Badgerys Creek DHL Development Stage 1

Noise Impact Assessment

DHL Supply Chain (Australia) Pty Ltd

Level 4, Building C
1 Homebush Bay Drive
RHODES 2138

Prepared by:

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Basis of Report

This report has been prepared by SLR Consulting Australia (SLR) with all reasonable skill, care and diligence, and taking account of the timescale and resources allocated to it by agreement with DHL Supply Chain (Australia) Pty Ltd (the Client). Information reported herein is based on the interpretation of data collected, which has been accepted in good faith as being accurate and valid.

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SLR disclaims any responsibility to the Client and others in respect of any matters outside the agreed scope of the work.

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1.0 Introduction

This report supports a State Significant Development Application (SSDA) (SSD-70818708) submitted to the Department of Planning, Housing and Industry (DPHI) on behalf of DHL Supply Chain (Australia) Pty Ltd (DHL). DHL is seeking to secure consent for the construction and operation of warehouse and logistics facilities, including two warehouses and associated landscaping works within part of Lot 1 in DP 1306448 at 1953-2109 Elizabeth Drive, Badgerys Creek known as the DHL Masterplan site. This SSDA represents the second of two SSDAs proposed by DHL and will apply to the southern half of the DHL Masterplan site.

SLR is suitably qualified and endorsed by the Planning Secretary to produce this noise impact assessment. SLR staff are members of the Australian Acoustical Society (AAS) and SLR is a member firm of the Association of Australasian Acoustical Consultants (AAAC).

This report summarises the assessment of the potential construction and operational noise impacts associated with the proposal.

The following report uses specialist acoustic terminology. An explanation of common terms is provided in **Appendix A**.

1.1 Proposal Description

The DHL Masterplan site occupies 25 hectares (ha) of the larger 171.84ha site at 1953-2109 Elizabeth Drive, Badgerys Creek, which is known as “Burrah Park site”. The wider Burrah Park site is subject to a separate SSDA (SSD-70316465) which has not been considered for this assessment. Therefore, this report will only consider the acoustic impacts related to construction activities and operation for the Stage 1 development.

DHL Stage 2 site occupies the northern portion of the DHL Masterplan Site and is the subject of SSDA (SSD-70817958).

Specifically, this SSDA seeks consent for:

- Staged construction of warehouse buildings for use as a logistics centre with 24 hour/ day, seven days a week operation, comprising the following:
  - Construction of two warehouses
  - Building fit out
  - Construction of hardstand, loading and carparking
  - Landscaping works
  - Signage.

1.2 Site Description

The site is located within Badgerys Creek, 12.5 km south-east of the Penrith Central Business District (CBD), 27 km west of Parramatta, and 47 km from the Sydney CBD. In its current setting, the site is bounded by agricultural uses to the east and west, rural residential land uses to the north and Elizabeth Drive and the currently under construction Western Sydney Airport to the immediate south. The future M12 Motorway is also located to the north and east of the site.

The site forms part of the Northern Gateway Precinct which is a major interface for the Western Sydney Airport and a specialised centre linking the Airport with the metropolitan cluster. It will be an employment precinct that can be easily accessed and will provide

skilled employment and business opportunities north of the Airport. Key objectives of the precinct are to:

- Facilitate the development of a high technology employment precinct.
- Facilitate a variety industrial and business enterprises in locations that support the principles of transit-oriented development.

Badgerys Creek Precinct is also to the east of the site. This precinct will support the Western Sydney Airport operations and be well connected to the Aerotropolis Core metropolitan centre to the south and the Northern Gateway to the north-west. The precinct will transform from lower density and less intensive land uses, buildings and structures to higher order employment-focused technology, advanced manufacturing and industry use.

The location context is shown in **Figure 1**. The DHL Masterplan is shown in **Figure 2** and the aerial plan including surrounding areas are shown in **Figure 3**.

Figure 1 Location Context Area Plan

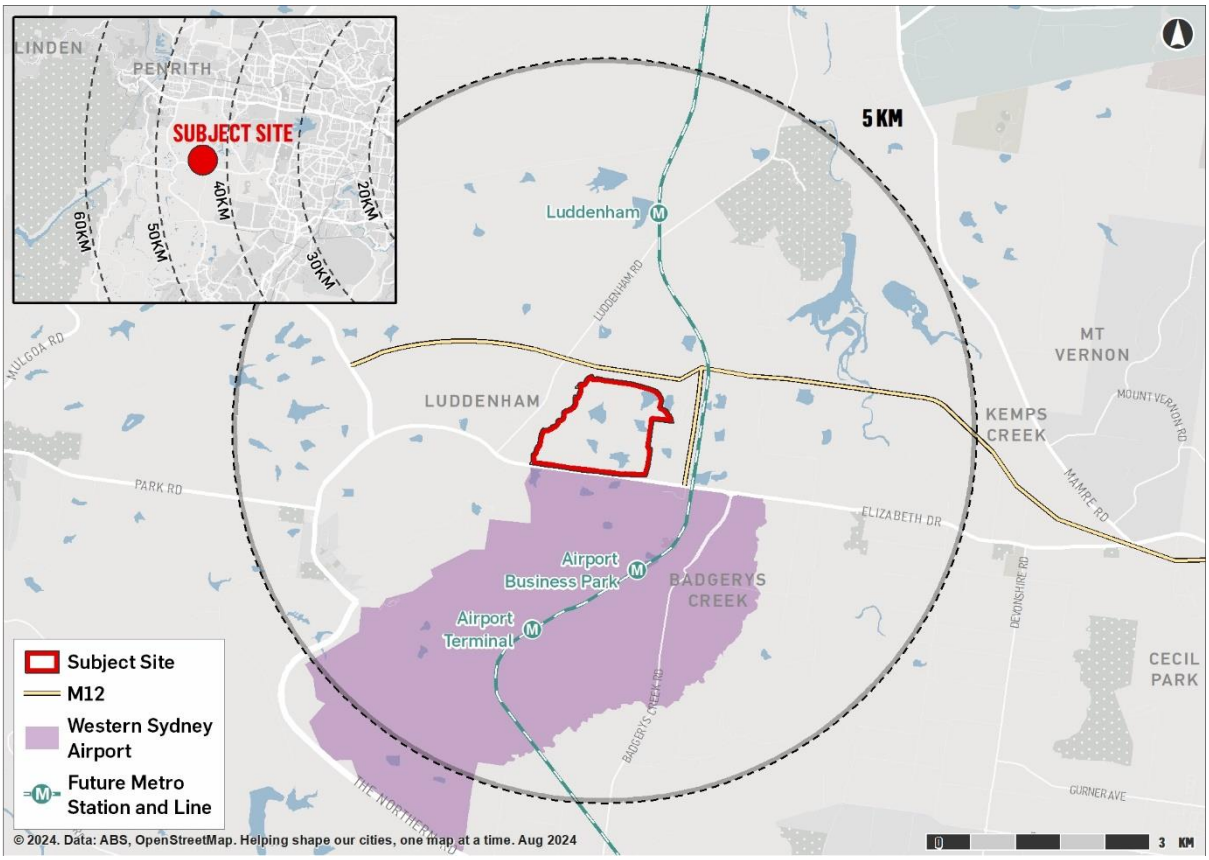


Figure 2 DHL Masterplan (Stage 1 in red box)

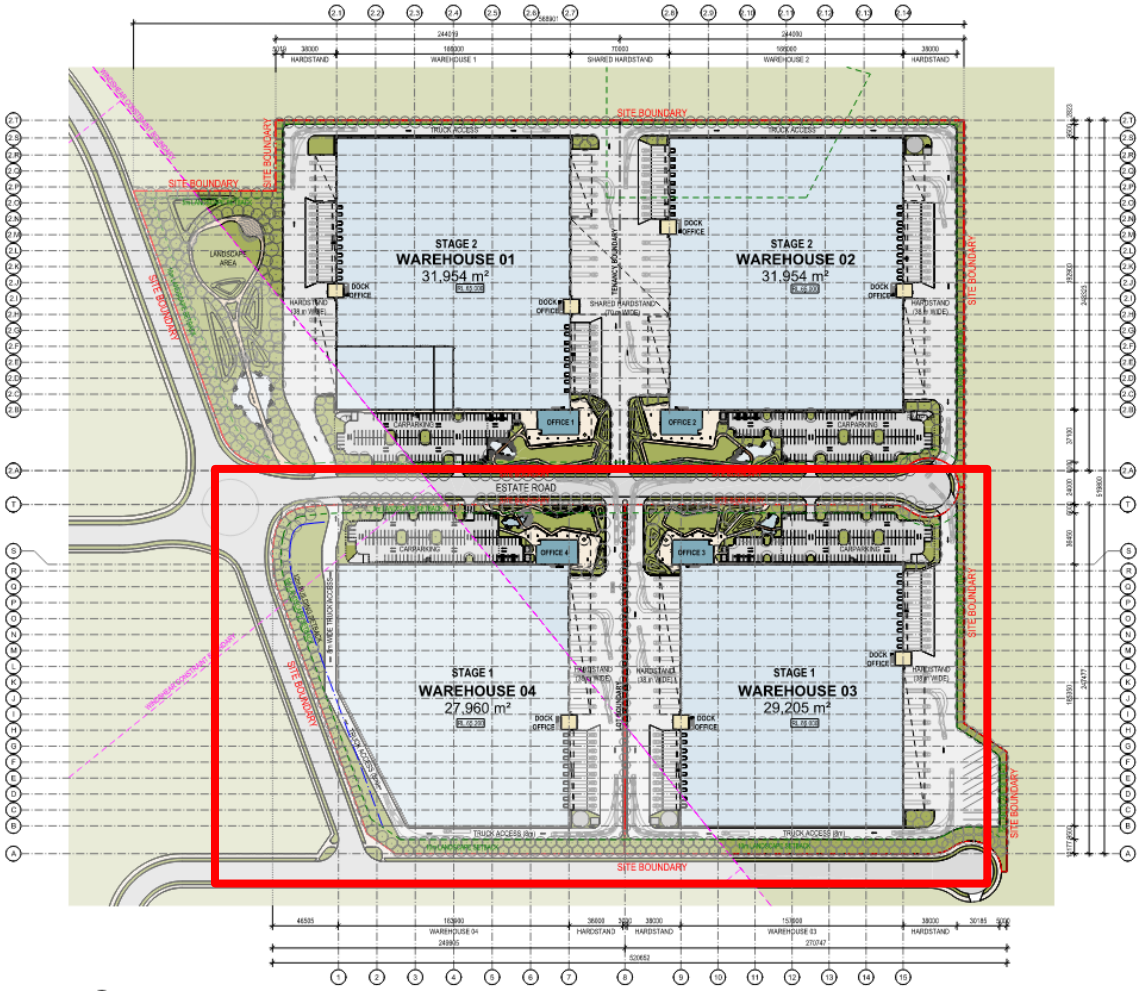
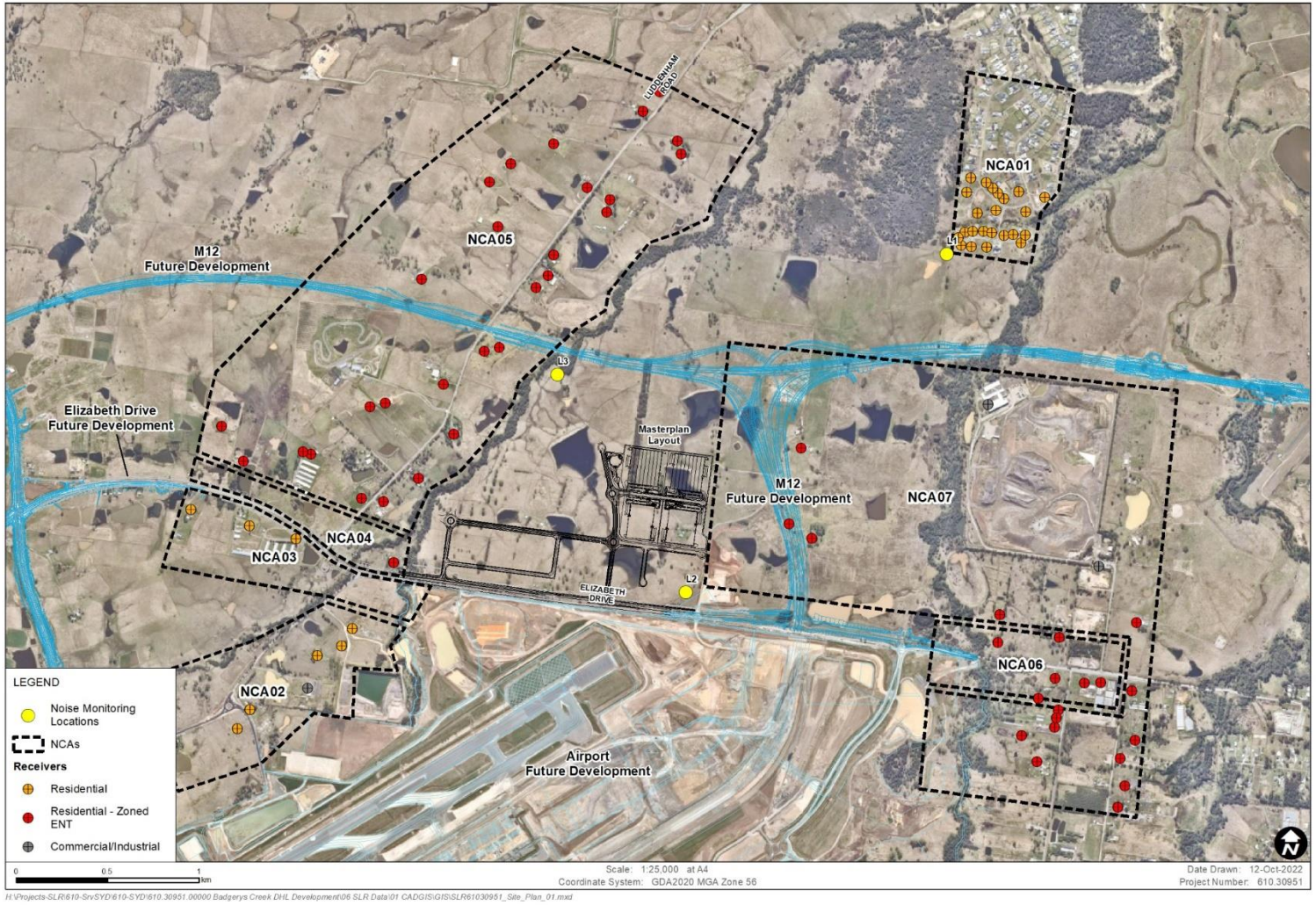


Figure 3 Site Location, Surrounding Receivers and Noise Monitoring Locations



1.2.1 Nearest Receivers

The nearest sensitive receivers are residential properties located to the west, south-west, north-east and east, at distances of around 900 m, 1,200 m, 1,700 m and 450 m, respectively.

The majority of the surrounding existing receivers are within the Northern Gateway Precinct or adjoining Badgerys Creek Precinct and on land zoned as enterprise (ENT). Exceptions to this are residential receivers to the north-east (in NCA01), which are on land zoned environmental living (E4), and residential receivers to the south-west (in NCA02 and NCA03), which are on land zoned Agribusiness (AGB).

It is understood that all existing receivers zoned as ENT will be redeveloped and replaced with a variety of future industrial and business enterprises as the Northern Gateway and Badgerys Creek Precincts progress.

