

ATTACHMENT 9

Noise Impact
Assessment prepared
by Noise Measurement
Services



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REPORT FOR Place Design Group *on behalf of Light Dreaming*

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Executive Summary

This Report is in response to a request from Place Design Group for a noise impact assessment of a proposed Environmental Facility & Tourist Attraction (“Lumina Night Walk”) at the Brisbane Botanic Gardens, Mt Coot-Tha (Lot 1 and 6 on SP266267). The site is within OP1 & OP3 Open Space Zones. The proposal is to conduct audio-visual events at multiple stations around a designated walking track. Proposed hours of operation are 6.00pm – 11.00pm (September to March) and 5.00pm – 11.00pm (April to August), Monday to Sunday (inc. public holidays). The purpose of this Report is to assess potential noise impacts onto nearby noise sensitive zones. The specific design and layout of events is yet to be determined, and parameters have been recommended to inform design choices and ensure compliance. The following Standards and policy documents are referenced:

- *Brisbane City Council City Plan 2014*
- *Environmental Protection (Noise) Policy 2019*
- *Environmental Protection Act 1994*
- Australian Standard AS1055:2018 – *Acoustics: Description and measurement of environmental noise*

Conclusions

It is concluded that –

- Subject to the considerations as presented in this Report, it is the opinion of this consultancy that the proposed development can meet the requirements of the *Brisbane City Plan 2014*, and be otherwise compliant with relevant regulatory requirements.
- The site is well buffered from noise sensitive areas, with a buffer distance of approximately 225m from the designated walking track
- Subject to controls on the amplification systems, noise emissions are forecast to meet criteria at all receivers during the proposed hours of operation.

Recommendations

It is recommended that –

- Acoustic testing be conducted once installation is complete to calibrate amplification systems to ensure compliance with criteria.
 - Calculations predict compliance at all receivers assuming levels of 85 dB(A) at 1m from a sound source. This level is intended to demonstrate that compliance can be managed at the expected sound levels, it is not intended to be a limit – the limit must be based on site measurements.
- A Noise Management Plan be adopted and implemented. An indicative plan is presented in **Appendix C**, which should be modified/adopted in active consultation with relevant stakeholders, particularly residents located across Mt Coot-Tha Road to the north.

1. Introduction

This Report is in response to a request from Place Design Group for a noise impact assessment of a proposed Environmental Facility & Tourist Attraction (“Lumina Night Walk”) at the Brisbane Botanic Gardens, Mt Coot-Tha (Lot 1 and 6 on SP266267). The site is within OP1 & OP3 Open Space Zones. The proposal is to conduct audio-visual events at multiple stations around a designated walking track. Proposed hours of operation are 6.00pm – 11.00pm (September to March) and 5.00pm – 11.00pm (April to August), Monday to Sunday (inc. public holidays). The purpose of this Report is to assess potential noise impacts onto nearby noise sensitive zones. The specific design and layout of events is yet to be determined, and parameters have been recommended to inform design choices and ensure compliance. The following Standards and policy documents are referenced:

- *Brisbane City Council City Plan 2014*
- *Environmental Protection (Noise) Policy 2019*
- *Environmental Protection Act 1994*
- *Australian Standard AS1055:2018 – Acoustics: Description and measurement of environmental noise*

Development plans are presented in **Appendix A**, while a glossary of terms and definitions is presented in **Appendix D**.

1.1 Development Site and Locale

Plate 1: Showing the development site (in blue) and locale (source: Google)



Plate 2: Showing zoning in the locale (source: Brisbane City Council)

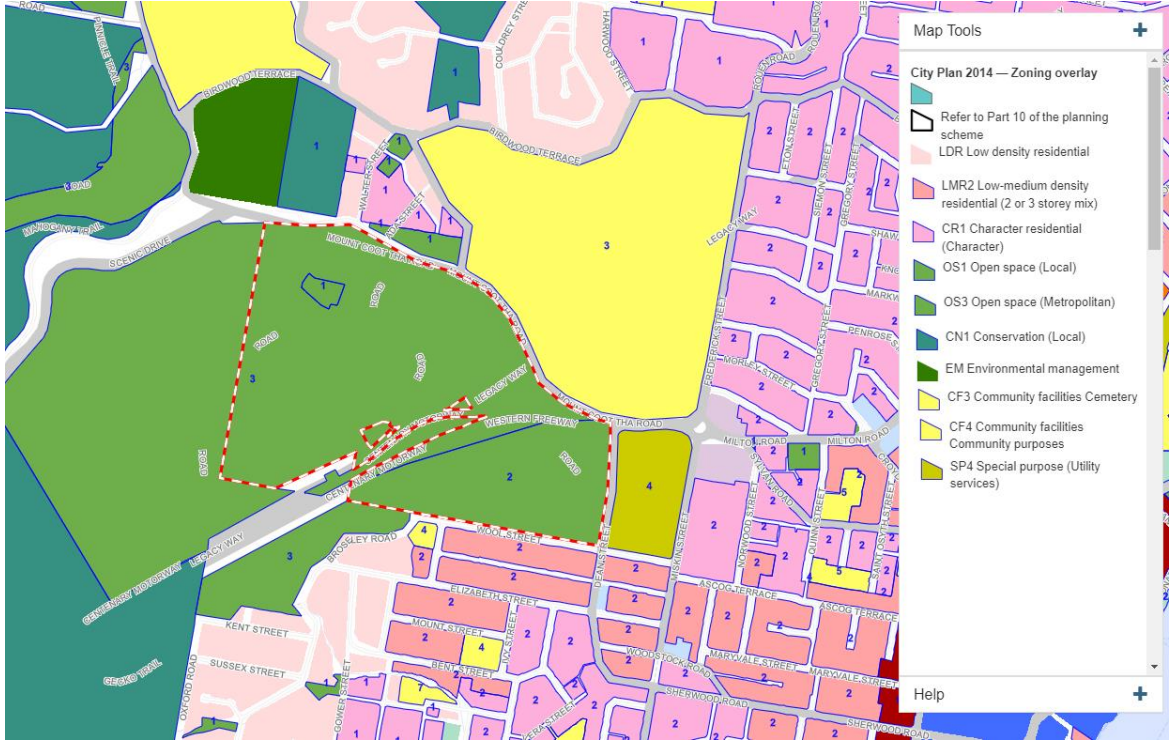
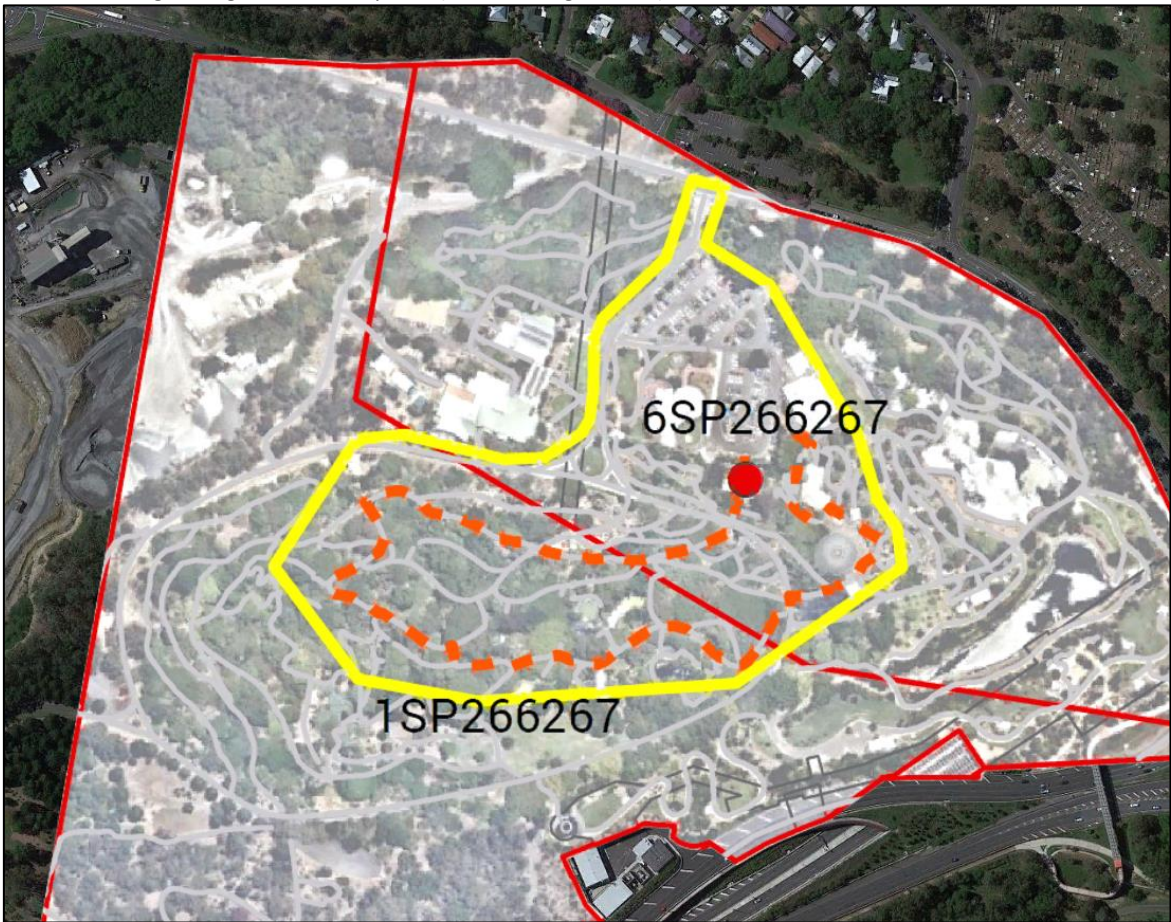


