

British Standard Institute (BSI) British Standard (BS) 5228 (2009 +A1 2014) Code of Practice for noise and vibration control of construction and open sites - Part 1: Noise (hereafter referred to as BS 5228 – 1) (BSI 2009 +A1 2014a);

BS 5228 (2009 +A1 2014) Code of Practice for noise and vibration control of construction and open sites - Part 2: Vibration (hereafter referred to as BS 5228 – 2) (BSI 2009 +A1 2014b);

BS 7385 (1993) Evaluation and measurement for vibration in buildings Part 2: Guide to damage levels from ground borne vibration (hereafter referred to as BS 7385 – 2). (BSI 1993);

BS 6472 (2008) Guide to Evaluation of human exposure to vibration in buildings, Part 1 Vibration sources other than blasting (hereafter referred to as BS 6472 – 1). (BSI 2008);

BS 8233:2014 Sound Insulation and Noise Reduction for Buildings (hereafter referred to as BS 8233 (BSI 2014);

BS 4142 (2014+A1 2019) Methods for rating and assessing industrial and commercial sound (hereafter referred to as BS 4142) (BSI 2014 +A1 2019);

UK Highways Agency (UKHA) Design Manual for Roads and Bridges (DMRB) LA 111 Sustainability & Environmental Appraisal. Noise and Vibration Rev 2, (hereafter referred to as DMRB Noise and Vibration) (UKHA 2020);

Dublin Local Authorities including Dublin City Council (DCC) and Fingal County Council (FCC). Dublin Agglomeration Third Environmental Noise Action Plan December 2018 – November 2023 (hereafter referred to as the Dublin Agglomeration NAP 2018 – 2023) (DCC; FCC; 2018);

Kildare County Council (KCC) Third Noise Action Plan 2019 – 2023 (KCC 2019);

Meath County Council (MCC) County Meath Noise Action Plan 2019 (MCC 2019);

European Communities (EC) (Environmental Noise) Regulations 2018 (S.I. No. 549 / 2018);

EC (Environmental Noise) Regulations 2006 (S.I. No. 140/2006)

EC Noise Emission by Equipment for Use Outdoors (Amendment) Regulations (S.I. No. 241 / 2006);

International Organization for Standarization (ISO) 9613-2:1996 Acoustics – Attenuation of sound during propagation outdoors - Part 2: General method of calculation (hereafter referred to as ISO 9613 – 2) (ISO 1996);

ISO 1996-1:2016 Acoustics - Description, measurement and assessment of environmental noise. Part 1: Basic quantities and assessment procedures (hereafter referred to as ISO 1996 – 1) (ISO 2016);

ISO 1996-2:2017 - Description, measurement and assessment of environmental noise - Part 2: Determination of sound pressure levels (hereafter referred to as ISO 1996 – 2) (ISO 2017);

Transport Infrastructure Ireland (TII) Guidelines for the Treatment of Noise and Vibration in National Road Schemes, Revision 1 (hereafter referred to as the TII Noise Guidelines 2004) (TII 2004);

Transport Infrastructure Ireland (TII) Code of engineering practice for works on, near, or adjacent the Luas light rail system (TII 2016);

Good Practice Guide for the Treatment of Noise during the Planning of National Road Schemes (hereafter referred to as the TII Noise Guidelines 2014) (TII 2014);

Reken- en Meetvoorschrift Railverkeerslawaai (RMR) ’96, Ministerie Volkshuisvesting, Ruimtelijke Ordening en Milieubeheer, 20 November 1996. (Calculation and Measurement requirements for rail transport noise. Dutch Ministry Housing, Spatial Planning and the Environment) (Hereafter referred to as RMR) (Dutch Housing, Spatial Planning and the Environment 1996);

The UK Department of Transport Calculation of Road Traffic Noise (hereafter referred to as CRTN) (UK Department of Transport 1998); and

World Health Organization (WHO) Environmental Noise Guidelines for the European Region (hereafter referred to as WHO Environmental Noise Guidelines) (WHO 2018).

EN 16272-2 : 2012 Railway Applications - Track - Noise Barriers and Related Devices Acting on Airborne Sound Propagation - Test Method for Determining the Acoustic Performance - Part 2: Intrinsic Characteristics - Airborne Sound Insulation in the Laboratory Under Diffuse Sound Field Conditions.