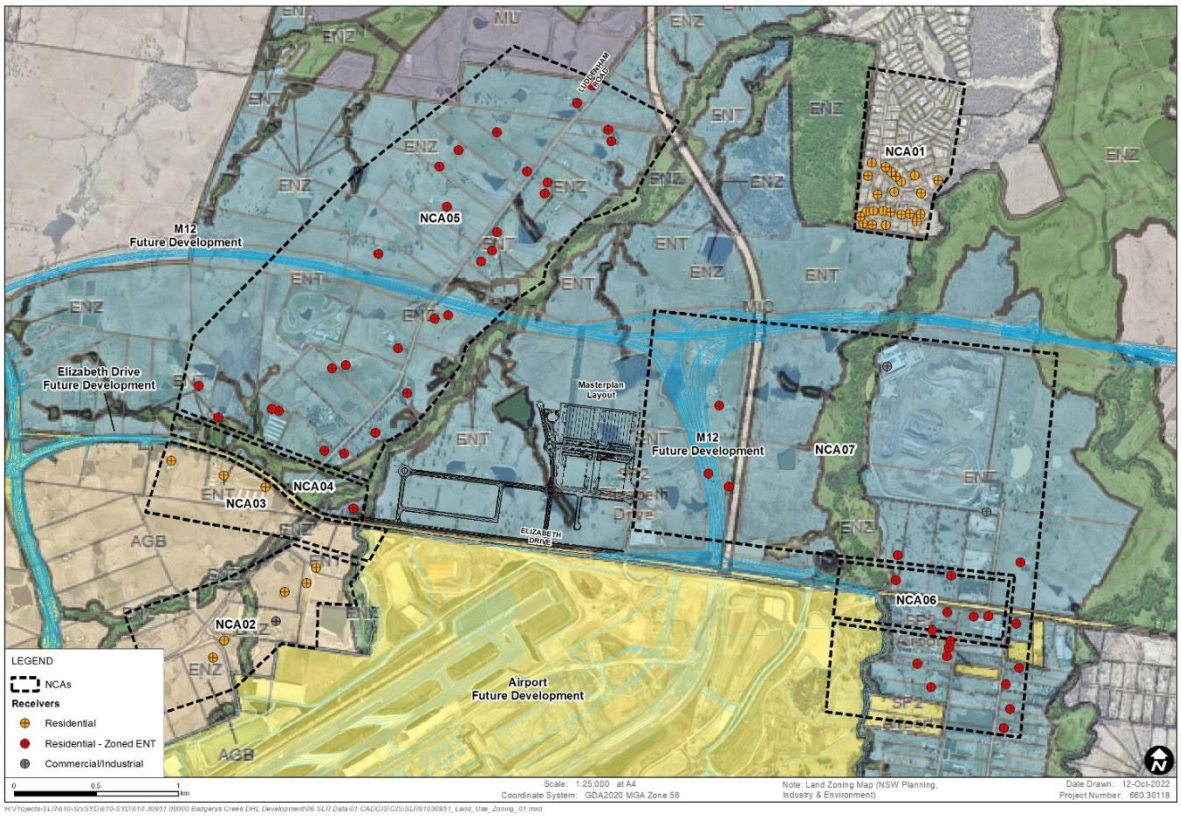
The surrounding areas have been separated into Noise Catchment Areas (NCAs). These are shown in **Figure 3** and described in **Table 1**. The land use zoning of the surrounding areas is shown in **Figure 4**.

Table 1 NCAs and Sensitive Receivers

NCA	Direction	Receiver Type	Land Use Zoning	Approx. Closest Distance (m)
Receivers outside the Northern Gateway/Badgerys Creek Precincts				
NCA01	North-east	Residential	E4	1,700
NCA02	South-west	Residential	AGB	1,500
		Commercial	AGB	1,800
NCA03	South-west	Residential	AGB	1,900
Receivers inside the Northern Gateway/Badgerys Creek Precincts				
NCA04	South-west	Residential	ENT	1,200
NCA05	West	Residential	ENT	900
NCA06	South-east	Residential	ENT	1,600
NCA07	East	Residential	ENT	450[1] to 1,600
		Industrial	ENT	1,500

Note 1: The nearest residential receivers to the east in NCA07 are within the M12 Motorway footprint.

Figure 4 Land Use Zoning



1.3 Secretary's Environmental Assessment Requirements

The Secretary's Environmental Assessment Requirements (SEARs) were issued by the Department of Planning and Environment (DPE) in March 2022. The requirements relevant to noise and vibration are shown in **Table 2**.

Table 2 Secretary's Environmental Assessment Requirements

Noise and Vibration	Where Addressed
Provide a noise and vibration assessment prepared in accordance with the relevant EPA guidelines. The assessment must detail construction and operational noise and vibration impacts on nearby sensitive receivers and structures and outline the proposed management and mitigation measures that would be implemented.	Criteria: **Section 3.0** Impacts: **Section 4.0** Mitigation: **Section 5.0**
Provide an assessment of the cumulative impacts (including noise, air quality and traffic) of the project and other approved and proposed developments in accordance with the Cumulative Impact Assessment Guidelines for State Significant Projects (DPIE, July 2021).	Criteria: **Section 3.0**

2.0 Existing Noise Environment

Unattended noise monitoring was completed at the site during August 2021. The measured noise levels have been used to determine the existing noise environment and to set the criteria used to assess the potential impacts from the proposal.

The monitoring equipment was positioned to measure existing noise levels that are representative of receivers potentially most affected by the proposal, within constraints such as accessibility, security and landowner permission. Various monitoring locations were chosen to represent different setback distances from both Elizabeth Drive and Luddenham Road.

The noise monitoring equipment continuously measured existing noise levels in 15-minute periods during the daytime, evening and night-time. All equipment carried current National Association of Testing Authorities (NATA) or manufacturer calibration certificates and equipment calibration was confirmed before and after each measurement.

The measured data has been processed to exclude noise from extraneous events and periods affected by adverse weather conditions, such as strong wind or rain (measured at Badgerys Creek Bureau of Meteorology Station), to establish representative existing noise levels in each Noise Catchment Area.

The noise monitoring locations are shown in **Figure 3** and the results are summarised in **Table 3**. Details of each monitoring location together with graphs of the measured daily noise levels are provided in **Appendix B**.

Table 3 Summary of Unattended Noise Monitoring Results

ID	Address/Description	Measured Noise Levels (dBA)					
		Background Noise (RBL)			Average Noise (L_{Aeq})		
		Day	Evening	Night	Day	Evening	Night
L01	Farmingdale Court, Luddenham	29	33	31	45	43	43
L02	150 metres north of Elizabeth Drive	40	36	35	53	50	52
L03	380 metres east of Luddenham Road	31	31	28	46	41	43

Note 1: The assessment periods are the daytime which is 7 am to 6 pm Monday to Saturday and 8 am to 6 pm on Sundays and public holidays, the evening which is 6 pm to 10 pm, and the night-time which is 10 pm to 7 am on Monday to Saturday and 10 pm to 8 am on Sunday and public holidays. See the NSW EPA Noise Policy for Industry.

Short-term attended noise monitoring was also completed. The attended measurements allow the contributions of the various noise sources at each location to be determined. Detailed observations from the attended measurements are provided in **Appendix B**.

The attended measurements were generally found to be consistent with the results of the unattended noise monitoring and show that existing noise levels are typically dominated by road traffic noise from the surrounding road network, along with general rural and environmental noise.

3.0 Assessment Criteria

3.1 Construction Noise Criteria

The NSW *Interim Construction Noise Guideline* (ICNG) is used to assess and manage impacts from construction noise on residences and other sensitive land uses in NSW.

The ICNG contains procedures for determining project specific Noise Management Levels (NMLs) for sensitive receivers based on the existing background noise in the area. The 'worst-case' noise levels from construction of a proposal are predicted and then compared to the NMLs in a 15-minute assessment period to determine the likely impact of the proposal.

The NMLs are not mandatory limits, however, where construction noise levels are predicted or measured to be above the NMLs, feasible and reasonable work practices to minimise noise emissions are to be investigated.

3.1.1 Residential Receivers

The ICNG approach for determining NMLs at residential receivers is shown in **Table 4**.

Table 4 ICNG NMLs for Residential Receivers

Time of Day	NML $L_{Aeq(15minute)}$	How to Apply
Standard Construction Hours Monday to Friday 7:00 am to 6:00 pm Saturday 8:00 am to 1:00 pm No work on Sundays or public holidays	Noise affected RBL[1] + 10 dB	• The noise affected level represents the point above which there may be some community reaction to noise • Where the predicted or measured $L_{Aeq(15minute)}$ is greater than the noise affected level, the proponent should apply all feasible and reasonable work practices to meet the noise affected level • The proponent should also inform all potentially impacted residents of the nature of works to be carried out, the expected noise levels and duration, as well as contact details.
	Highly Noise Affected 75 dBA	• The Highly Noise Affected (HNA) level represents the point above which there may be strong community reaction to noise • Where noise is above this level, the relevant authority (consent, determining or regulatory) may require respite periods by restructuring the hours that the very noisy activities can occur, taking into account: o Times identified by the community when they are less sensitive to noise (such as before and after school for works near schools or mid-morning or mid-afternoon for works near residences o If the community is prepared to accept a longer period of construction in exchange for restrictions on construction times.
Outside Standard Construction Hours	Noise affected RBL + 5 dB	• A strong justification would typically be required for works outside the recommended standard hours • The proponent should apply all feasible and reasonable work practices to meet the noise affected level • Where all feasible and reasonable practises have been applied and noise is more than 5 dB above the noise

Time of Day	NML $L_{Aeq(15minute)}$	How to Apply
		affected level, the proponent should negotiate with the community.

Note 1: The RBL is the Rating Background Level and the ICNG refers to the calculation procedures in the NSW Industrial Noise Policy (INP). The INP has been superseded by the NSW EPA Noise Policy for Industry (NPfI).

3.1.2 'Other Sensitive' Land Uses and Commercial Receivers

Non-residential land uses have been identified in the study area. The NMLs for 'other sensitive' receivers are shown in **Table 5**.

Table 5 Construction Noise Management Levels at 'Other Sensitive' Land Uses

Land Use	Noise management level $L_{Aeq(15minute)}$ (dBA) (applied when the property is in use)	
	Internal	External
ICNG 'other sensitive' receivers		
Classrooms at schools and other educational institutions	45	55[1]
Hospital wards and operating theatres	45	65[2]
Places of worship	45	55[1]
Active recreation areas (characterised by sporting activities and activities which generate noise)	-	65
Passive recreation areas (characterised by contemplative activities that generate little noise)	-	60
Commercial	-	70
Industrial	-	75
Non-ICNG 'other sensitive' receivers		
n/a	n/a	n/a

Note 1: It is assumed that these receivers have windows partially open for ventilation which results in internal noise levels being around 10 dB lower than the external noise level.

Note 2: It is assumed that these receivers have fixed windows which conservatively results in internal noise levels being around 20 dB lower than the external noise level.

Note 3: Taken from AS2107.

3.1.3 NML Summary

The construction NMLs for the proposal have been determined using the results from the unattended noise monitoring and are shown in **Table 6**.

Table 6 Project Specific Noise Management Levels

NCA	Receiver Type	Monitoring Location	Measured RBL[1] (dBA)			NML ($L_{Aeq(15minute)}$ (dBA)				Sleep Disturbance Screening Level[2] (L_{Amax} dBA)
						Standard Construction Hours (RBL+10dB)	Out of Hours (RBL+5dB)			
			Day	Eve.	Night	Day	Day	Eve.	Night	Night
NCA01	Residential	L01	35[3]	33	31	45	40	38	36	52
NCA02	Residential	L03	35[3]	31	30[3]	45	40	36	35	52
NCA03/04	Residential	L02	40	36	35	50	45	41	40	52
NCA05	Residential	L03	35[3]	31	30[3]	45	40	36	35	52
NCA06	Residential	L02	40	36	35	50	45	41	40	52
NCA07	Residential	L03	35[3]	31	30[3]	45	40	36	35	52
All	Industrial	n/a				75				n/a
All	Commercial	n/a				70				n/a

Note 1: RBL = Rating Background Level.

Note 2: Sleep disturbance screening level is RBL+15 dB or 52 dBA, whichever is higher.

Note 3: The NPfI minimum RBL value has been used due to the measured RBL being below the NPfI minimum value.

3.2 Construction Vibration Criteria

The effects of vibration from construction works can be divided into three categories:

- Those in which the occupants of buildings are disturbed (human comfort)
- Those where building contents may be affected (building contents)
- Those where the integrity of the building may be compromised (structural or cosmetic damage).

3.2.1 Human Comfort Vibration

People can sometimes perceive vibration impacts when vibration generating construction works are located close to occupied buildings.

Vibration from construction works tends to be intermittent in nature and the EPA's *Assessing Vibration: a technical guideline* (2006) provides criteria for intermittent vibration based on the Vibration Dose Value (VDV). The 'preferred' and 'maximum' VDVs for human comfort impacts are shown in **Table 7**.

Table 7 Vibration Dose Values for Intermittent Vibration

Building Type	Assessment Period	Vibration Dose Value[1] ($m/s^{1.75}$)	
		Preferred	Maximum
Critical Working Areas (eg operating theatres or laboratories)	Day or night-time	0.10	0.20
Residential	Daytime	0.20	0.40
	Night-time	0.13	0.26
Offices, schools, educational institutions and places of worship	Day or night-time	0.40	0.80
Workshops	Day or night-time	0.80	1.60

Note 1: The VDV accumulates vibration energy over the daytime and night-time assessment periods, and is dependent on the level of vibration as well as the duration.

3.2.2 Effects on Building Contents

People perceive vibration at levels well below those likely to cause damage to building contents. For most receivers, the human comfort vibration criteria are the most stringent and it is generally not necessary to set separate criteria for vibration effects on typical building contents.

Exceptions to this can occur when vibration sensitive equipment, such as electron microscopes, are located in buildings near to construction works. No such items of equipment have been identified in the project area.

3.2.3 Structural and Cosmetic Damage Vibration

If vibration from construction works is sufficiently high it can cause damage to structural elements of affected buildings. The levels of vibration required to cause cosmetic damage tend to be at least an order of magnitude (10 times) higher than those at which people can perceive vibration.

Examples of damage that can occur includes cracks or loosening of drywall surfaces, cracks in supporting columns and loosening of joints. Structural damage vibration limits are contained in British Standard BS 7385 and German Standard DIN 4150.

BS 7385

British Standard BS 7385 recommends vibration limits for transient vibration judged to give a minimal risk of vibration induced damage to affected buildings. The limits for residential and industrial buildings are shown in **Table 8**.

Table 8 BS 7385 Transient Vibration Values for Minimal Risk of Damage

Group	Type of Building	Peak Component Particle Velocity in Frequency Range of Predominant Pulse	
		4 Hz to 15 Hz	15 Hz and Above
1	Reinforced or framed structures. Industrial and heavy commercial buildings	50 mm/s at 4 Hz and above	
2	Unreinforced or light framed structures. Residential or light commercial type buildings	15 mm/s at 4 Hz increasing to 20 mm/s at 15 Hz	20 mm/s at 15 Hz increasing to 50 mm/s at 40 Hz and above

Note 1: Where the dynamic loading caused by continuous vibration may give rise to dynamic magnification due to resonance, especially at the lower frequencies where lower guide values apply, then the guide values may need to be reduced by up to 50%.

For heritage buildings, the standard states that “a building of historical value should not (unless it is structurally unsound) be assumed to be more sensitive”.

DIN 4150

For continuous long-term vibration or repetitive vibration with the potential to cause fatigue effects, DIN 4150 provides the following Peak Particle Velocity (PPV) values as safe limits, below which even superficial cosmetic damage is not to be expected:

- 2.5 mm/s for buildings of great intrinsic value (eg heritage listed buildings).

General Vibration Screening Criteria

The Transport for NSW Construction Noise and Vibration Strategy (CNVS) specifies general vibration screening criteria based on BS 7385. It notes that for most construction activities involving intermittent vibration such as rock breakers, piling rigs, vibratory rollers, excavators and the like, vibration predominantly occurs at frequencies greater than 4 Hz and therefore specifies the following conservative vibration damage screening levels:

- Reinforced or heavy frame structures: 25 mm/s
- Unreinforced or light frame structures: 7.5 mm/s.