Plate 3: Showing the night walk activity area (source: Google; client)



1.2 Sensitive Receivers

The development site is located adjacent to transport infrastructure, quarry and cemetery, which are not classified as sensitive uses or zones under the *City Plan 2014*. Assessment has therefore been conducted to the Residential and Environmental Zone boundaries. Seven sensitive receivers – referred to as R1 to R7 in this Report – have been assessed, representing the most affected locations of these sensitive zone boundaries. The locations of R1 to R7 are presented in **Plate 4** and **Table 1** below.

Plate 4: Showing sensitive receivers R1 to R7

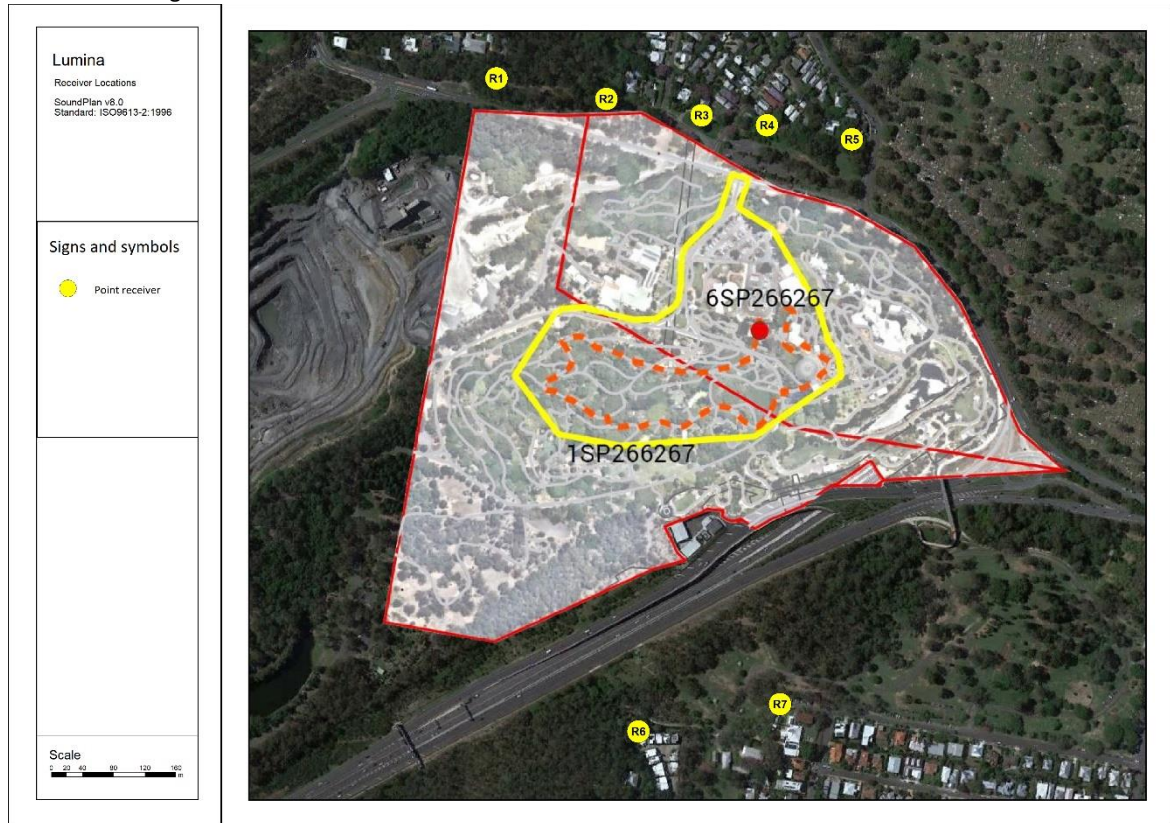


Table 1: Showing sensitive receivers R1 to R7 by Universal Transverse Mercator (UTM)

Receiver	Address	Coordinates		Zone
		Easting	Northing	
R1	47 Old Mt Coot-Tha Road	497432	6961149	EM
R2	360 Birdwood Terrace	497573	6961123	CN1
R3	7 Old Mt Coot-Tha Road	497695	6961102	CR1
R4	26 Ada Street	497695	6961102	CR1
R5	8 Horrocks Street	497888	6961071	CR1
R6	Unit 7, 111 Elizabeth Street	497614	6960312	LDR
R7	257 Broseley Road	497796	6960347	CF4

2. Measurement of Ambient Noise Levels

2.1 Ambient Noise Survey – Measurement Procedures

In order to assess the existing acoustic environment in the locale, an ambient noise survey was conducted on site. The environmental noise logger was installed at a location north-west of the proposed activity area, approximately 75m from Mt Coot-Tha Road. The microphone was at a height of 1.4m in a free-field environment. Background levels measured at this location are considered representative of the locality generally, and conservatively representative of the most affected residential interface(s). The measurement location is referred to as ML1 in this Report, and is presented in **Plate 5** and **Photo 1** below.