At locations where the predicted and/or measured vibration levels are greater than shown above, a more detailed analysis of the building structure, vibration source, dominant frequency and dynamic characteristics of the structure would be required to determine the applicable safe vibration levels.

Heritage

Heritage structures are also assessed against the above screening criteria as they should not be assumed to be more sensitive to vibration unless they are found to be structurally unsound following an inspection. In this case a 2.5 mm/s criterion can be applied in accordance with DIN 4150. No such structures have been identified in the project area.

3.2.4 Minimum Working Distances for Vibration Intensive Works

Minimum working distances for typical vibration intensive construction equipment are provided in the Roads and Maritime *Construction Noise and Vibration Guideline* (CNVG) and are shown in **Table 9**. The minimum working distances are for both cosmetic damage (from BS 7385 and DIN 4150) and human comfort (from the NSW EPA Vibration Guideline). They are based on empirical data which suggests that where works are further from receivers than the quoted minimum distances then impacts are not considered likely.

The minimum working distances for human comfort relate to continuous vibration. For most construction activities, vibration emissions are intermittent and for this reason, higher vibration levels occurring over shorter periods are allowed.

Table 9 Recommended Minimum Working Distances from Vibration Intensive Equipment

Plant Item	Rating/Description	Minimum Distance		
		Cosmetic Damage		Human Response (NSW EPA Guideline)
		Residential and Light Commercial (BS 7385)	Heritage Items (DIN 4150, Group 3)	
Vibratory Roller	<50 kN (1–2 tonne)	5 m	11 m	15 m to 20 m
	<100 kN (2–4 tonne)	6 m	13 m	20 m
	<200 kN (4–6 tonne)	12 m	15 m	40 m
	<300 kN (7–13 tonne)	15 m	31 m	100 m
	>300 kN (13–18 tonne)	20 m	40 m	100 m
	>300 kN (>18 tonne)	25 m	50 m	100 m
Small Hydraulic Hammer	300 kg (5 to 12 t excavator)	2 m	5 m	7 m
Medium Hydraulic Hammer	900 kg (12 to 18 t excavator)	7 m	15 m	23 m
Large Hydraulic Hammer	1,600 kg (18 to 34 t excavator)	22 m	44 m	73 m
Vibratory Pile Driver	Sheet piles	2 m to 20 m	5 m to 40 m	20 m
Piling Rig – Bored	≤ 800 mm	2 m (nominal)	5 m	4 m
Jackhammer	Hand held	1 m (nominal)	3 m	2 m

The minimum working distances are indicative and will vary depending on the particular item of equipment and local geotechnical conditions. The distances apply to cosmetic damage of typical buildings under typical geotechnical conditions.

3.3 Operational Noise Criteria

The *NSW Noise Policy for Industry* (NPfI) was released in 2017 and sets out the requirements for the assessment and management of operational noise from industry in NSW.

The NPfI defines how to determine 'trigger levels' for noise emissions from industrial developments. Where a development is likely to exceed the trigger levels at existing noise sensitive receivers, feasible and reasonable noise management measures are required to be considered to reduce the impacts.

There are two types of trigger levels – one to account for 'intrusive' noise impacts and one to protect the 'amenity' of particular land uses:

- The **intrusiveness** of an industrial noise source is generally considered acceptable if the L_{Aeq} noise level of the source, measured over a period of 15-minutes, does not exceed the representative background noise level by more than 5 dB. Intrusive noise levels are only applied to residential receivers. For other receiver types, only the amenity levels apply.
- To limit continual increases in noise levels from the use of the intrusiveness level alone, the ambient noise level within an area from all industrial sources should remain below the recommended **amenity** levels specified in the NPfI for that particular land use.

Intrusive and amenity noise levels are not used directly as regulatory limits. They are used to assess the potential impact of noise, assess feasible and reasonable mitigation options and subsequently determine achievable noise requirements.

The NPfI provides guidance on assigning residential receiver amenity noise categories based on the site-specific features shown in **Table 10**.

Table 10 Residential Receiver Amenity

Receiver Category	Typical Planning Land Use Zoning	Typical Existing Background Noise Levels (RBL)	Description
Rural	RU1 – primary production RU2 – rural landscape RU4 – primary production small lots R5 – large lot residential E4 – environmental living	Daytime <40 dBA Evening <35 dBA Night <30 dBA	Rural – an area with an acoustical environment that is dominated by natural sounds, having little or no road traffic noise and generally characterised by low background noise levels. Settlement patterns would be typically sparse. Note: Where background noise levels are higher than those presented due to existing industry or intensive agricultural activities, the selection of a higher noise amenity area should be considered.

Receiver Category	Typical Planning Land Use Zoning	Typical Existing Background Noise Levels (RBL)	Description
Suburban residential	RU5 – village RU6 – transition R2 – low density residential R3 – medium density residential E2 – environmental conservation E3 – environmental management	Daytime <45 dBA Evening <40 dBA Night <35dBA	Suburban – an area that has local traffic with characteristically intermittent traffic flows or with some limited commerce or industry. This area often has the following characteristic: evening ambient noise levels defined by the natural environment and human activity.
Urban residential	R1 – general residential R4 – high density residential B1 – neighbourhood centre (boarding houses and shop-top housing) B2 – local centre (boarding houses) B4 – mixed use	Daytime >45 dBA Evening >40 dBA Night >35 dBA	Urban – an area with an acoustical environment that: • Is dominated by 'urban hum' or industrial source noise, where urban hum means the aggregate sound of many unidentifiable, mostly traffic and/or industrial related sound sources • Has through-traffic with characteristically heavy and continuous traffic flows during peak periods • Is near commercial districts or industrial districts • Has any combination of the above.

Amenity noise categories for the surrounding receivers have been determined with reference to the NPfI. The assessment is shown in **Table 11**.

Table 11 Residential Receiver Amenity Category Assessment

Area	Land Use Zoning	Existing Background Noise Levels RBL (dBA)			Resulting Amenity Classification	Discussion
		Day	Eve	Night		
All receivers	Enterprise (ENT), agribusiness (AGB) and environmental living (E4)	29-40	31-36	28-35	Rural (current) Urban (future)	The surrounding area is zoned as ENT, AGB and E4. ENT and AGB zonings are not identified in **Table 10**. The area currently has an acoustical environment that is influenced by natural sounds and generally characterised by low background noise levels. Background noise levels will, however, significantly increase over time as the area is developed. Western Sydney Airport is currently under construction to the

Area	Land Use Zoning	Existing Background Noise Levels RBL (dBA)			Resulting Amenity Classification	Discussion
		Day	Eve	Night		
						immediate south of the development site and the future M12 Motorway is to the north and east. The M12 Motorway corridor is located between the development site and the nearest receivers to the north-east and east. It is understood that all land zoned ENT would be developed and ultimately replaced with a variety of future industrial and business enterprises as part of the Northern Gateway and Badgerys Creek Precincts. The current amenity classification of the surrounding area is considered to be rural, however, when considering the extensive development that will occur and the close proximity of major sources of future noise that are unrelated to the development site, including Western Sydney Airport and the M12 Motorway, the future amenity classification for all NCAs is considered urban.

3.3.1 Project Noise Trigger Levels

The trigger levels for industrial noise from the project are summarised in **Table 12** and **Table 13** for rural (current amenity) and urban (future amenity), respectively. The Project Noise Trigger Levels (PNTL) are the most stringent of the intrusiveness and amenity trigger level for each period and are highlighted below.

Table 12 Project Noise Trigger Levels – Rural

NCA	Receiver Type	Period	Recommended Amenity Noise Level L_{Aeq} (period)	Measured Noise Level (dBA)		Project Noise Trigger Levels $L_{aeq\ (15minute)}$ (dBA)	
				RBL[1]	L_{Aeq} (period)	Intrusiveness	Amenity[2,3]
01 (L01)	Residential	Daytime	50	35 (29 actual)[4]	45	**40**	48
		Evening	45	33	43	**38**	43
		Night-time	40	31	43	**36**	38
02 (L03)	Residential	Daytime	50	35 (31 actual)[4]	46	**40**	48
		Evening	45	31	41	**36**	43

NCA	Receiver Type	Period	Recommended Amenity Noise Level L_{Aeq} (period)	Measured Noise Level (dBA)		Project Noise Trigger Levels L_{aeq} (15minute) (dBA)	
				RBL[1]	L_{Aeq} (period)	Intrusiveness	Amenity[2,3]
		Night-time	40	30 (28 actual)[4]	43	**35**	38
03/04 (L02)	Residential	Daytime	50	40	53	**45**	48
		Evening	45	36	50	**41**	43
		Night-time	40	35	52	40	**38**
05 (L03)	Residential	Daytime	50	35 (31 actual)[4]	46	**40**	48
		Evening	45	31	41	**36**	43
		Night-time	40	30 (28 actual)[4]	43	**35**	38
06 (L02)	Residential	Daytime	50	40	53	**45**	48
		Evening	45	36	50	**41**	43
		Night-time	40	35	52	40	**38**
07 (L03)	Residential	Daytime	50	35 (31 actual)[4]	46	**40**	48
		Evening	45	31	41	**36**	43
		Night-time	40	30 (28 actual)[4]	43	**35**	38
-	Commercial	When in use	65	-	-	**-**	63
-	Industrial	When in use	70	-	-	**-**	68

Note 1: RBL = Rating Background Level

Note 2: The recommended amenity noise levels have been reduced by 5 dB to give the project amenity noise levels due to other sources of industrial noise likely to be present in the future, as outlined in the NPfI. This addresses the potential cumulative impacts from the development and any existing/future projects.

Note 3: The project amenity noise levels have been converted to a 15-minute level by adding 3 dB, as outlined in the NPfI.

Note 4: The NPfI minimum RBL value has been used due to the measured RBL being below the NPfI minimum value.

Table 13 Project Noise Trigger Levels – Urban

NCA	Receiver Type	Period	Recommended Amenity Noise Level L_{Aeq} (period)	Measured Noise Level (dBA)		Project Noise Trigger Levels $L_{Aeq(15minute)}$ (dBA)	
				RBL[1]	L_{Aeq} (period)	Intrusiveness	Amenity[2,3]
01	Residential	Daytime	60	n/a[5]	n/a[5]	n/a[5]	**58**
		Evening	50	n/a[5]	n/a[5]	n/a[5]	**48**
		Night-time	45	n/a[5]	n/a[5]	n/a[5]	**43**
02	Residential	Daytime	60	n/a[5]	n/a[5]	n/a[5]	**58**
		Evening	50	n/a[5]	n/a[5]	n/a[5]	**48**
		Night-time	45	n/a[5]	n/a[5]	n/a[5]	**43**
03/04	Residential	Daytime	60	n/a[5]	n/a[5]	n/a[5]	**58**
		Evening	50	n/a[5]	n/a[5]	n/a[5]	**48**
		Night-time	45	n/a[5]	n/a[5]	n/a[5]	**43**
05	Residential	Daytime	60	n/a[5]	n/a[5]	n/a[5]	**58**
		Evening	50	n/a[5]	n/a[5]	n/a[5]	**48**
		Night-time	45	n/a[5]	n/a[5]	n/a[5]	**43**
06	Residential	Daytime	60	n/a[5]	n/a[5]	n/a[5]	**58**
		Evening	50	n/a[5]	n/a[5]	n/a[5]	**48**
		Night-time	45	n/a[5]	n/a[5]	n/a[5]	**43**
07	Residential	Daytime	60	n/a[5]	n/a[5]	n/a[5]	**58**
		Evening	50	n/a[5]	n/a[5]	n/a[5]	**48**
		Night-time	45	n/a[5]	n/a[5]	n/a[5]	**43**
-	Commercial	When in use	65	-	-	**-**	63
-	Industrial	When in use	70	-	-	**-**	68

Note 1: RBL = Rating Background Level

Note 2: The recommended amenity noise levels have been reduced by 5 dB to give the project amenity noise levels due to other sources of industrial noise likely to be present in the future, as outlined in the NPfI. This addresses the potential cumulative impacts from the development and any existing/future projects.

Note 3: The project amenity noise levels have been converted to a 15-minute level by adding 3 dB, as outlined in the NPfI.

Note 4: The NPfI minimum RBL value has been used due to the measured RBL being below the NPfI minimum value.

Note 5: The intrusiveness criteria are not considered relevant in this case as future background noise levels would be significantly higher than existing due to extensive development in the area, including Western Sydney Airport and M12 Motorway which are both adjacent to the site.

3.3.2 Cumulative Noise Impacts

The NSW Government *Cumulative Impact Assessment Guidelines for State Significant Projects* requires that the potential combined effect of cumulative impacts on all nearby

industrial developments to be considered when assessing potential noise impacts from state significant projects. The guideline references the NPfI when determining the approach to assessing the cumulative industrial noise impacts.

The NPfI states that it aims to limit continuing increases in cumulative industrial noise through the application of amenity noise levels, which are applicable to all industrial noise sources in an area.

The NPfI requires that the amenity noise levels which are applied to an individual project be reduced by 5 dB to allow for the potential cumulative impact from multiple sources of industrial noise in an area (including existing and new).

By doing this, the policy accounts for potential cumulative impacts by lowering the criteria for each individual development to ensure that the ambient noise level within an area from all industrial noise sources combined remains below the recommended amenity noise levels, where feasible and reasonable. The NPfI states that *"where the project amenity noise level applies and it can be met, no additional consideration of cumulative industrial noise is required"*.

The potential cumulative impacts from the development and other sources of industrial noise in the area are therefore accounted for in the proposal-specific PNTLs (see).

3.3.3 Sleep Disturbance

The potential for sleep disturbance from maximum noise level events during the night-time period from the development is required to be considered.

The NPfI defines the sleep disturbance screening level as 52 dBA LAFmax or the prevailing background level plus 15 dB, whichever is greater.

The sleep disturbance screening levels for the development are shown in **Table 14**.

Table 14 Sleep Disturbance Screening Levels

Location	Noise Level (dBA)	
	Measured Prevailing Night-time Background Level	Sleep Disturbance Screening Level[1]
NCA01	31	52
NCA02	30	52
NCA03/04	35	52
NCA05	30	52
NCA06	35	52
NCA07	30	52

Note 1: The sleep disturbance screening level as 52 dBA LAFmax or the prevailing background level plus 15 dB, whichever is greater

A detailed maximum noise level event assessment should be completed where the sleep disturbance screening level is exceeded. The detailed assessment should cover the maximum noise level, the extent to which the maximum noise level exceeds the RBL, and the number of times this happens during the night-time period.

The NPfI refers to the *Road Noise Policy* (RNP) for additional information regarding sleep disturbance. enHealth Council studies are referenced which indicate that for short-term or transient noise events, for good sleep over eight hours the indoor LAFmax sound pressure level should ideally not exceed around 45 dBA more than 10 or 15 times per night.

The RNP goes on to conclude that from the research on sleep disturbance to date:

- Maximum internal noise levels below 50 dBA to 55 dBA are unlikely to awaken people from sleep
- One or two events per night with maximum internal noise levels of 65-70 dBA are not likely to affect health and wellbeing significantly.

3.3.4 Noise Source Inventory

A noise source inventory which includes the details of the various operational noise sources at the development is shown in .

Table 15 Noise Source Inventory

Category	Noise Source	Usage	Reference for Noise Data
On-site traffic	Light vehicles	Light vehicles would access the development and park in the various car parks. Modelled in all locations shown in **Figure 5** using vehicle volumes in **Table 22**.	Sound power level taken from measurement data of various light vehicle types and models at speeds of up to around 40 km/h, including vehicle acceleration.
	Medium vehicles	Deliveries to the development would be via medium and heavy vehicles. Medium and heavy vehicles would access the development and travel to the various hardstands/loading docks. Modelled on all medium/heavy vehicle routes shown in **Figure 5** using vehicle volumes in **Table 22**.	Sound power level taken from historical measurement data of various medium rigid truck types and models in approximate 5 to 15 tonne range.
	Heavy vehicles		Sound power level taken from Federal Highway Administration's Traffic Noise Model. Assumes slow speed for 80% of the time and truck acceleration for 20% of the time.
Hardstand and loading docks	Forklifts, reversing alarms, air brakes, roller doors	Heavy vehicle deliveries would be unloaded by forklifts in the various hardstands/loading docks. Modelled in all hardstands/loading docks shown in **Figure 5** using vehicle volumes in **Table 22**. Forklifts have been conservatively assumed to operate externally at all hardstands/loading docks.	Sound power level taken from historical measurement data of typical loading dock activities at similar warehousing and distribution facilities.
Internal activities	Typical warehousing and distribution activities	Internal noise-generating activities at all warehouses would be associated with typical warehousing and distribution activities. Noise from these activities is expected to be minimal.	Sound power level based on observations of typical internal activities at similar warehousing and distribution facilities.

Category	Noise Source	Usage	Reference for Noise Data
Mechanical plant	Warehouse air-conditioning units	All warehouses are expected to be temperature controlled and at this stage of design will include 15 outdoor air-conditioning rooftop mounted units.	Sound power level for warehouse mechanical plant are adopted from manufacturer provided data.
	Smoke exhaust fans	Smoke exhaust fans will only be used during an emergency and are not expected to be used during normal operation.	Not assessed.
	Office air-conditioning units	Air-conditioning units would be used for all office buildings. At this early stage of the development, specific mechanical plant requirements for each building have not been determined.	Sound power level taken from measurement data and manufacturers specification data for typical air-conditioning units.

3.3.5 Corrections for Annoying Noise Characteristics

Sources of industrial noise can cause greater annoyance where they contain certain characteristics, such as tonality, intermittency or dominant low-frequency content. The NPfI specifies the following modifying factor corrections, shown in **Table 16**, which are to be applied where annoying characteristics are present.

Table 16 NPfI Modifying Factor Corrections

Factor	Assessment / Measurement	When to Apply	Correction[1]
Tonal noise	One-third octave or narrow band analysis	Level of one-third octave band exceeds the level of the adjacent bands on both sides by the levels defined in the NPfI.	5 dB[2]
Low-frequency noise	Measurement of source contribution C-weighted and A-weighted level and one-third octave measurements	Measure/assess source contribution C and A weighted $L_{eq,t}$ levels over same time period. Correction to be applied where the C minus A level is 15 dB or more and the level to which the thresholds defined in the NPfI are exceeded.	2 or 5 dB[2]
Intermittent noise	Subjectively assessed but should be assisted with measurement to gauge the extent of change in noise level	The source noise heard at the receiver varies by more than 5 dB and the intermittent nature of the noise is clearly audible. The NPfI further defines intermittent noise as noise where the level suddenly drops/increases several times during the assessment period, with a noticeable change in source noise level of at least 5 dB, for example, equipment cycling on and off. The intermittent correction does not apply to short-term events that emerge above the general industrial noise level	5 dB[3]

Factor	Assessment / Measurement	When to Apply	Correction[1]
		and is therefore not applicable to industrial or commercial sites that have vehicle or plant movements at night, including audible reversing alarms. The intermittency correction is not intended to be applied to changes in noise level due to meteorology.	
Maximum adjustment	Refer to individual modifying factors	Where two or more modifying factors are indicated.	Maximum correction of 10 dB[2] (excluding duration correction)

Note 1: Corrections to be added to the measured or predicted levels.

Note 2: Where a source emits tonal and low-frequency noise, only one 5 dB correction should be applied if the tone is in the low-frequency range, that is, at or below 160 Hz.

Note 3: Adjustment to be applied to night-time only.

Details of the modifying factor corrections applied in the assessment are provided in **Section 4.2**.

3.3.6 Residual Impacts

The NPfI defines residual noise impacts as exceedances of the Project Noise Trigger Levels which remain after all feasible and reasonable source and pathway mitigation measures have been considered.

The significance of residual noise impacts, as defined in the NPfI, is shown in **Table 17.** Examples of receiver-based treatments that can be used to mitigate residual impacts are shown in **Table 18**.

Table 17 NPfI Significance of Residual Noise Impacts

If the Predicted Noise Level minus the Project Noise Trigger Level is:	And the Total Cumulative Industrial Noise Levels is:	Then the Significance of the Residual Noise Level is:
≤ 2 dBA	Not applicable	Negligible
≥ 3 but ≤ 5 dBA	< recommended amenity noise level or > recommended amenity noise level, but the increase in total cumulative industrial noise level resulting from the development is less than or equal to 1dB	Marginal
≥ 3 but ≤ 5 dBA	> recommended amenity noise level and the increase in total cumulative industrial noise level resulting from the development is more than 1 dB	Moderate
> 5 dBA	≤ recommended amenity noise level	Moderate
	> recommended amenity noise level	Significant

Table 18 NPfI Examples of Receiver-based Treatments to Mitigate Residual Noise Impacts

Significance of Residual Noise Impact	Example of Potential Treatment
Negligible	The exceedances would not be discernible by the average listener and therefore would not warrant receiver-based treatments or controls.
Marginal	Provide mechanical ventilation/comfort condition systems to enable windows to be closed without compromising internal air quality/amenity.
Moderate	As for 'marginal', but also upgraded facade elements, such as windows, doors or roof insulation, to further increase the ability of the building facade to reduce noise levels.
Significant	May include suitable commercial agreements where considered feasible and reasonable.

3.3.7 Traffic on Surrounding Roads

The potential impacts from project related traffic on the surrounding public roads are assessed using the NSW EPA Road Noise Policy (RNP).

An initial screening test is first applied to evaluate if existing road traffic noise levels are expected to increase by more than 2.0 dB. Where this is considered likely, further assessment is required using the RNP criteria shown in **Table 19**.

Table 19 RNP Criteria for Assessing Traffic on Public Roads

Road Category	Type of Project/Land Use	Assessment Criteria (dBA)	
		Daytime (7 am – 10 pm)	Night-time (10 pm – 7 am)
Freeway / arterial / sub-arterial roads	Existing residences affected by additional traffic on existing freeways/arterial/sub-arterial roads generated by land use developments	$L_{Aeq(15hour)}$ 60 (external)	$L_{Aeq(9hour)}$ 55 (external)
Local roads	Existing residences affected by additional traffic on existing local roads generated by land use developments	$L_{Aeq(1hour)}$ 55 (external)	$L_{Aeq(1hour)}$ 50 (external)

3.4 Aircraft Noise

The potential aircraft noise impacts on the development site from Western Sydney Airport are assessed using *Australian Standard AS2021:2015 – Acoustics Aircraft Noise Intrusion – Building Siting and Construction*. The standard provides 'building site acceptability' guidance based on the Australian Noise Exposure Forecast (ANEF) zone of the site. The building site acceptability recommendations are shown in **Table 20**.

Table 20 Building Site Acceptability Based on ANEF Zones

Building Type	ANEF Zone of Site		
	Acceptable	Conditionally Acceptable	Unacceptable
Commercial building	Less than 25 ANEF	25 to 35 ANEF	Greater than 35 ANEF
Light industrial	Less than 30 ANEF	30 to 40 ANEF	Greater than 40 ANEF
Other industrial	Acceptable in all ANEF zones		

4.0 Methodology

4.1 Construction Noise and Vibration Assessment

A noise model of the study area has been used to predict noise levels from the proposed construction work to all surrounding receivers. The model uses ISO 9613 algorithms in SoundPLAN software.

Local terrain, receiver buildings and structures were digitised in the noise model to develop a three-dimensional representation of the construction sites and surrounding areas.

Construction noise levels have been predicted for activities associated with DHL Stage 1 only.

4.1.1 Construction Activities

Representative scenarios have been developed to assess the likely impacts from the various construction phases of the proposal. These scenarios are shown in **Table 21**.

The assessment uses 'realistic worst-case' scenarios to determine the impacts from the noisiest 15-minute period that are likely to occur for each work scenario, as required by the ICNG. The impacts represent construction noise levels without mitigation applied.

The sound power levels for the construction equipment used in each scenario is presented in **Appendix C**.

Table 21 Construction Equipment

Scenario	Works Activity	Equipment
W.01	Site establishment	Generator, hand Tools, truck
W.02	Demolition	Excavator with breaker, excavator, front end loader, generator, truck
W.03	Earth works	Excavator, generator, roller – vibratory, truck
W.04	Concreting works	Concrete mixer truck, concrete pump, concrete vibrator, generator, truck
W.05	Road works	Concrete mixer truck, concrete pump, excavator, road profiler, truck
W.06	Stormwater and Pavements	Excavator with breaker, excavator, tipper truck, truck, grader, roller – vibratory, roller - smooth drum, truck (water cart), mobile crane – franna, concrete mixer truck
W.07	Finishing works	Elevated working platform, generator, hand tools, mobile crane – franna, truck

4.1.2 Hours of Construction

Construction activities for the proposal would only be undertaken during the following hours:

- 7:00 am to 6:00 pm, Mondays to Fridays
- 8:00 am to 1:00 pm on Saturdays
- At no time on Sundays or Public Holidays.

4.2 Operational Noise Assessment

The potential operational noise levels from the proposal have been predicted to the surrounding receivers using the CONCAWE industrial noise algorithm in SoundPLAN. The model includes ground topography, ground type (ground absorption modelled 0.75 for rural areas), buildings and representative worst-case noise sources from the proposal.

The potential impacts have been determined by comparing the predicted worst-case noise levels to the NPfI PNTLs in a 15-minute assessment period.

Operational noise levels have been assessed for the following scenarios:

- DHL Stage 1 (ie operation of Warehouse 3 and 4)

4.2.1 Operational Noise Sources

The development comprises of various lots with associated ancillary offices, estate roads, heavy vehicle access, hardstands, light vehicle access and carparking. Vehicles would access the site from Elizabeth Drive. Heavy vehicles would park in the hard stand loading areas while they are loaded/unloaded, before exiting the site. Light vehicle carparking is provided at each warehouse and would generally be used by staff.

Internal noise sources would generally be minimal and associated with typical logistical, distribution, warehousing and office space activities. There would be no use of manufacturing equipment within any warehouses.

Roof mounted mechanical plant would be provided for each office and the warehouse. The development would operate 24 hours a day.

The main sources of operational noise at the development are expected to include:

- On-site light and heavy vehicle movements
- Loading dock activities in hardstands
- Mechanical plant
- Off-site vehicle movements.

A summary of the expected noise sources and worst-case assessment scenarios associated with the operation of the development is provided below.

On-Site Traffic

On-site vehicles have been modelled using the data in **Table 22** and **Table 23**. The volumes are representative of the expected worst-case 15-minute period for the daytime, evening and night-time. The volumes conservatively assume that light and heavy vehicles concurrently access the various warehouse tenancies during the worst-case 15-minute assessment period. In reality, vehicle access to each warehouse would be unlikely to occur concurrently, particularly during the night-time.

Heavy vehicle deliveries to the warehouses would be via a range of freight vehicles including medium trucks (ie rigid trucks or similar) and heavy trucks (ie semi-trailers or similar).

Table 22 Vehicle Traffic Data – Worst-case 15-Minute Period

Lot	Vehicle Type	Number of Vehicles in Worst-case 15-minute Period[1]		
		Daytime (7am to 6pm)	Evening (6pm to 10pm)	Night-time (10pm to 7am)
WH1	Heavy trucks	5	2	3
	Medium trucks	10	1	5
	Light vehicles	58	14	34
WH2	Heavy trucks	5	2	3
	Medium trucks	10	1	5
	Light vehicles	58	14	34
WH3	Heavy trucks	5	2	3
	Medium trucks	10	1	4
	Light vehicles	58	14	28
WH4	Heavy trucks	5	2	3
	Medium trucks	10	1	5
	Light vehicles	55	12	30

Note 1: Total vehicles, includes both inbound and outbound vehicles. Volumes are rounded up to whole numbers for display purposes.

Table 23 Vehicle Sound Power Levels

Vehicle	Movement	Sound Power Level (dBA)	Vehicle Speed (km/h)
Heavy trucks	Access routes	108[1]	25
	On-lot routes and hardstands		10
Medium trucks	Access routes	103[1]	25
	On-lot routes and hardstands		10
Light vehicles	Car park	96[2]	20

Note 1: Sound power level for large trucks based on 106 dBA for trucks at slow speed for 80% of the time and 111 dBA for trucks accelerating for 20% of the time and is representative of trucks with three or more axles. Sound power level for medium trucks based on 100 dBA for trucks at slow speed for 80% of the time and 106 dBA for trucks accelerating for 20% of the time and is representative of trucks with two axles and six tires. Sound power levels taken from the Federal Highway Administration's Traffic Noise Model.

Note 2: Sound power level taken from *Road Traffic Noise Prediction Model "ASJ RTN-Model 2013" Proposed by the Acoustical Society of Japan – Part 2: Study on Sound Emission of Road Vehicles*, OKADA et al, Internoise 2014, and accounts for vehicles accelerating.

Hardstands and Loading Docks

Details of the hardstand and loading dock noise sources are shown in **Table 24**. The various sources have been modelled in the hardstand areas (see **Figure 5**) based on the corresponding number of heavy vehicle movements in the worst-case 15-minute periods (see **Table 24**).

Table 24 Typical Hardstand and Loading Dock Noise Sources

Noise Source	Sound Power Level (dBA)[1]	Typical Duration of Use in Worst-case 15-minute Period
Truck reversing alarm	107[2,3]	30 seconds
Forklift reversing alarm	102[2,3]	90 seconds
Air brakes	118	1 second
Roller door	94	15 seconds
Electric forklift	84	900 seconds

Note 1: SWLs based on measurement data, where appropriate.

Note 2: SWL based on recommendation to use broadband reversing alarms, see **Section 6.2**.

Note 3: SWL includes a -3 dB reduction due to alarms being discrete events.

Internal Activities

The future tenants of the warehouses would likely be associated with typical warehousing and distribution uses. Internal noise-generating activities at all warehouses are expected to generally be minimal. A sound power level of 75 dBA has been applied at openings in the facades of each warehouse to cover potential break-out noise from general internal activities, based on observations of loading activities at similar warehouse facilities. Warehouse roller shutter doors are assumed to be open during loading dock activities.

The facade and roof construction of the warehouses would be metal sheeting (Colorbond or similar). The proposed warehouse construction is expected to be sufficient to minimise noise breakout through the facade and roof to a level that results in negligible to external noise emissions.

Mechanical Plant

Preliminary mechanical plant selections have been provided for the development. All warehouses are expected to be temperature controlled and will each consist of fifteen (15) rooftop mounted air-conditioning units.

Additionally, eight (8) rooftop smoke exhaust fans are expected to only operation during an emergency and have not been assessed for normal operations.

External mechanical plant has been modelled with client provided data for the selected equipment and is summarised in **Table 25**. The locations of the sources are shown in **Figure 5**.

Table 25 Mechanical Plant

Noise Source	Sound Power Level (dBA)	Location and Operating Hours
Air-conditioning equipment ActronAir PKV2000T	83	Warehouse roofs. Assumed to operate 24/7.
Smoke exhaust fans Fantech SS1256CA6/30	99	Warehouse roofs. Only operates during an emergency and is not assessed for normal operations.