Plate 5: Showing measurement location ML1 (source: Google)

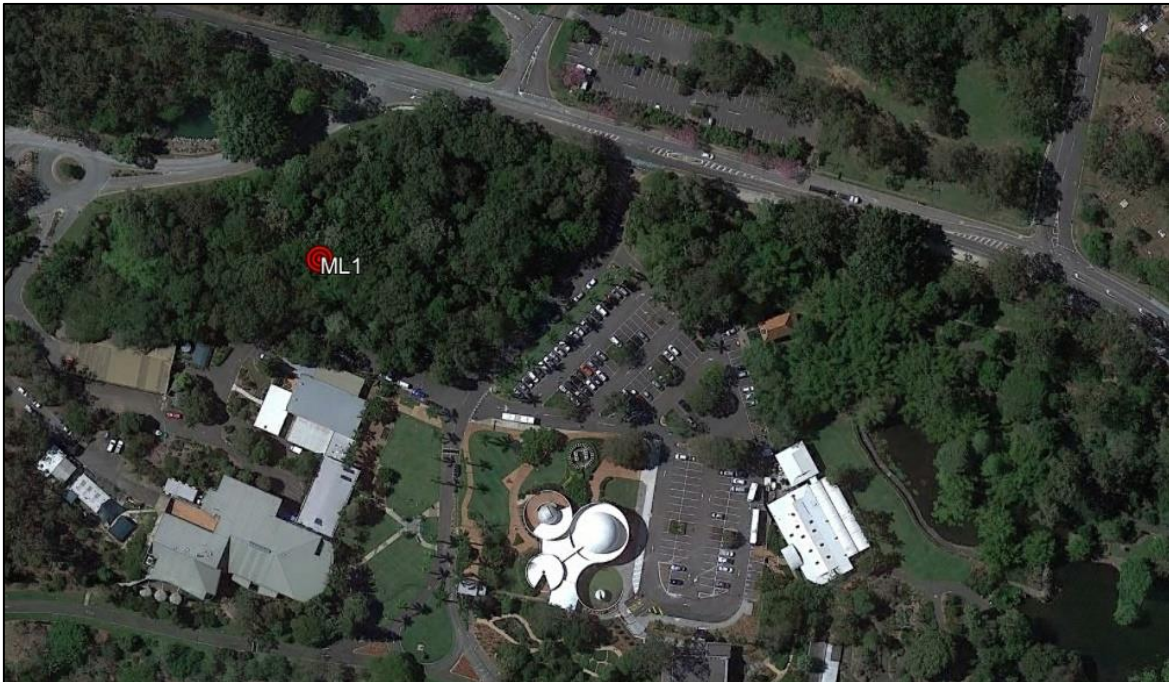


Photo 1: Showing measurement location ML1



The noise logger was field calibrated before and after each measurement session, and no significant drift was observed from the reference signal. All instrumentation used in this assessment holds a current calibration certificate from a certified NATA calibration laboratory. The following instrumentation was used:

- Larson Davis LXT Class 2 environmental noise logger
- Larson Davis CAL200 Class 1 calibrator

2.2 Ambient Noise Survey – Measurement Results

Ambient sound pressure levels were measured generally in accordance with Australian Standard *AS1055.2018 - Acoustics-Description and measurement of environmental noise*. Ambient noise levels were recorded at 15 minute intervals between the 23rd and 30th of June 2022. Noise levels are presented in **Figure 1** below, and **Table 2** following.

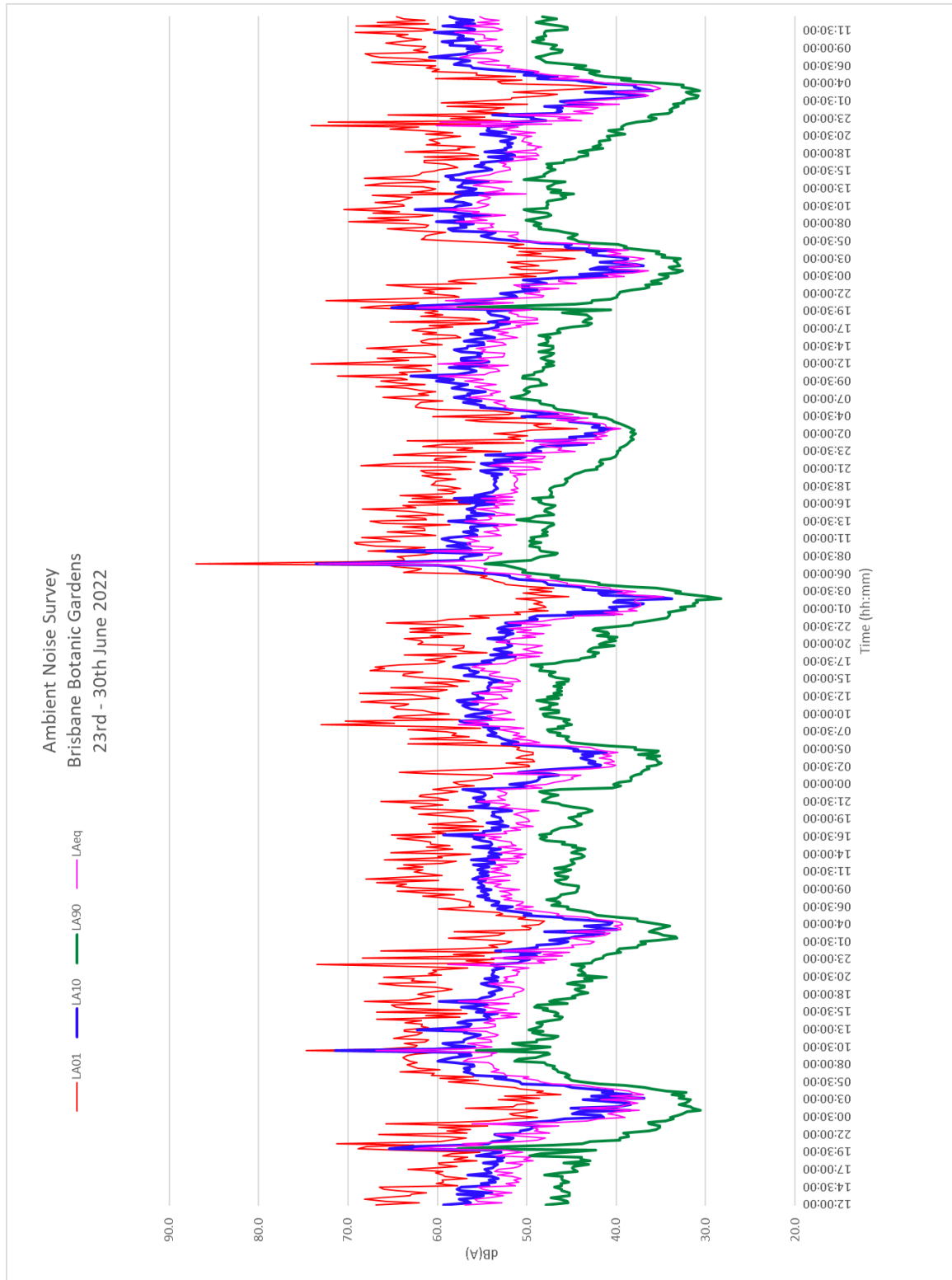


Figure 1: Ambient noise levels at ML1, 23rd – 30th June 2022. Levels are in dB(A), free-field

Table 2: Averaged measured noise levels at ML1, 23rd – 30th June 2022. Levels are in dB(A), free-field

Day	Date	Period	L ₀₁	L ₁₀	L ₉₀	L _{eq}
Thursday	23 rd / 30 th June	7:00am – 6:00pm	67	56	47	54
		6:00pm – 10:00pm	68	55	45	55
		10:00pm – 7:00am	63	46	36	50
Friday	24 th June	7:00am – 6:00pm	66	57	48	56
		6:00pm – 10:00pm	65	54	44	52
		10:00pm – 7:00am	60	46	36	47
Saturday	25 th June	7:00am – 6:00pm	65	55	46	53
		6:00pm – 10:00pm	63	54	45	52
		10:00pm – 7:00am	61	48	39	49
Sunday	26 th June	7:00am – 6:00pm	67	55	47	54
		6:00pm – 10:00pm	63	53	42	51
		10:00pm – 7:00am	62	49	40	50
Monday	27 th June	7:00am – 6:00pm	68	57	49	59
		6:00pm – 10:00pm	63	54	45	51
		10:00pm – 7:00am	62	46	38	48
Tuesday	28 th June	7:00am – 6:00pm	67	56	48	55
		6:00pm – 10:00pm	68	55	44	55
		10:00pm – 7:00am	62	48	41	48
Wednesday	29 th June	7:00am – 6:00pm	68	57	47	54
		6:00pm – 10:00pm	63	53	41	50
		10:00pm – 7:00am	62	46	37	47
Arithmetic Average		Day	67	56	47	55
		Evening	65	54	44	52
		Night	62	47	38	49

The levels above include noise measured from all sources in the locale, including road traffic, quarry activity, meteorology and wildlife. Road traffic noise was observed to be the dominant noise source in the locale, and measured levels are considered to be consistent with an acoustic environment generally controlled by road traffic noise at background levels. The Rating Background Levels (RBL) at ML1 have been calculated in accordance with the BCC Noise Impact Assessment Planning Scheme Policy, and are presented in **Table 3** below.

Table 3: Rating Background Levels (RBL) at ML1

Location	Day (7am – 6pm)	Evening (6pm – 10pm)	Night (10pm – 7am)
ML1	46	42	33

3. Noise Assessment Criteria

3.1 Brisbane City Council City Plan 2014

The operations on Lot 1 and Lot 6, lie within OP1 & OP3 Open Space zones, and the proposed activities are to be defined as an Environmental Facility & Tourist attraction. While reference is made to amenity in the Park Code (Part 9.3.16), and in pre-lodgement discussions (Council Ref# A005974076, dated 6th April 2022), specific noise criteria are not specified. Assessment has therefore been conducted to the noise emission criteria contained within the Centre or Mixed Use Code, representing the ‘best fit’ of proposed activities. The relevant criteria are presented below.

Table 4: Centre or mixed use code Noise (planning) criteria (Table 9.3.3.3.F from *City Plan 2014*, in part)

Criteria location*	Intrusive noise criteria Day, evening and night $L_{Aeq,adj,T}$ are not greater than the RBL plus the value in this column for the relevant criteria location, where T equals: Day – 11hr Evening – 4hr Night – 9hr	Acoustic amenity criteria Day, evening and night $L_{Aeq,adj,T}$ are not greater than the values in this column for the relevant criteria location, where T equals: Day – 11hr Evening – 4hr Night – 9hr		
		Day	Evening	Night
		Environmental management zone boundary	0 dB(A)	40 dB(A)
Conservation zone boundary	0 dB(A)	40 dB(A)	40 dB(A)	40 dB(A)
Character residential zone boundary	3dB(A)	50dB(A)	45dB(A)	40dB(A)
Low density residential zone boundary	3dB(A)	55dB(A)	45dB(A)	40dB(A)

* Note: No specific criteria are provided for the Community Facilities zone, although educational uses are defined as noise sensitive. To protect acoustic amenity, character criteria have been applied at receiver R7.

Table 5: Centre or mixed use code Low frequency noise criteria (Table 9.3.3.3.G from *City Plan 2014*, in part)

Criteria location*	Day (7am-6pm) $L_{Ceq,adj,11hr}$ is not greater than the following values at the relevant criteria location	Evening (6pm-10pm) $L_{Ceq,adj,4hr}$ is not greater than the following values at the relevant criteria location	Night (10pm-7am) $L_{Ceq,adj,9hr}$ is not greater than the following values at the relevant criteria location
Environmental management zone boundary	65 dB(C)	65 dB(C)	65 dB(C)
Conservation zone boundary	65 dB(C)	65 dB(C)	65 dB(C)
Character residential zone boundary	65 dB(C)	65 dB(C)	60 dB(C)
Low density residential zone boundary	65 dB(C)	65 dB(C)	60 dB(C)

* Note: No specific criteria are provided for the Community Facilities zone, although educational uses are defined as noise sensitive. To protect acoustic amenity, residential criteria have been applied at receiver R7.

Table 6: Centre or mixed use code Night-time noise criteria (Table 9.3.3.3.H from *City Plan 2014*, in part)

Criteria location*	Where the existing $L_{Aeq,9hr}$ night at the criteria location is:	Average of the highest 15 single L_{Amax} events over a given night (10pm-7am) period is not greater than the following values at the relevant criteria location	The absolute highest single L_{Amax} event over a given night (10pm-7am) period is not greater than the following values at the relevant criteria location:
At the zone boundary of: <ul style="list-style-type: none"> Character residential zone Low density residential zone 	<45dB(A)	50dB(A)	55dB(A)
	45 to 60dB(A)	$L_{Aeq,9hr \text{ night}} + 5\text{dB(A)}$	$L_{Aeq,9hr \text{ night}} + 10\text{dB(A)}$
	>60dB(A)	65dB(A)	70dB(A)

* Note: No specific criteria are provided for the Community Facilities zone, although educational uses are defined as noise sensitive. To protect acoustic amenity, residential criteria have been applied at receiver R7. Similarly, no criteria are provided for the Environmental Management Zone or Conservation Zone, and residential criteria have been applied to receivers R1 & R2.