4.2.2 Corrections for Annoying Noise Characteristics

The potential annoying noise characteristics and modifying factor corrections relevant to the proposal are:

- **Tonality** – the only source identified with potential tonal characteristics is reversing alarms. However, when considering broadband reversing alarms have been recommended as a noise mitigation measure (see **Section 6.2**), it is unlikely that this noise source would result in tonal noise impacts and no corrections have been applied.
- **Low frequency noise** – previous measurements of sources similar to those operating at the development indicate that no sources are expected to result in low frequency noise impacts.
- **Intermittent noise** – the NPfI defines intermittent noise as noise heard at the receiver where the level suddenly drops or increases several times during the assessment period, with a noticeable change of at least 5 dB, such as where equipment cycles on and off. The intermittent correction does not apply to short-term events that emerge above the general industrial noise level and is therefore not applicable to industrial or commercial sites that have vehicle or plant movements at night, including audible reversing alarms. No sources have been identified with potential intermittent characteristics.

Figure 5 Modelled Noise Sources

4.2.3 Noise Sources with Potential for Sleep Disturbance

As the development is proposed to operate 24-hours a day, noise emissions during the night-time require assessment for potential sleep disturbance at the nearest residential receivers. The details of typical activities with the potential to cause sleep disturbance are shown in **Table 26**.

Table 26 Sleep Disturbance Noise Events – L_{Amax} Sound Power Levels

Noise Source	Sound Power Level L_{Amax} (dBA)
Heavy truck movement	111
Heavy truck airbrake	118
Truck reversing alarm	110
Forklift reversing alarm	105
Roller door	94

4.2.4 Off-site Road Traffic

Traffic associated with the development would enter and exit the development from the south via Elizabeth Drive, with the majority of traffic travelling directly to the Northern Road or the M7 Motorway. The potential noise impacts from additional traffic have been assessed based on traffic data shown in **Table 27**.

Table 27 Traffic Volumes – All Warehouses

Road	Existing Traffic volumes (2018)				Development Related Traffic Volumes			
	Daytime (7am to 10pm)		Night-time (10pm to 7am)		Daytime (7am to 10pm)		Night-time (10pm to 7am)	
	Light	Heavy	Light	Heavy	Light	Heavy	Light	Heavy
Elizabeth Drive	8,595	2,149	2,025	506	7,479	1,535	394	81

4.2.5 Weather Conditions

Certain weather conditions can increase noise levels by focusing noise towards receivers. Noise-enhancing weather conditions can occur where wind blows from the source to the receiver, or where temperature inversions occur.

The NPfI defines 'standard' and 'noise-enhancing' weather conditions as shown in **Table 28**. Noise-enhancing weather should be included in the assessment where it occurs for more than 30% of the daytime, evening or night-time period in any season.

Table 28 Standard and Noise-enhancing Weather Conditions

Weather Conditions	Meteorological Parameters
Standard	Daytime/evening/night-time: stability categories A–D with wind speed up to 0.5 m/s
Noise-enhancing	Daytime/evening: stability categories A–D with light winds up to 3 m/s Night-time: stability categories A–D with light winds up to 3 m/s and/or stability category F with winds up to 2 m/s

Meteorological modelling was completed in 2019 for air pollution dispersion modelling. This data was analysed to determine the likely frequency of noise-enhancing wind and temperature inversion conditions which may affect noise levels at the site.

The meteorological modelling indicated that standard weather conditions were appropriate for the daytime, evening and night-time, and noise-enhancing weather conditions during the night-time. The weather conditions used in the assessment are shown in **Table 29**.

Table 29 Modelled Weather Conditions

Period	Weather Condition	Meteorological Parameters used in Assessment
Daytime	Standard	Stability category D with source to receiver wind up to 0.5 m/s
Evening	Standard	Stability category D with source to receiver wind up to 0.5 m/s
Night-time	Standard	Stability category D with source to receiver wind up to 0.5 m/s
	Noise-enhancing	Stability category F with source to receiver wind up to 2 m/s

4.3 Aircraft Noise Assessment

The potential aircraft noise impacts on the development site from Western Sydney Airport have been assessed using the Western Sydney Airport Noise Modelling Tool, which provides Australian Noise Exposure Concept (ANEC) contours for the area surrounding the airport. These have been compared to the 'building site acceptability' categories for 'light industrial' uses in *Australian Standard AS2021:2015 – Acoustics Aircraft Noise Intrusion*.

5.0 Assessment of Impacts

5.1 Construction Noise

The predicted construction noise levels from DHL Stage 1 at the most-affected sensitive receivers surrounding the site are shown in **Table 30** and exceedances of the NMLs are shown in **Table 31**.

The predictions represent a realistic worst-case scenario where the equipment in each scenario is working concurrently and the nearest location to each receiver. It is expected that noise levels would frequently be lower than the worst-case levels presented.

Table 30 Predicted Construction Noise Levels at Nearest Receivers

ID	Receiver Type	NML (Daytime)	Predicted Noise Level – $L_{Aeq(15minute)}$ (dBA)						
			Site establish.	Demolition	Earth works	Concreting works	Road works	Stormwater & Pavements	Finishing works
NCA01	Residential	45	21	33	27	25	26	33	22
NCA02	Residential	45	24	36	30	28	29	36	25
	Commercial	70	22	34	28	26	27	34	23
NCA03	Residential	50	21	33	27	25	26	33	22
NCA04	Residential	50	29	41	35	33	34	41	30
NCA05	Residential	45	31	43	37	35	36	43	32
NCA06	Residential	50	25	37	31	29	30	37	26
NCA07	Residential	45	36	48	42	40	41	48	37
	Industrial	75	26	38	32	30	31	38	27

Table 31 Predicted Exceedances at Nearest Receivers

ID	Receiver Type	NML (Daytime)	Predicted Exceedance – $L_{Aeq(15minute)}$ (dB)						
			Site establish.	Demolition	Earth works	Concreting works	Road works	Stormwater & Pavements	Finishing works
NCA01	Residential	45	-	-	-	-	-	-	-
NCA02	Residential	45	-	-	-	-	-	-	-
	Commercial	70	-	-	-	-	-	-	-
NCA03	Residential	50	-	-	-	-	-	-	-
NCA04	Residential	50	-	-	-	-	-	-	-
NCA05	Residential	45	-	-	-	-	-	-	-
NCA06	Residential	50	-	-	-	-	-	-	-
NCA07	Residential	45	-	3	-	-	-	3	-
	Industrial	75	-	-	-	-	-	-	-

Legend (NML exceedances) = Minor to marginal (1 to 10 dB exceedance); = Moderate (11 to 20 dB exceedance); = High (>20 dB exceedance)

The above worst-case predictions show the following:

- Noise levels are expected to comply the NMLs at the nearest receivers during the majority of the work, with minor exceedances predicted during certain noisy stages.
- The NMLs are predicted to be exceeded at the nearest receivers in NCA07 by up to 3 dB during the worst-case impacts. The higher exceedances are predicted to occur when noise intensive items of equipment such as rockbreakers are being used during activities such as 'Demolition' or 'Stormwater and pavements' works. Noise levels at more distant receivers or during less noise intensive activities are generally expected to comply with NMLs.
- No residential receivers are predicted to be highly noise affected (ie ≥75 dBA) during any of the construction work.

The presented worst-case impacts would only be expected to occur when noisy work is being completed close to the site boundaries, relative to each receiver. When work is in central areas of the site, or when less noise intensive equipment is being used, the noise levels are expected to reduce.

Feasible and reasonable construction noise mitigation measures should be applied where exceedances of the NMLs are predicted. Construction noise mitigation and management measures are discussed in **Section 6.1**.

5.2 Construction Vibration

The major potential sources of vibration from the proposed construction activities would likely be during:

- 'Earth works' when vibratory rollers are being used
- 'Demolition' when rockbreakers are being used.

Vibration offset distances have been determined from the CNVG minimum working distances for cosmetic damage and human comfort (see **Table 9**) and the assessment is summarised in **Figure 6** for a large vibratory roller. Buildings within the minimum working distances are shown in the figure.

Figure 6 Construction Vibration – Large Vibratory Roller

Cosmetic Damage and Human Comfort Assessment

The above figure shows that the distance between the construction work and the nearest sensitive receivers is sufficient for receiver buildings to be outside of the cosmetic damage and human comfort minimum working distances for vibration intensive equipment.

Feasible and reasonable construction vibration mitigation measures should be applied where vibration intensive works are required within the minimum working distances. Construction mitigation and management measures are discussed further in **Section 6.1**.

5.3 Operational Noise

Operational noise levels have been assessed for the following scenarios:

- DHL Stage 1 (ie operation of Warehouse 3 and 4)

5.3.1 Predicted Operational Noise Levels

A summary of the worst-case DHL Stage 1 operational noise assessment at the receivers surrounding the proposal is shown in **Table 32** for the current rural amenity classification and in **Table 33** for the future urban amenity classification. The predicted worst-case levels are compared to the PNTLs to determine the potential impact from the proposal. Noise contours of the predicted worst-case operational noise impacts are in **Appendix D**.

A detailed assessment of all potential feasible and reasonable mitigation measures that could be applied to the development to minimise the impacts has been completed and is summarised in **Section 6.2**. The following predictions include the recommended mitigation measures, where appropriate.

Table 32 Operational Noise Assessment – DHL Stage 1, Rural (Current Amenity)

NCA	Receiver Type	Period (weather)	$L_{Aeq(15\ minutes)}$ Noise Level (dBA)			Compliance
			Noise Criteria	Predicted	Exceedance	
Receivers outside the Northern Gateway/Badgerys Creek Precincts						
NCA01	Residential	Daytime (standard)	40	28	-	Yes
		Evening (standard)	38	22	-	Yes
		Night-time (standard)	36	25	-	Yes
		Night-time (noise-enhancing)	36	29	-	Yes
NCA02	Residential	Daytime (standard)	40	29	-	Yes
		Evening (standard)	36	24	-	Yes
		Night-time (standard)	35	27	-	Yes
		Night-time (noise-enhancing)	35	31	-	Yes
	Commercial	When in use (standard)	63	27	-	Yes
NCA03	Residential	Daytime (standard)	45	26	-	Yes
		Evening (standard)	41	21	-	Yes
		Night-time (standard)	38	24	-	Yes
		Night-time (noise-enhancing)	38	28	-	Yes
Receivers inside the Northern Gateway/Badgerys Creek Precincts (zoned enterprise)						
NCA04	Residential	Daytime (standard)	45	33	-	Yes
		Evening (standard)	41	28	-	Yes
		Night-time (standard)	38	31	-	Yes
		Night-time (noise-enhancing)	38	35	-	Yes
NCA05	Residential	Daytime (standard)	40	35	-	Yes

NCA	Receiver Type	Period (weather)	$L_{Aeq(15\ minutes)}$ Noise Level (dBA)			Compliance
			Noise Criteria	Predicted	Exceedance	
		Evening (standard)	36	30	-	Yes
		Night-time (standard)	35	33	-	Yes
		Night-time (noise-enhancing)	35	37	2	Marginal
NCA06	Residential	Daytime (standard)	45	30	-	Yes
		Evening (standard)	41	24	-	Yes
		Night-time (standard)	38	27	-	Yes
		Night-time (noise-enhancing)	38	31	-	Yes
NCA07	Residential	Daytime (standard)	40	42	2	Marginal
		Evening (standard)	36	36	-	Yes
		Night-time (standard)	35	39	4	No
		Night-time (noise-enhancing)	35	42	7	No
	Industrial	When in use (standard)	68	31	-	Yes

Table 33 Operational Noise Assessment – DHL Stage 1, Urban (Future Amenity)

NCA	Receiver Type	Period (weather)	$L_{Aeq(15\ minutes)}$ Noise Level (dBA)			Compliance
			Noise Criteria	Predicted	Exceedance	
Receivers outside the Northern Gateway/Badgerys Creek Precincts						
NCA01	Residential	Daytime (standard)	58	28	-	Yes
		Evening (standard)	48	22	-	Yes
		Night-time (standard)	43	25	-	Yes
		Night-time (noise-enhancing)	43	29	-	Yes
NCA02	Residential	Daytime (standard)	58	29	-	Yes

NCA	Receiver Type	Period (weather)	$L_{Aeq(15\ minutes)}$ Noise Level (dBA)			Compliance
			Noise Criteria	Predicted	Exceedance	
		Evening (standard)	48	24	-	Yes
		Night-time (standard)	43	27	-	Yes
		Night-time (noise-enhancing)	43	31	-	Yes
	Commercial	When in use (standard)	63	27	-	Yes
NCA03	Residential	Daytime (standard)	58	26	-	Yes
		Evening (standard)	48	21	-	Yes
		Night-time (standard)	43	24	-	Yes
		Night-time (noise-enhancing)	43	28	-	Yes
Receivers inside the Northern Gateway/Badgerys Creek Precincts (zoned enterprise)						
NCA04	Residential	Daytime (standard)	58	33	-	Yes
		Evening (standard)	48	28	-	Yes
		Night-time (standard)	43	31	-	Yes
		Night-time (noise-enhancing)	43	35	-	Yes
NCA05	Residential	Daytime (standard)	58	35	-	Yes
		Evening (standard)	48	30	-	Yes
		Night-time (standard)	43	33	-	Yes
		Night-time (noise-enhancing)	43	37	-	Yes
NCA06	Residential	Daytime (standard)	58	30	-	Yes
		Evening (standard)	48	24	-	Yes
		Night-time (standard)	43	27	-	Yes

NCA	Receiver Type	Period (weather)	$L_{Aeq(15\ minutes)}$ Noise Level (dBA)			Compliance
			Noise Criteria	Predicted	Exceedance	
		Night-time (noise-enhancing)	43	31	-	Yes
NCA07	Residential	Daytime (standard)	58	42	-	Yes
		Evening (standard)	48	36	-	Yes
		Night-time (standard)	43	39	-	Yes
		Night-time (noise-enhancing)	43	42	-	Yes
	Industrial	When in use (standard)	68	31	-	Yes

DHL Stage 1 – Current Rural Amenity Classification

The above assessment indicates the following:

- Noise from the proposal is predicted to comply with the PNTLs at all receivers which are outside the Northern Gateway/Badgerys Creek Precincts:
  - NCA01 to NCA03 – compliance is predicted during all periods/scenarios.
- Noise from the proposal is generally predicted to comply with the PNTLs at all receivers which are within the Northern Gateway/Badgerys Creek Precincts, except for a minor 2 dB exceedance identified in NCA05 and up to a 7 dB exceedance in NCA07:
  - NCA04 and NCA06 – compliance is predicted during all periods/scenarios.
  - NCA05 – marginal 2 dB exceedance during the noise-enhancing night-time period. Compliance predicted during all other periods/scenarios.
  - NCA07 – compliance is predicted during the daytime and evening. Exceedances ranging from 2 dB to 7 dB are predicted during the daytime, night-time with standard weather and night-time with noise-enhancing weather.
    - During the daytime, the 2 dB exceedance is limited to the closest receiver which is within the footprint of the currently under construction M12 Motorway and are understood to be removed as part of upcoming construction activities.
    - During the night-time with standard weather conditions, the 4 dB exceedance is limited to the closest receiver which is within the footprint of the currently under construction M12 Motorway and are understood to be removed as part of upcoming construction activities.
    - During the night-time with noise-enhancing weather conditions, the 7 dB exceedance is predicted at the closest receiver to the site within NCA07. Additionally, the noise levels at two other receivers in close-proximity to the site are predicted to exceed the criteria by up to 5 dB. All receivers where exceedances are identified are within the footprint of the currently under construction M12 Motorway and are understood to be removed as part of upcoming construction activities.

DHL Stage 1 – Future Urban Amenity Classification

The above assessment indicates the following:

- Noise from the proposal is predicted to comply with the PNTLs at all surrounding receivers.

5.3.2 Sleep Disturbance

The predicted night time maximum noise levels at the nearest residential receivers are shown in **Table 34**. These include the mitigation measures specified in **Section 6.2**, where appropriate.