Noise limits for the proposed development have been determined with reference to the Rating Background Levels and $L_{Aeq,9hr}$ measured at ML1 (as discussed in **Section 2**), and summarized below.

Table 7: Criteria Summary

Criteria location	Intrusive Noise Criteria				Acoustic Amenity Criteria		
	Metric	Day	Evening	Night	Day	Evening	Night
$L_{Aeq,adj,T}$							
Environmental management zone boundary	RBL + 0	46	42	33	40	40	40
Conservation zone boundary	RBL + 0	46	42	33	40	40	40
Character residential zone boundary	RBL + 3	49	45	36	50	45	40
Low density residential zone boundary	RBL + 3	49	45	36	55	45	40
		Day	Evening		Night		
$L_{Ceq,adj,T}$							
Environmental management zone boundary	65 dB(C)		65 dB(C)		65 dB(C)		
Conservation zone boundary	65 dB(C)		65 dB(C)		65 dB(C)		
Character residential zone boundary	65 dB(C)		65 dB(C)		60 dB(C)		
Low density residential zone boundary	65 dB(C)		65 dB(C)		60 dB(C)		
		Average of 15 highest L_{Amax} events			Single highest L_{Amax} event		
L_{max}							
At the zone boundary of: <ul style="list-style-type: none"> Character residential zone Low density residential zone 	54			59			

Only one hour of activity is proposed during the day period (5pm – 6pm, April to August only), and the conversion of $L_{eq,1hr}$ to $L_{eq,12hr}$ assuming one hour of activity amounts to a difference of 11 dB. Day criteria have therefore been adjusted by +11 dB to account for one hour of proposed activity during the assessment period. Similarly, only one hour of activity is proposed during the night period (10pm – 11pm), and the conversion of $L_{eq,1hr}$ to $L_{eq,9hr}$ assuming one hour of activity amounts to a difference of 10 dB. Night criteria have therefore been adjusted by +10 dB to account for one hour of proposed activity during the assessment period. Design criteria – representing the most stringent of applicable criteria – are presented in **Table 8** below.

Table 8: Showing design criteria

Receiver	Zone	Descriptor	Criteria		
			Day	Evening	Night
Noise (planning) criteria					
R1	EM	$L_{Aeq,adj,T}$	57	40	43
R2	CN1	$L_{Aeq,adj,T}$	57	40	43
R3	CR1	$L_{Aeq,adj,T}$	60	45	46
R4	CR1	$L_{Aeq,adj,T}$	60	45	46
R5	CR1	$L_{Aeq,adj,T}$	60	45	46
R6	LDR	$L_{Aeq,adj,T}$	60	45	46
R7	CF4	$L_{Aeq,adj,T}$	60	45	46
Low frequency noise criteria					
R1	EM	$L_{Aeq,adj,T}$	76	65	75
R2	CN1	$L_{Ceq,adj,T}$	76	65	75
R3	CR1	$L_{Ceq,adj,T}$	76	65	70
R4	CR1	$L_{Ceq,adj,T}$	76	65	70
R5	CR1	$L_{Ceq,adj,T}$	76	65	70
R6	LDR	$L_{Ceq,adj,T}$	76	65	70
R7	CF4	$L_{Ceq,adj,T}$	76	65	70
Night-time noise criteria					
R1	EM	L_{max}	-	-	54
R2	CN1	L_{max}	-	-	54
R3	CR1	L_{max}	-	-	54
R4	CR1	L_{max}	-	-	54
R5	CR1	L_{max}	-	-	54
R6	LDR	L_{max}	-	-	54
R7	CF4	L_{max}	-	-	54

3.2 Environmental Protection (Noise) Policy 2019

The *Environmental Protections (Noise) Policy 2019* establishes Acoustic Quality Objectives (AQO) to protect or enhance stated environmental values. The environmental values to be enhanced or protected under the policy are the qualities of the acoustic environment that are conducive to protecting the health and biodiversity of ecosystems; and the qualities of the acoustic environment that are conducive to human health and well-being, including ensuring a suitable acoustic environment for individual's to sleep, study and learn, to be involved in recreation including relaxation and conversation; and the qualities of the acoustic environment that are conducive to protecting the amenity of the community.

The acoustic quality objectives do not apply to noise from aircraft movement, noise from the ordinary use of a public road or State-controlled road and noise from the ordinary use of a busway, light rail or rail transport infrastructure. It is furthermore noted that Brisbane City Council provides specific criteria for the assessment of noise emissions from the development onto nearby sensitive uses, and that the AQO are not intended to override Council policies, where in force. Application of BCC policy is therefore considered to achieve the policy intent of the *Environmental Protection (Noise) Policy 2019*.

3.3 Environmental Protection Act 1994

State requirements for outdoor events are set out under section 440x of the *Environmental Protection Act 1994*. Specifically:

“An occupier or premises must not use, or permit the use of, the premises for an open-air event on any day–

- (a) before 7a.m., if the use causes audible noise; or
- (b) from 7a.m. to 10p.m, if the use causes noise of more than 70 dB(A); or
- (c) from 10p.m. to midnight, if the use causes noise of more than the lessor of the following–
 - (i) 50dB(A);
 - (ii) 10dB(A) above the background level. “

While audibility can be a difficult criterion to operationalized, activity is not proposed between midnight and 7am, and this criterion is therefore not applicable. It is also noted State criteria are less stringent than Council criteria during the evening period. It is similarly concluded that the applicable criterion between 10pm and 11pm is also less stringent than Council criteria, since the lowest $L_{90,10pm-11pm}$ measured at ML1 was 37 dB(A) (state criteria not being directly referenced to the RBL, which includes noise measured during quieter parts of the night).

It is therefore concluded that meeting Council criteria also demonstrates compliance with State requirements under the *Environmental Protection Act 1994*.

4. Noise Impact Assessment

4.1 Noise Sources

The proposed events – “Lumina Night Walks” – consist of audiovisual displays at various locations around a designated walking track. The specific layout of Lumina Zones (discrete stations with amplified sound) are yet to be determined, and may change throughout the life span of the project. Similarly, precise speaker locations and music/soundscape source material is yet to be developed. Preliminary assessment has been conducted under a conservative scenario of 10 stations distributed around the designated track, operating continuously and simultaneously. Speaker source levels of 85 dB(A) at 1m have been adopted and are understood to be typical of previous Lumina events. A line source is also included along the track to represent ambient sound along the entire track at a level of 75 dB(A) SPL. Design reference spectra for amplified music has been adopted as per the *Office of Liquor and Gaming Regulation Guideline 51*.

Other sources of noise identified with the proposed events are patron noise (talking/laughing¹) and car park activity². Vehicle movements are based on nominal car and heavy vehicle flows through the car parking area. The heavy vehicles included in the noise model are intended to represent large vehicles such as buses and delivery trucks. Noise emissions from these sources have been modelled to sensitive receivers R1 – R7 using the environmental noise model presented in **Appendix B**. Design source levels are presented in **Table 9** below, with noise source locations presented in **Plate 6** following.

Table 9: Design source sound power levels

Name	Descriptor	Sound Power Levels in dB(Z)								Total in dB(A)
		63 Hz	125 Hz	250 Hz	500 Hz	1 kHz	2 kHz	4 kHz	8 kHz	
Car movements (Leq modelled as 170vph at 20kph)	L _{eq}	74	81	75	72	75	76	72	69	81
	L _{max}	87	94	88	85	88	89	85	82	94
Truck / bus movements (Leq modelled as 8vph at 20kph)	L _{eq}	102	96	92	90	90	86	82	79	94
	L _{max}	114	108	104	102	102	98	94	91	106
Car door ‘slam’*	L _{max}	88	92	87	89	92	87	85	83	95
Raised male voice	L _{eq}	49	54	60	63	66	67	65	65	73
Lumina Track (level per metre)	L _{eq}	84	88	79	78	75	74	74	74	83
Lumina zone^	L _{eq}	94	98	89	88	85	84	84	84	93
	L _{max}	104	108	99	98	95	94	94	94	103
Equivalent Sound Pressure Levels at 1m										
Car movements	L _{eq}	66	73	67	64	67	69	65	62	73
	L _{max}	79	86	80	77	80	81	77	74	86
Truck / bus movements	L _{eq}	94	88	84	82	82	78	74	71	86
	L _{max}	106	100	96	94	94	90	86	83	98
Car door ‘slam’*	L _{max}	80	84	80	81	85	79	77	76	88
Raised male voice	L _{eq}	42	46	52	55	59	59	58	57	65
Lumina Track (level per metre)	L _{eq}	76	80	71	70	67	66	66	66	75
Lumina zone^	L _{eq}	87	91	82	81	78	77	77	77	85
	L _{max}	97	101	92	91	88	87	87	87	95

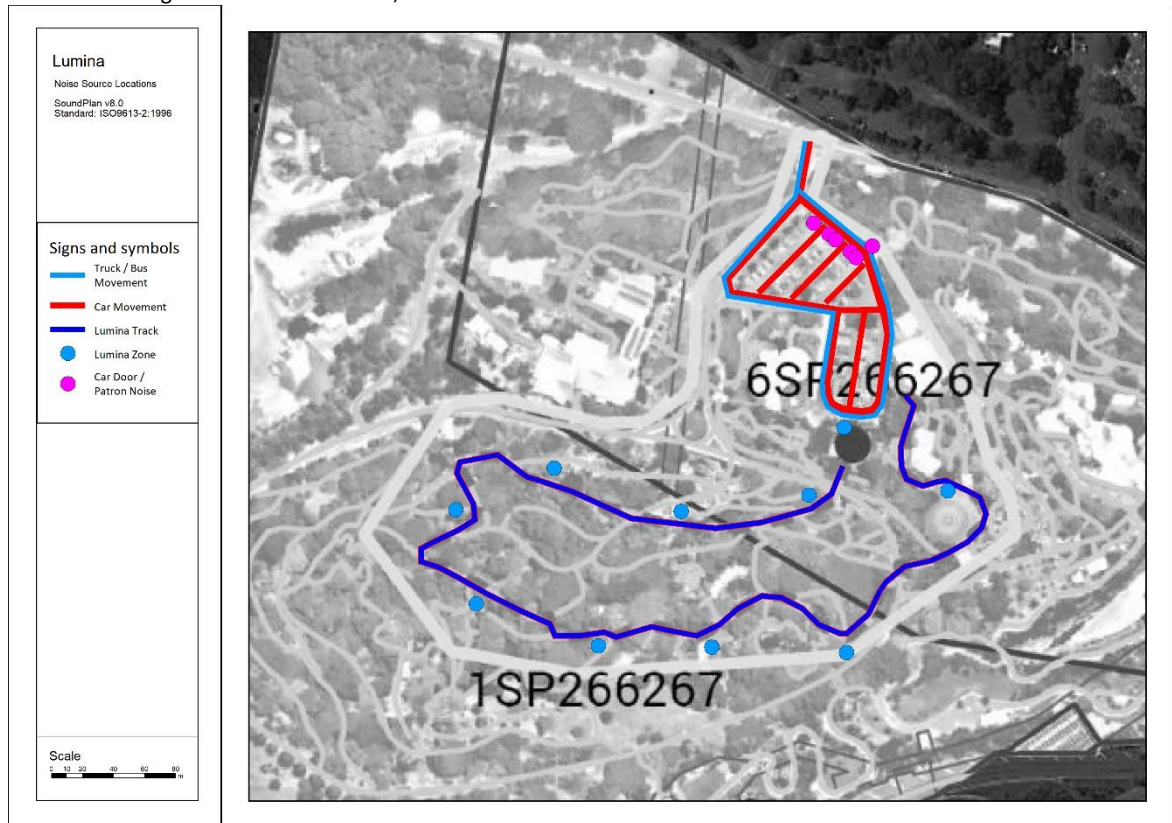
* Identified as an impulsive source

¹ As per Harris, CM, “*Handbook of Acoustical Measurements and Noise Control*” -3rd Ed, Chapter 16.3 (Mc-Graw-Hill Inc)

² Vehicle movements as per the Association of Australasian Acoustical Consultants – *Guideline for Child Care Centre Acoustic Assessment v3.0*, and car door ‘slams’ as per measurements previously undertaken by NMS

^ Identified as a tonal source

Plate 6: Showing noise source locations, as modelled



4.2 Environmental Noise Calculations

Forecast noise emissions from all sources are presented in **Table 10** below, along with applicable criteria. Further details of the environmental noise model are presented in **Appendix B**.

Table 10: Noise emissions forecast (all sources) and criteria

Receiver	Descriptor	Forecast	Criteria			Assessment
			Day	Evening	Night	
Noise (planning) criteria						
R1	L _{Aeq,adj,T}	32	57	40	43	Pass
R2	L _{Aeq,adj,T}	37	57	40	43	Pass
R3	L _{Aeq,adj,T}	41	60	45	46	Pass
R4	L _{Aeq,adj,T}	42	60	45	46	Pass
R5	L _{Aeq,adj,T}	43	60	45	46	Pass
R6	L _{Aeq,adj,T}	30	60	45	46	Pass
R7	L _{Aeq,adj,T}	41	60	45	46	Pass
Low frequency noise criteria						
R1	L _{Ceq,adj,T}	48	76	65	75	Pass
R2	L _{Ceq,adj,T}	53	76	65	75	Pass
R3	L _{Ceq,adj,T}	55	76	65	70	Pass
R4	L _{Ceq,adj,T}	56	76	65	70	Pass
R5	L _{Ceq,adj,T}	56	76	65	70	Pass
R6	L _{Ceq,adj,T}	48	76	65	70	Pass
R7	L _{Ceq,adj,T}	55	76	65	70	Pass
Night-time noise criteria						
R1	L _{max}	37	-	-	54	Pass
R2	L _{max}	44	-	-	54	Pass
R3	L _{max}	52	-	-	54	Pass
R4	L _{max}	53	-	-	54	Pass
R5	L _{max}	47	-	-	54	Pass
R6	L _{max}	22	-	-	54	Pass
R7	L _{max}	34	-	-	54	Pass