Table 34 Sleep Disturbance Assessment – DHL Stage 1

NCA	Source	Maximum Noise Level LAmax (dBA)			Exceedance	Below Screening Level
		Sleep Dist. Screening Level	Predicted – Masterplan			
			Standard Weather	Noise-Enhancing Weather		
Receivers outside the Northern Gateway/Badgerys Creek Precincts						
NCA01	All sources	52	Up to 37	Up to 41	-	Yes
NCA02	All sources	52	Up to 39	Up to 43	-	Yes
NCA03	All sources	52	Up to 33	Up to 37	-	Yes
Receivers inside the Northern Gateway/Badgerys Creek Precincts (zoned enterprise)						
NCA04	All sources	52	Up to 44	Up to 48	-	Yes
NCA05	All sources	52	Up to 45	Up to 49	-	Yes
NCA06	All sources	52	Up to 41	Up to 45	-	Yes
NCA07	Airbrake	52	52	56	4	No
	Heavy trucks reversing alarm		44	48	-	Yes
	Forklift reversing alarm		39	43	-	Yes
	Roller door		31	33	-	Yes
	Medium trucks		45	48	-	Yes
	Cars		34	37	-	Yes

The above shows that maximum noise levels are expected to comply with the sleep disturbance screening level at all receivers outside the Northern Gateway/Badgerys Creek Precincts.

Maximum noise levels are also generally expected to comply with the sleep disturbance screening level at receivers within the Northern Gateway/Badgerys Creek Precincts, except at the nearest three receivers in NCA07 when truck airbrakes are used in certain hardstand areas. These exceedances are at receivers which are within the footprint of the currently under construction M12 Motorway and are understood to be removed as part of upcoming construction activities.

The NPfI requires a detailed maximum noise level assessment to be completed where night-time noise levels exceed the screening level.

5.3.2.1 Detailed Maximum Noise Level Assessment

The detailed maximum noise level assessment is summarised in **Table 35**. Noise from truck airbrakes is predicted to exceed the sleep disturbance screening level at the three nearest receivers within the Northern Gateway Precinct in NCA07.

Table 35 Detailed Maximum Noise Level Assessment

Receiver	Maximum Noise Level L_{Amax} (dBA)					Comments
	Sleep Disturbance Goals (dBA)		Development Related Maximum Noise Events		Existing Maximum Noise Levels	
	Awakening Response[1]	Good Sleep[2]	Predicted	Frequency of Occurrence		
NCA07	65	Around 55 (10 to 15 times per night)	31 to 56	>10-15 events	55-65	**Awakening Response:** maximum noise levels are predicted to be below the 'awakening response' level at all surrounding receivers. **Good Sleep:** maximum noise levels are predicted to marginally exceed the 'good sleep' noise level goal. **Existing maximum noise levels:** the unattended noise monitoring showed that existing maximum noise levels were measured to frequently be in the order of 55 to 65 dBA at L02 and L03, with occasional events over 65 dBA. Development related maximum noise levels are likely to be lower in magnitude than existing maximum noise levels.

Note 1: Based on RNP guidance that maximum internal noise levels below 50 dBA to 55 dBA are unlikely to awaken people from sleep. This equates to an external noise level of 65 dBA when assuming a 10 dB loss for partially open windows for ventilation.

Note 2: Based on RNP guidance that for a good sleep over eight hours the indoor LAmax sound pressure level should not exceed around 45 dBA more than 10 or 15 times per night. This equates to an external noise level of around 55 dBA when assuming a 10 dB loss for partially open windows for ventilation.

The predicted maximum noise levels from truck airbrakes at all receivers are expected to be below the levels outlined in the RNP that would be considered to have the potential to result in sleep disturbance.

It is noted that a marginal 1 dB exceedance of the "Good Sleep" criteria is observed at one receiver in NCA07 for the noise enhanced weather condition. This is considered negligible and is unlikely to cause sleep disturbance.

Additionally, the frequency of future maximum noise level events not related to the proposal is expected to increase as the surrounding area is developed and projects such as the Western Sydney Airport and M12 Motorway become operational.

Based on the above, the predicted infrequent sleep disturbance screening level exceedances are considered of low significance and do not warrant any further mitigation measures.

5.3.3 Off-site Traffic Assessment

Traffic associated with the development would enter and exit the site from the south via Elizabeth Drive, with the majority of traffic travelling directly to the Northern Road or the M7

Motorway. Development related heavy vehicles are anticipated to be via a range of vehicle types, include large and medium trucks.

It is expected that traffic noise levels in the area would increase as the Northern Gateway Precinct and surrounding areas, including Western Sydney Airport and M12 Motorway, are developed and the various estates/projects become operational. Impacts from increased traffic noise are likely to occur at certain receivers as traffic volumes in the area increase. These impacts should, however, be considered as temporary as the potentially affected receivers within the precinct are zoned ENT enterprise and will be redeveloped and replaced with a variety of future industrial and business enterprises.

5.4 Aircraft Noise Impacts

The potential aircraft noise impacts on the site from Western Sydney Airport are summarised in **Table 36**.

Table 36 Western Sydney Airport – Building Site Acceptability Based on ANEF Zones

Assessment Scenario	Building Site Acceptability Based on ANEF Zones
Year 2030 Prefer 05 Direction (majority of departures to the north-east and arrivals from the south-west)	The site buildings are less than 30 ANEC, which is considered ‘acceptable’ for light industrial uses.
Year 2030 Prefer 23 Direction (majority of departures to the south-west and arrivals from the north-east)	The site buildings are less than 30 ANEC, which is considered ‘acceptable’ for light industrial uses.
Year 2050 Prefer 05 Direction (majority of departures to the north-east and arrivals from the south-west)	The site buildings are less than 30 ANEC, which is considered ‘acceptable’ for light industrial uses.
Year 2050 Prefer 23 Direction (majority of departures to the south-west and arrivals from the north-east)	The site buildings are less than 30 ANEC, which is considered ‘acceptable’ for light industrial uses.

The potential impacts from Western Sydney Airport and requirements for building envelope mitigation should be reviewed as the project progresses.

6.0 Mitigation and Management Measures

6.1 Construction Impacts

The impacts during construction of the project are predicted to be typical of major construction works near to sensitive receivers. No works outside of standard construction hours are currently proposed.

The use of standard mitigation measures to minimise the impacts is considered sufficient to control the majority of the impacts. Examples of measures which could be applied to the work are provided in the Roads and Maritime (now Transport for NSW) *Construction Noise and Vibration Guideline* (see **Appendix E**).

A Construction Noise and Vibration Management Plan (CNVMP) would be prepared before any work begins. This would identify all potentially impacted receivers, assess the potential noise and vibration impacts from the project and provide details regarding how the impacts would be minimised through the use of all feasible and reasonable mitigation measures. The CNVMP would also contain procedures for handling complaints, should they occur, and detail any compliance monitoring requirements.

6.2 Operational Noise Impacts

Where operational noise impacts from the site are predicted to exceed the relevant noise criteria, feasible and reasonable operational noise mitigation and management measures should be considered, with the aim of reducing noise emissions to the relevant criteria.

The typical hierarchy for mitigation and management of industrial noise sources is as follows:

- Reducing noise emissions at the source (ie noise source control)
- Reducing noise in transmission to the receiver (ie noise path control)
- Reducing noise at the receiver (ie at-receiver control).

A detailed assessment of all potential feasible and reasonable mitigation measures that could be applied to the development to minimise the impacts has been completed and is summarised in **Table 37**.

Table 37 Operational Noise Mitigation Options

Ref.	Mitigation Option	Noise Impact/Benefit	Reasonable and Feasible to Apply
Source Control			
S1	Optimised site layout to minimise noise emissions from the site	Where possible, the site layout has been designed so that the warehouse buildings screen the noisier areas of the development (ie hardstands and truck routes) from the nearest receivers.	Yes – applied during design of the concept masterplan
S2	Limit vehicle movements	A reduction in concurrent vehicle movements across the site by staggering delivery/pickup times and/or employee shift change times could reduce noise emissions.	No – vehicle volumes used in this assessment are likely needed to meet tenant's requirements. Placing restrictions on allowable vehicle movements across the different tenancies is unlikely to be feasible and reasonable.

Ref.	Mitigation Option	Noise Impact/Benefit	Reasonable and Feasible to Apply
		In practice, this would occur naturally across the estate due to operational requirements of the different tenants.	
S3	Hardstand/external equipment use	Minimising the concurrent use of forklifts or other mobile plant outside the warehouses and/or limiting their use to the less sensitive day and evening periods. In practice, this would occur naturally across the estate due to operational requirements of the different tenants.	No – placing restrictions on allowable external use of forklifts and equipment across the different tenancies is unlikely to be feasible and reasonable.
S4	Quieter mobile plant and equipment	Use of quieter mobile plant and equipment options, such as electric forklifts instead of gas forklifts.	Yes – the development proposes to use quieter equipment such as electric forklifts instead of gas forklifts.
S5	Use broadband and/or ambient sensing alarms on trucks and forklifts where they are required to reverse during the night-time.	Reduce potential for annoying noise emissions during the night-time from forklifts and trucks.	Yes – use broadband and/or ambient sensing alarms on forklifts and trucks where they are required to reverse during the night-time.
S6	Appropriate specification and location of mechanical plant during detailed design.	If noise impacts from mechanical plant are identified during detailed design, quieter plant could be selected, or the plant could be relocated to a location screened from view of the nearest receivers, where appropriate.	Specific impacts from mechanical plant were not identified during this assessment. Noise impacts from mechanical plant would be investigated further during detailed design or construction certificate stages when specific plant requirements are identified.
S7	Appropriate design of warehouses during detailed design.	Appropriate warehouse materials to minimise noise break-out from internal activities would be selected during detailed design. Where it is identified that noisier equipment is required to be used within the warehouse buildings than currently assumed (eg manufacturing equipment instead of standard warehousing and distribution equipment), facade and roof construction can use materials that provide a greater acoustic benefit.	Potentially – noise impacts from internal equipment would be investigated further during construction certificate stages if tenants require manufacturing plant or other noisy equipment.
S8	Roller doors kept closed when loading/unloading is not occurring to	Use of roller doors to minimise internal noise breakout.	Yes – roller doors should be kept closed when not in use for loading/unloading trucks.

Ref.	Mitigation Option	Noise Impact/Benefit	Reasonable and Feasible to Apply
	minimise noise breakout.		
S9	Appropriate design of site layout to minimise the need for trucks to stop or brake outside of loading docks with line of sight to residential receivers.	Minimise noise emissions, particularly from truck airbrakes.	Yes – applied during design of the concept masterplan
S10	Production of an Operational Noise Management Plan.	This would detail the measures that could be used by the various tenants to minimise general noise emissions from the site. Reference can be made to the Best Management Practice (BMP) and Best Available Technology Economically Available (BATEA) measures listed in the NPfI (see **Appendix F**).	Yes
Path Control			
P1	Noise barriers	Construction of noise barriers along boundary fence locations or other strategic locations could be used to reduce noise levels where plant or equipment are in line of sight of the nearest receivers.	Operational noise levels from DHL Stage 1 are generally predicted to comply with the noise goals, except for minor exceedances at the two nearest residential receivers to the east (when assuming a rural amenity classification). The potential noise impacts are limited to receivers within the Northern Gateway Precinct which are zoned enterprise. These receivers are also within the M12 Motorway corridor footprint and expected to be developed into future industrial and business enterprises, meaning permanent noise barriers to mitigate these receivers are unlikely to be reasonable.
Receiver Control			
R1	At-property treatments	The NPfI notes that noise mitigation at a residence may be required to be considered where the residual impact exceeds the PNTLs by ≥3 dB. At-property treatments typically include mechanical ventilation to allow windows to be closed as a noise mitigation measure, together	No residual impacts are predicted at any receivers with either rural or urban amenity classifications.

Ref.	Mitigation Option	Noise Impact/Benefit	Reasonable and Feasible to Apply
		with upgraded facade elements such as windows, doors and acoustic seals.	
Verification Monitoring			
V1	Noise monitoring	Verify post-construction operational noise levels are in-line with predictions and the mitigation is working as intended.	Yes

Compliance with the noise goals is predicted at all receivers for DHL Stage 1 when assuming the future urban amenity classification. Compliance is mostly predicted when assuming the current rural amenity classification, except for minor exceedances at the nearest two receivers to the east of the site in NCA07. These receivers are within the footprint of the currently under construction M12 Motorway and are understood to be removed as part of upcoming construction activities.

Consideration of the zoning, future uses of the area and the increasing noise environmental due to substantial redevelopment of the surrounding area, including Western Sydney Airport and M12 Motorway, should be taken into account when determining whether mitigation and management measures for temporary impacts at these receivers are feasible and reasonable.

It is noted that several assumptions have been made regarding the likely future sources of noise. The noise predictions in this report should be regarded as indicative for planning purposes and are required to be confirmed at a later stage when detailed information is available.

7.0 Conclusion

SLR has been engaged to assess the potential construction and operational noise emissions from the proposed Badgerys Creek DHL Development Stage 1 project, which is a warehouse and distribution development located on Elizabeth Drive, Luddenham.

Construction noise levels are generally predicted to comply with the management levels, however, minor exceedances are predicted at some of the nearest sensitive receivers during noisy work stages. Work would be limited to daytime hours only, and standard mitigation measures have been recommended to address the potential construction impacts.

Operational noise levels from DHL Stage 1 are expected to comply with the noise goals when assuming an urban amenity classification, which is considered representative of the future noise environment. The use of a rural amenity results in marginal exceedances of the trigger levels at the nearest receivers in NCA05 and an exceedance of up to 7 dB in NCA07. However, the affected receivers within these zones are expected to be redeveloped as part of the Badgerys Creek Precinct upgrade or are within the M12 development's footprint and are expected to be removed.

A range of feasible and reasonable mitigation measures have been recommended to control the impacts. As the aforementioned exceedances are considered temporary whilst the surrounding area transitions to an urban amenity, no additional mitigation measures are warranted. It is recommended that an agreement between the client and affected residents is agreed upon and should be undertaken on a case by case basis.

Based on the predicted levels and indicative mitigation measures, the proposal is considered appropriate from an acoustic standpoint.

Appendix A Acoustic Terminology

Badgerys Creek DHL Development Stage 1

Noise Impact Assessment

DHL Supply Chain (Australia) Pty Ltd

SLR Project No.: 610.30951.00000

10 October 2024

1. Sound Level or Noise Level

The terms 'sound' and 'noise' are almost interchangeable, except that 'noise' often refers to unwanted sound.

Sound (or noise) consists of minute fluctuations in atmospheric pressure. The human ear responds to changes in sound pressure over a very wide range with the loudest sound pressure to which the human ear can respond being ten million times greater than the softest. The decibel (abbreviated as dB) scale reduces this ratio to a more manageable size by the use of logarithms.

The symbols SPL, L or LP are commonly used to represent Sound Pressure Level. The symbol LA represents A-weighted Sound Pressure Level. The standard reference unit for Sound Pressure Levels expressed in decibels is 2 x 10-5 Pa.

2. 'A' Weighted Sound Pressure Level

The overall level of a sound is usually expressed in terms of dBA, which is measured using a sound level meter with an 'A-weighting' filter. This is an electronic filter having a frequency response corresponding approximately to that of human hearing. People's hearing is most sensitive to sounds at mid frequencies (500 Hz to 4,000 Hz), and less sensitive at lower and higher frequencies. Different sources having the same dBA level generally sound about equally loud.

A change of 1 dB or 2 dB in the level of a sound is difficult for most people to detect, whilst a 3 dB to 5 dB change corresponds to a small but noticeable change in loudness. A 10 dB change corresponds to an approximate doubling or halving in loudness. The table below lists examples of typical noise levels.