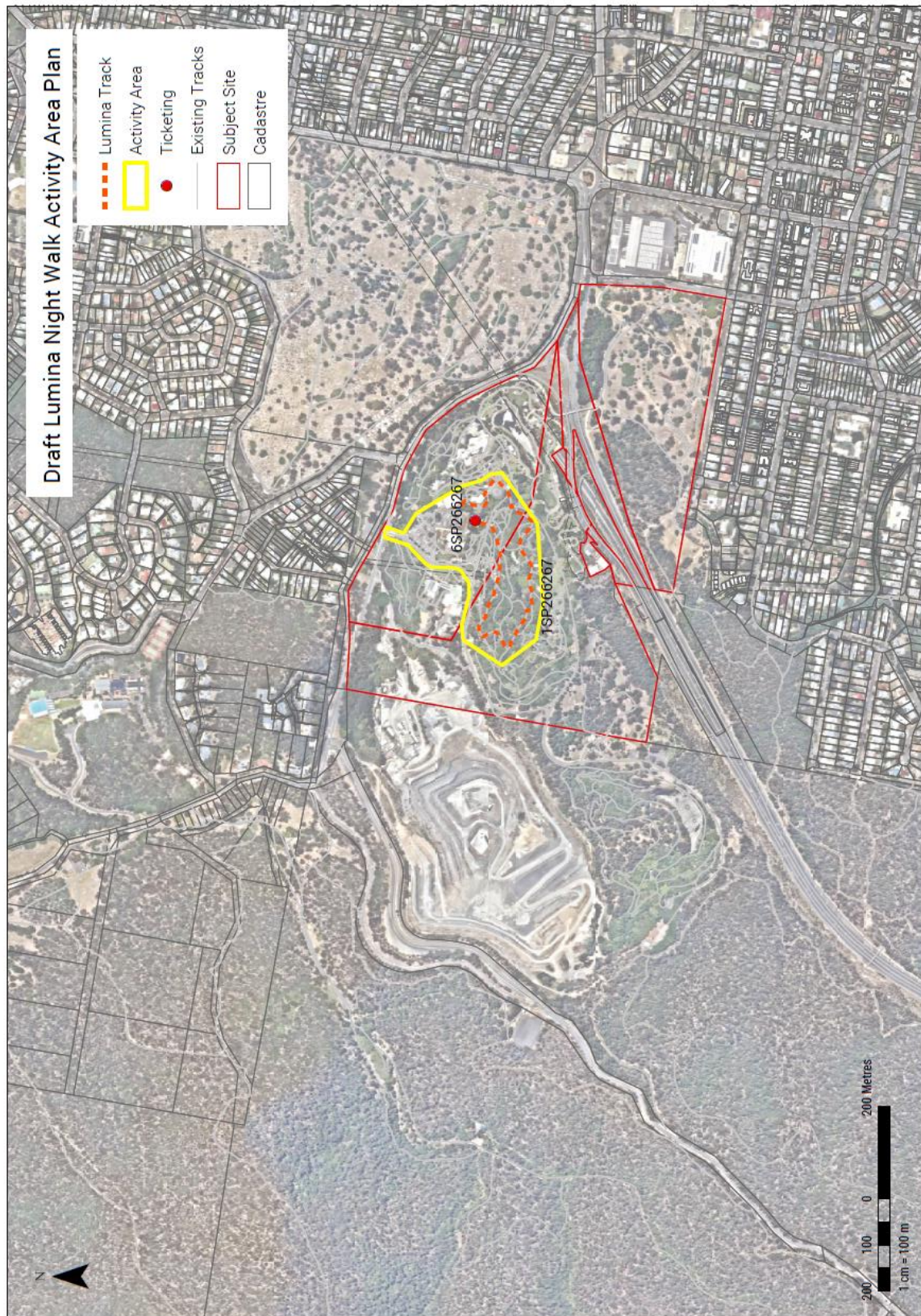
4.3 Discussion

As presented in **Section 4.2** above, noise emissions are forecast to meet criteria at all sensitive zone boundaries during the proposed hours of operation. Calculations represent a conservative layout of Lumina zones, and while the precise speaker locations are yet to be determined (and may move over time), the assessment scenario is considered as a reasonable worst-case layout that encompasses all potential configurations.

It is also noted that the precise music/soundscape material is yet to be determined, and that calculations assume a nominal level of 85 dB(A) at 1m, and typical spectra for amplified music. To ensure that amplified sound achieves the required criteria, it is recommended that on-site testing be conducted to calibrate speaker levels with design calculations once the installation is complete. It is – however – not expected that direct measurement of amplified sound will be possible at sensitive zone boundaries, since noise from existing transport infrastructure is expected to be substantively higher, and to generally mask event noise.

While compliance with criteria is predicted under a worst-case scenario, amplified music can be audible over long distances, depending on meteorological effects and the existence (or otherwise) of masking noise from existing transport infrastructure. To further protect acoustic amenity beyond compliance with mandated criteria, it is recommended that a Noise Management Plan be adopted and implemented for event management. An indicative plan is presented in **Appendix C**, which should be modified/adopted in active consultation with relevant stakeholders, particularly residents located across Mt Coot-Tha Road to the north.

Appendix A: Development Plans



AUDIO REFERENCE

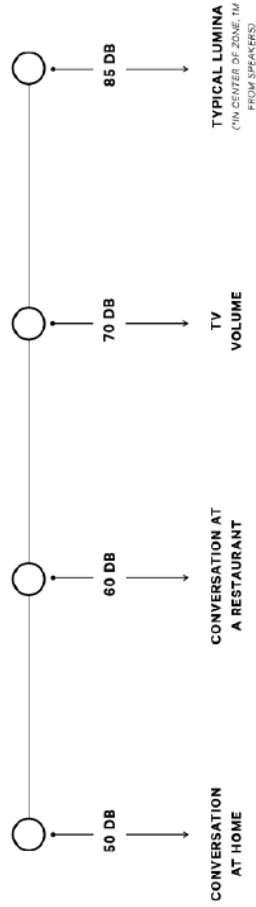
EXAMPLES OF DIFFERENT PRACTICES



SOUND APPROACH AND LIMITATIONS

In terms of DB, a standard Lumina Zone is between 70-85DB with a peak around 85-90DB when measured inside the zone. Without a study, we cannot determine the impact past a 100m, since too many factors can vary the result. We can do this study remotely but strongly suggest an on-site validation.

As a reference, please see indications on decibel level & ideal parameters for a multimedia experience:



DISTANCE & MEASUREMENTS:

Example: A level of 85db at 1m = 50 db at 100m

Appendix B: Environmental Noise Model

Noise levels from the proposed development have been predicted to the closest sensitive receptors using SoundPLAN v8.0 and the prediction methodology ISO 9613-2: 1996. Sound power levels used in the noise model have been sourced from the SoundPlan Emission Library and from various published sources. The noise model includes screening from existing topography and structures. Topographic information was sourced from Geoscience Australia.