Sound Pressure Level (dBA)	Typical Source	Subjective Evaluation
130	Threshold of pain	Intolerable
120	Heavy rock concert	Extremely noisy
110	Grinding on steel	
100	Loud car horn at 3 m	Very noisy
90	Construction site with pneumatic hammering	
80	Kerbside of busy street	Loud
70	Loud radio or television	
60	Department store	Moderate to quiet
50	General Office	
40	Inside private office	Quiet to very quiet
30	Inside bedroom	
20	Recording studio	Almost silent

5. Frequency Analysis

Other weightings (eg B, C and D) are less commonly used than A-weighting. Sound Levels measured without any weighting are referred to as 'linear', and the units are expressed as dB(lin) or dB.

3. Sound Power Level

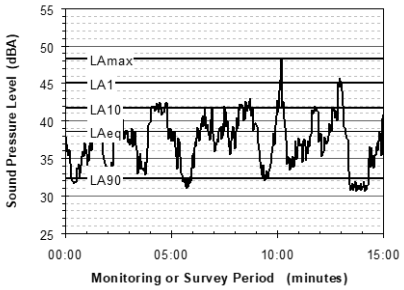
The Sound Power of a source is the rate at which it emits acoustic energy. As with Sound Pressure Levels, Sound Power Levels are expressed in decibel units (dB or dBA), but may be identified by the symbols SWL or LW, or by the reference unit 10^{-12} W.

The relationship between Sound Power and Sound Pressure is similar to the effect of an electric radiator, which is characterised by a power rating but has an effect on the surrounding environment that can be measured in terms of a different parameter, temperature.

4. Statistical Noise Levels

Sounds that vary in level over time, such as road traffic noise and most community noise, are commonly described in terms of the statistical exceedance levels L_{AN}, where L_{AN} is the A-weighted sound pressure level exceeded for N% of a given measurement period. For example, the L_{A1} is the noise level exceeded for 1% of the time, L_{A10} the noise exceeded for 10% of the time, and so on.

The following figure presents a hypothetical 15 minute noise survey, illustrating various common statistical indices of interest.



Of particular relevance, are:

L_{A1} The noise level exceeded for 1% of the 15 minute interval.

L_{A10} The noise level exceeded for 10% of the 15 minute interval. This is commonly referred to as the average maximum noise level.

L_{A90} The noise level exceeded for 90% of the sample period. This noise level is described as the average minimum background sound level (in the absence of the source under consideration), or simply the background level.

L_{Aeq} The A-weighted equivalent noise level (basically, the average noise level). It is defined as the steady sound level that contains the same amount of acoustical energy as the corresponding time-varying sound.

7. Vibration

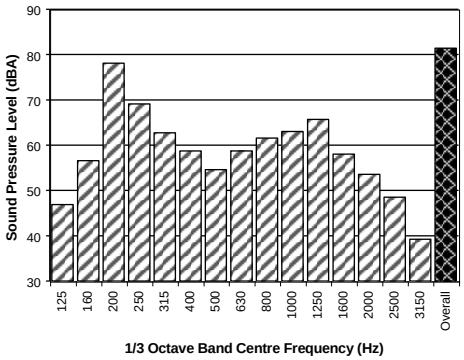
Frequency analysis is the process used to examine the tones (or frequency components) which make up the overall noise or vibration signal.

The units for frequency are Hertz (Hz), which represent the number of cycles per second.

Frequency analysis can be in:

- Octave bands (where the centre frequency and width of each band is double the previous band)
- 1/3 octave bands (three bands in each octave band)
- Narrow band (where the spectrum is divided into 400 or more bands of equal width)

The following figure shows a 1/3 octave band frequency analysis where the noise is dominated by the 200 Hz band. Note that the indicated level of each individual band is less than the overall level, which is the logarithmic sum of the bands.



6. Annoying Noise (Special Audible Characteristics)

A louder noise will generally be more annoying to nearby receivers than a quieter one. However, noise is often also found to be more annoying and result in larger impacts where the following characteristics are apparent:

- Tonality - tonal noise contains one or more prominent tones (ie differences in distinct frequency components between adjoining octave or 1/3 octave bands), and is normally regarded as more annoying than 'broad band' noise.
- Impulsiveness - an impulsive noise is characterised by one or more short sharp peaks in the time domain, such as occurs during hammering.
- Intermittency - intermittent noise varies in level with the change in level being clearly audible. An example would include mechanical plant cycling on and off.
- Low Frequency Noise - low frequency noise contains significant energy in the lower frequency bands, which are typically taken to be in the 10 to 160 Hz region.

Vibration may be defined as cyclic or transient motion. This motion can be measured in terms of its displacement, velocity or acceleration. Most assessments of human response to vibration or the risk of damage to buildings use measurements of vibration velocity. These may be expressed in terms of 'peak' velocity or 'rms' velocity.

The former is the maximum instantaneous velocity, without any averaging, and is sometimes referred to as 'peak particle velocity', or PPV. The latter incorporates 'root mean squared' averaging over some defined time period.

Vibration measurements may be carried out in a single axis or alternatively as triaxial measurements (ie vertical, longitudinal and transverse).

The common units for velocity are millimetres per second (mm/s). As with noise, decibel units can also be used, in which case the reference level should always be stated. A vibration level V, expressed in mm/s can be converted to decibels by the formula 20 log (V/Vo), where Vo is the reference level (10-9 m/s). Care is required in this regard, as other reference levels may be used.

8. Human Perception of Vibration

People are able to 'feel' vibration at levels lower than those required to cause even superficial damage to the most susceptible classes of building (even though they may not be disturbed by the motion). An individual's perception of motion or response to vibration depends very strongly on previous experience and expectations, and on other connotations associated with the perceived source of the vibration. For example, the vibration that a person responds to as 'normal' in a car, bus or train is considerably higher than what is perceived as 'normal' in a shop, office or dwelling.

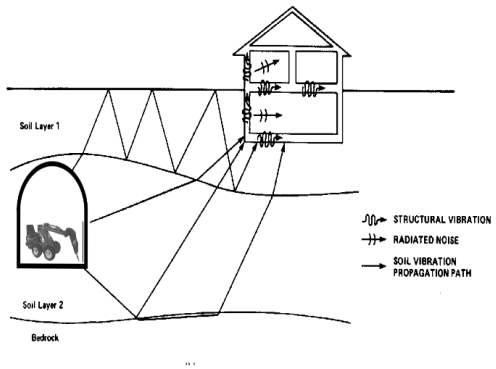
9. Ground-borne Noise, Structure-borne Noise and Regenerated Noise

Noise that propagates through a structure as vibration and is radiated by vibrating wall and floor surfaces is termed 'structure-borne noise', 'ground-borne noise' or 'regenerated noise'. This noise originates as vibration and propagates between the source and receiver through the ground and/or building structural elements, rather than through the air.

Typical sources of ground-borne or structure-borne noise include tunnelling works, underground railways, excavation plant (eg rockbreakers), and building services plant (eg fans, compressors and generators).

The following figure presents an example of the various paths by which vibration and ground-

borne noise may be transmitted between a source and receiver for construction activities occurring within a tunnel.



The term ‘regenerated noise’ is also used in other instances where energy is converted to noise away from the primary source. One example would be a fan blowing air through a discharge grill. The fan is the energy source and primary noise source. Additional noise may be created by the aerodynamic effect of the discharge grill in the airstream. This secondary noise is referred to as regenerated noise.

Appendix B Unattended Noise Monitoring

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Appendix C Construction Noise Sources

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Scenario	Total SWL	Circular Saw[1]	Concrete Mixer Truck	Concrete Pump	Concrete Vibrator	Elevated Working Platform	Excavator - Breaker[1]	Excavator (14 tonne)	Excavator (22 tonne)	Front End Loader	Generator	Grader	Hand Tools	Mobile Crane - Franna	Mobile Crane (400 tonne)	Road Profiler	Roller - Smooth Drum	Roller - Vibratory (12 tonne)[1]	Semi Trailer	Tipper Truck	Truck
Sound Power Level[2]		106	103	106	102	97	121	97	99	104	102	108	94	98	106	107	107	109	106	97	107
Estimated on-time in 15 minutes		15	7.5	7.5	15	15	5	7.5	7.5	7.5	15	15	15	7.5	15	15	15	15	5	15	5
Scenario																					
W.01 Site establishment	105										X		X								X
W.02 Demolition	117						X		X	X	X										X
W.03 Earth works	111								X		X							X			X
W.04 Concreting works	109		X	X	X						X										X
W.05 Structure works	110		X	X				X								X					X
W.06 Stormwater & Pavements	117		X				X	X				X		X			X	X		X	X
W.07 Finishing works	106					X					X		X	X							X
W.07 Construction of Warehouse 1.1	111	X				X					X				X				X		

Note 1: Equipment classed as 'annoying' in the ICNG and requires a 5 dB correction.

Note 2: Sound power level data is taken from the DEFRA Noise Database, *RMS Construction and Vibration Guideline* and TfNSW *Construction Noise and Vibration Strategy*.

Appendix D Operational Noise Contours

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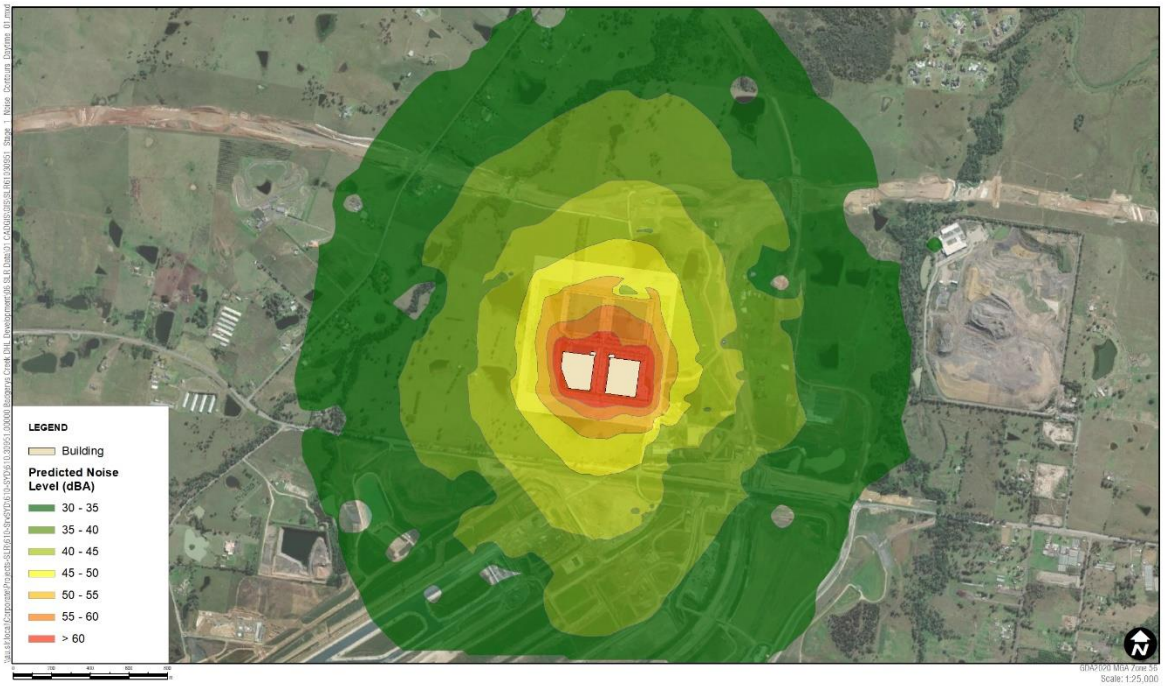
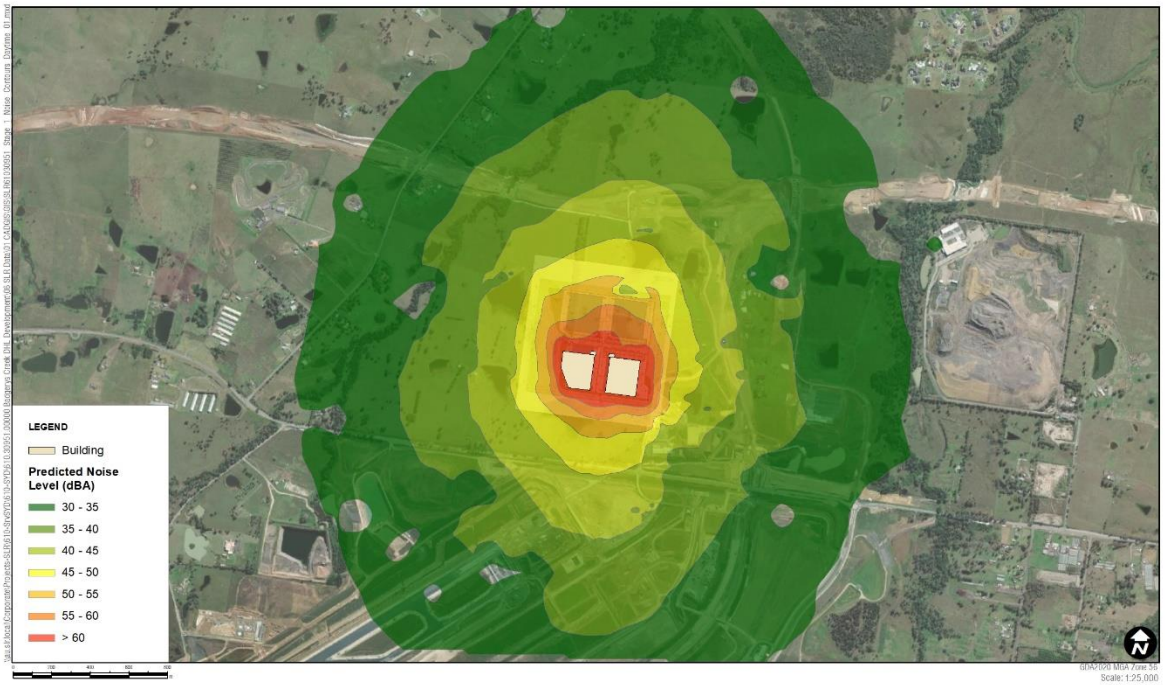
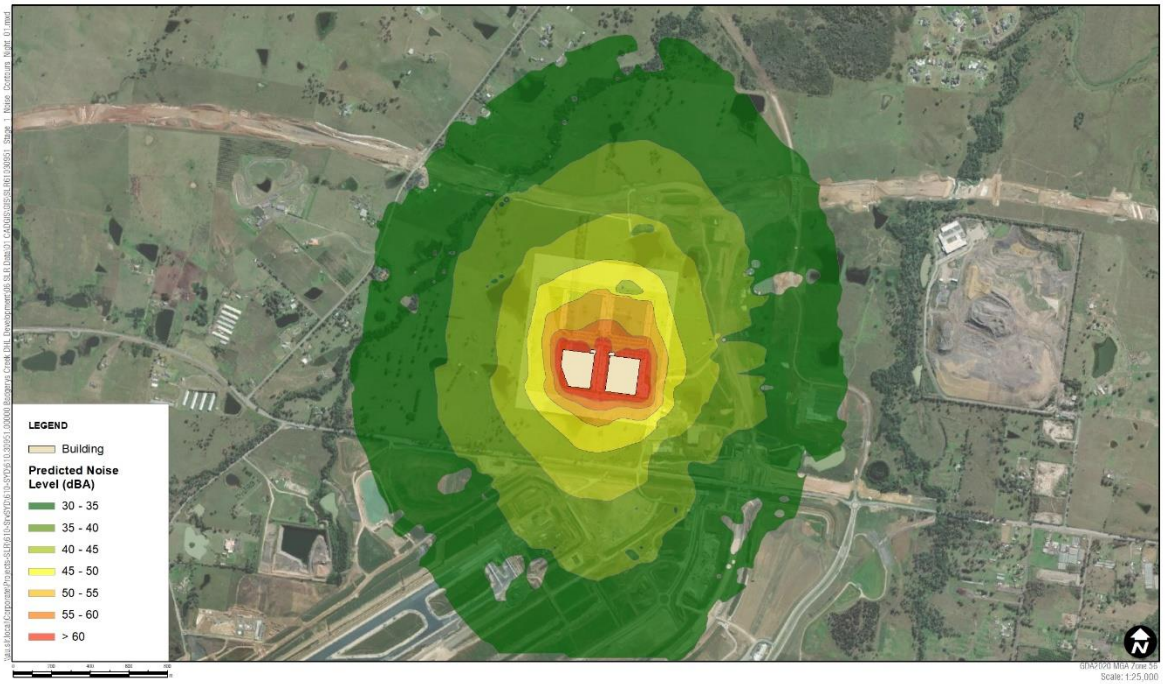
Daytime (Standard Weather)



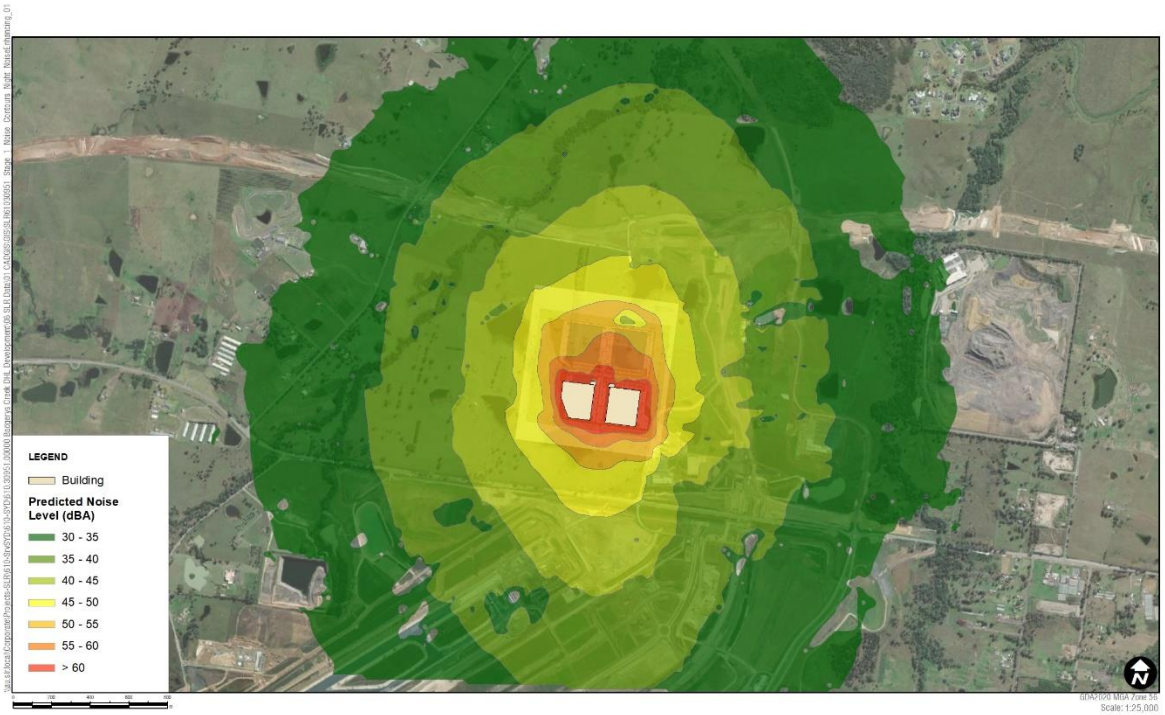
Evening (Standard Weather)



Night-time (Standard Weather)



Night-time (Noise-enhancing Weather)



Appendix E CNVG Mitigation Measures

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CNVG Standard Mitigation and Management Measures

Action Required	Applies To	Details
Management measures		
Implementation of any project specific mitigation measures required.	Airborne noise	Implementation of any project specific mitigation measures required.
Implement community consultation or notification measures.	Airborne noise Ground-borne noise & vibration	Notification detailing work activities, dates and hours, impacts and mitigation measures, indication of work schedule over the night-time period, any operational noise benefits from the works (where applicable) and contact telephone number. Notification should be a minimum of 7 calendar days prior to the start of works. For projects other than maintenance works more advanced consultation or notification may be required. Please contact Roads and Maritime Communication and Stakeholder Engagement for guidance. Website (If required) Contact telephone number for community Email distribution list (if required) Community drop-in session (if required by approval conditions).
Site inductions	Airborne noise Ground-borne noise & vibration	All employees, contractors and subcontractors are to receive an environmental induction. The induction must at least include: • all project specific and relevant standard noise and vibration mitigation measures • relevant licence and approval conditions • permissible hours of work • any limitations on high noise generating activities • location of nearest sensitive receivers • construction employee parking areas • designated loading/unloading areas and procedures • site opening/closing times (including deliveries) • environmental incident procedures.
Behavioral practices	Airborne noise	No swearing or unnecessary shouting or loud stereos/radios on site. No dropping of materials from height, throwing of metal items and slamming of doors.
Verification	Airborne noise Ground-borne noise & vibration	Where specified under **Appendix C** of the CNVG a noise verification program is to be carried out for the duration of the works in accordance with the Construction Noise and Vibration Management Plan and any approval and licence conditions.
Attended vibration measurements	Ground-borne vibration	Where required attended vibration measurements should be undertaken at the commencement of vibration generating activities to confirm that vibration levels are within the acceptable range to prevent cosmetic building damage.
Update Construction Environmental Management Plans	Airborne noise Ground-borne noise & vibration	The CEMP must be regularly updated to account for changes in noise and vibration management issues and strategies.

Action Required	Applies To	Details
Building condition surveys	Vibration Blasting	Undertake building dilapidation surveys on all buildings located within the buffer zone prior to commencement of activities with the potential to cause property damage
Source controls		
Construction hours and scheduling	Airborne noise Ground-borne noise & vibration	Where feasible and reasonable, construction should be carried out during the standard daytime working hours. Work generating high noise and/or vibration levels should be scheduled during less sensitive time periods.
Construction respite period during normal hours and out-of-hours work	Ground-borne noise & vibration Airborne noise	See **Appendix C** of the CNVG for more details on the following respite measures: • Respite Offers (RO) • Respite Period 1 (R1) • Respite Period 2 (R2) • Duration Respite (DR)
Equipment selection.	Airborne noise Ground-borne noise & vibration	Use quieter and less vibration emitting construction methods where feasible and reasonable. For example, when piling is required, bored piles rather than impact-driven piles will minimise noise and vibration impacts. Similarly, diaphragm wall construction techniques, in lieu of sheet piling, will have significant noise and vibration benefits. Ensure plant including the silencer is well maintained.
Plant noise levels.	Airborne-noise	The noise levels of plant and equipment must have operating Sound Power or Sound Pressure Levels compliant with the criteria in Appendix H of the CNVG. Implement a noise monitoring audit program to ensure equipment remains within the more stringent of the manufacturers specifications or Appendix H of the CNVG.
Rental plant and equipment.	Airborne-noise	The noise levels of plant and equipment items are to be considered in rental decisions and in any case cannot be used on site unless compliant with the criteria in Table 2 of the CNVG.
Use and siting of plant.	Airborne-noise	The offset distance between noisy plant and adjacent sensitive receivers is to be maximised. Plant used intermittently to be throttled down or shut down. Noise-emitting plant to be directed away from sensitive receivers. Only have necessary equipment on site.
Plan worksites and activities to minimise noise and vibration.	Airborne noise Ground-borne vibration	Locate compounds away from sensitive receivers and discourage access from local roads. Plan traffic flow, parking and loading/unloading areas to minimise reversing movements within the site. Where additional activities or plant may only result in a marginal noise increase and speed up works, consider limiting duration of impact by concentrating noisy activities at one location and move to another as quickly as possible. Very noise activities should be scheduled for normal working hours. If the work can not be undertaken during the day, it should be completed before 11:00pm. Where practicable, work should be scheduled to avoid major student examination periods when students are studying for examinations such as before or during Higher School Certificate and at the end of higher education semesters. If programmed night work is postponed the work should be re-programmed and the approaches in this guideline apply again.

Action Required	Applies To	Details
Reduced equipment power	Airborne noise Ground-borne vibration	Use only the necessary size and power.
Non-tonal and ambient sensitive reversing alarms	Airborne noise	Non-tonal reversing beepers (or an equivalent mechanism) must be fitted and used on all construction vehicles and mobile plant regularly used on site and for any out of hours work. Consider the use of ambient sensitive alarms that adjust output relative to the ambient noise level.
Minimise disturbance arising from delivery of goods to construction sites.	Airborne noise	Loading and unloading of materials/deliveries is to occur as far as possible from sensitive receivers. Select site access points and roads as far as possible away from sensitive receivers. Dedicated loading/unloading areas to be shielded if close to sensitive receivers. Delivery vehicles to be fitted with straps rather than chains for unloading, wherever possible. Avoid or minimise these out of hours movements where possible.
Engine compression brakes	Construction vehicles	Limit the use of engine compression brakes at night and in residential areas. Ensure vehicles are fitted with a maintained Original Equipment Manufacturer exhaust silencer or a silencer that complies with the National Transport Commission's 'In-service test procedure' and standard.
Path controls		
Shield stationary noise sources such as pumps, compressors, fans etc.	Airborne noise	Stationary noise sources should be enclosed or shielded where feasible and reasonable whilst ensuring that the occupational health and safety of workers is maintained. **Appendix D** of AS 2436:2010 lists materials suitable for shielding.
Shield sensitive receivers from noisy activities.	Airborne noise	Use structures to shield residential receivers from noise such as site shed placement; earth bunds; fencing; erection of operational stage noise barriers (where practicable) and consideration of site topography when situating plant.
Receptor control		
Structural surveys and vibration monitoring	Ground-borne vibration	Pre-construction surveys of the structural integrity of vibration sensitive buildings may be warranted. At locations where there are high-risk receptors, vibration monitoring should be conducted during the activities causing vibration.
See **Appendix C** of the CNVG for additional measures	Airborne noise Ground-borne vibration	In some instances, additional mitigation measures may be required.

Appendix F NPfI Mitigation Measures

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Best Management Practice (BMP)

Best management practice (BMP) is the application of particular operational procedures that minimise noise while retaining productive efficiency.

Where applied, these measures and practices are often documented in a noise management plan so that operational practices and undertakings are clearly understood and applied at all levels of an industrial operation. Application of BMP can include the following types of practice:

- Using the quietest plant that can do the job
    - Scheduling the use of noisy equipment at the least-sensitive time of day
- Not operating, or reducing operations at night
    - Siting noisy equipment behind structures that act as barriers, or at the greatest distance from the noise-sensitive area or orienting the equipment so that noise emissions are directed away from any sensitive areas, to achieve the maximum attenuation of noise
- Where there are several noisy pieces of equipment, scheduling operations so they are used separately rather than concurrently
    - Keeping equipment well-maintained and operating it in a proper and efficient manner
- Using ‘quiet’ practices when operating equipment, for example, positioning idling trucks in appropriate areas
    - Running staff-education programs and regular tool box talks on the effects of noise and the use of quiet work practices.

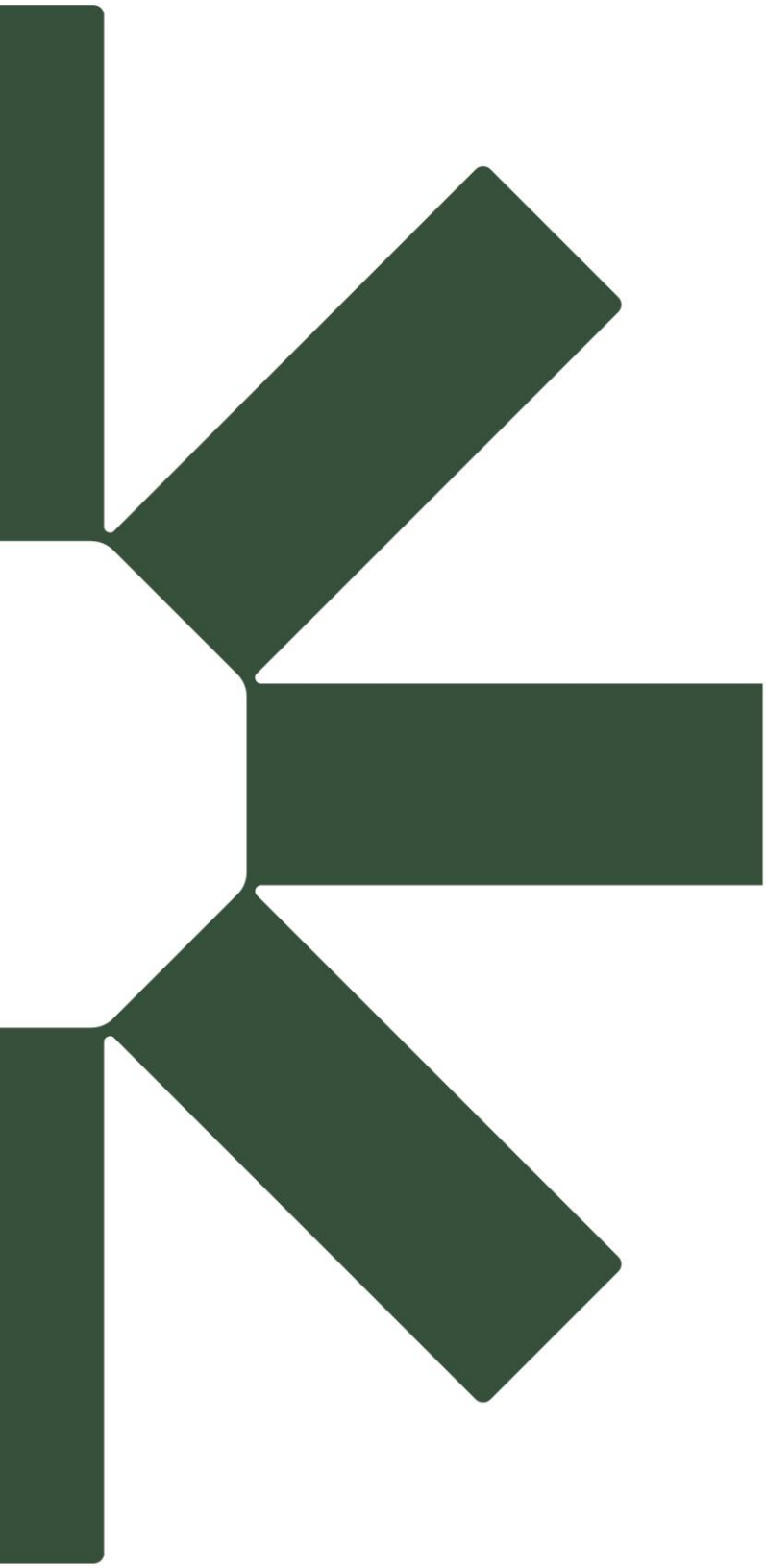
Best Available Technology Economically Achievable (BATEA)

With ‘Best available technology economically achievable’ (BATEA), equipment, plant and machinery that produce noise incorporate the most advanced and affordable technology to minimise noise output. Affordability is not necessarily determined by the price of the technology alone. Increased productivity may also result from using more advanced equipment, offsetting the initial outlay, for example, using ‘quieter’ equipment that can be operated over extended hours. Old or badly-designed equipment can often be a major source of noise.

Where BMP fails to achieve the required noise reduction by itself, the BATEA approach should then be considered. Examples of uses of BATEA include:

- Considering alternatives to tonal reversing alarms (where work health and safety is appropriately considered)
    - Using equipment with efficient muffler design
- Using quieter engines, such as electric instead of internal combustion
    - Fitting and maintaining noise reduction packages on plant and equipment
- Using efficient enclosures for noise sources
    - Damping or lining metal trays or bins
- Active noise control.

For many industries there are a wide range of factors that can restrict the feasibility and reasonableness of applying BMP or BATEA measures on a particular site. Work health and safety considerations must also be taken into account as well as any other regulatory and process requirements.



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