All prediction models have limits to their accuracy of prediction. This is due to the inherent nature of the calculation algorithms that go into the design of the models, the assumptions made in the implementation of the model, and the availability of good source sound power data. Various researchers have suggested that an un-calibrated model has an accuracy of ± 5 dB while a calibrated model has an accuracy of ± 2 dB. Calibration means that the model has been established with reference to measured sound levels at a receiver, known source levels and tightly defined propagation variables (wind speed and direction, for example). Alternatively, a series of predictions with different programs but the same assumption variables can be used for verification purposes. This model presents a prediction of a future noise source where validation to a site measurement is not yet possible, the model is therefore considered to be un-calibrated.

Noise Source Levels

The proposed events – “Lumina Night Walks” – consist of audiovisual displays at various locations around a designated walking track. The specific layout of Lumina Zones (discrete stations with amplified sound) are yet to be determined, and may change throughout the life span of the project. Similarly, precise speaker locations and music/soundscape source material is yet to be developed. Preliminary assessment has been conducted under a conservative scenario of 10 stations distributed around the designated track, operating continuously and simultaneously. Speaker source levels of 85 dB(A) at 1m have been adopted and are understood to be typical of previous Lumina events. A line source is also included along the track to represent ambient sound along the entire track at a level of 75 dB(A) SPL. Design reference spectra for amplified music has been adopted as per the *Office of Liquor and Gaming Regulation Guideline 51*.

Other sources of noise identified with the proposed events are patron noise (talking/laughing³) and car park activity⁴. Vehicle movements are based on nominal car and heavy vehicle flows through the car parking area. Noise emissions from these sources have been modelled to sensitive receivers R1 – R7 using the environmental noise model presented in **Appendix B**. Design source levels are presented in **Table B1** below, with noise source locations presented in **Plate B1**.

³ As per Harris, CM, “*Handbook of Acoustical Measurements and Noise Control*” -3rd Ed, Chapter 16.3 (Mc-Graw-Hill Inc)

⁴ Vehicle movements as per the Association of Australasian Acoustical Consultants – *Guideline for Child Care Centre Acoustic Assessment v3.0*, and car door ‘slams’ as per measurements previously undertaken by NMS

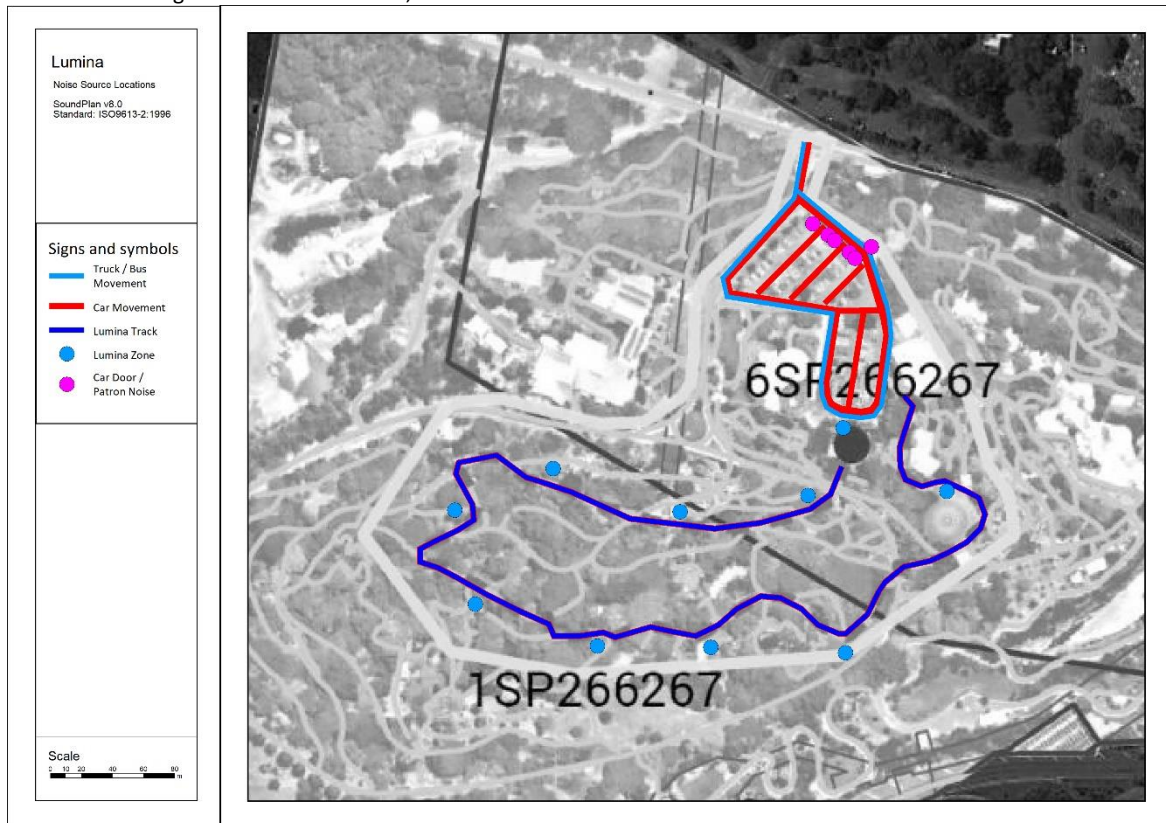
Table B1: Design source sound power levels

Name	Descriptor	Sound Power Levels in dB(Z)								Total in dB(A)
		63 Hz	125 Hz	250 Hz	500 Hz	1 kHz	2 kHz	4 kHz	8 kHz	
Car movements (Leq modelled as 170vph at 20kph)	Leq	74	81	75	72	75	76	72	69	81
	L _{max}	87	94	88	85	88	89	85	82	94
Truck / bus movements (Leq modelled as 8vph at 20kph)	Leq	102	96	92	90	90	86	82	79	94
	L _{max}	114	108	104	102	102	98	94	91	106
Car door 'slam'*	L _{max}	88	92	87	89	92	87	85	83	95
Raised male voice	Leq	49	54	60	63	66	67	65	65	73
Lumina Track (level per metre)	Leq	84	88	79	78	75	74	74	74	83
Lumina zone^	Leq	94	98	89	88	85	84	84	84	93
	L _{max}	104	108	99	98	95	94	94	94	103

* Identified as an impulsive source

^ Identified as a tonal source

Plate B1: Showing noise source locations, as modelled



Sensitive Receptors

The development site is located adjacent to transport infrastructure, quarry and cemetery, which are not classified as sensitive uses or zones under the *City Plan 2014*. Assessment has therefore been conducted to the Residential and Environmental Zone boundaries. Seven sensitive receivers – referred to as R1 to R7 in this Report – have been assessed, representing the most affected locations of these sensitive zone boundaries. The locations of R1 to R7 are presented in **Plate B2** and **Table B2**.

Plate B2: Showing sensitive receivers R1 to R7

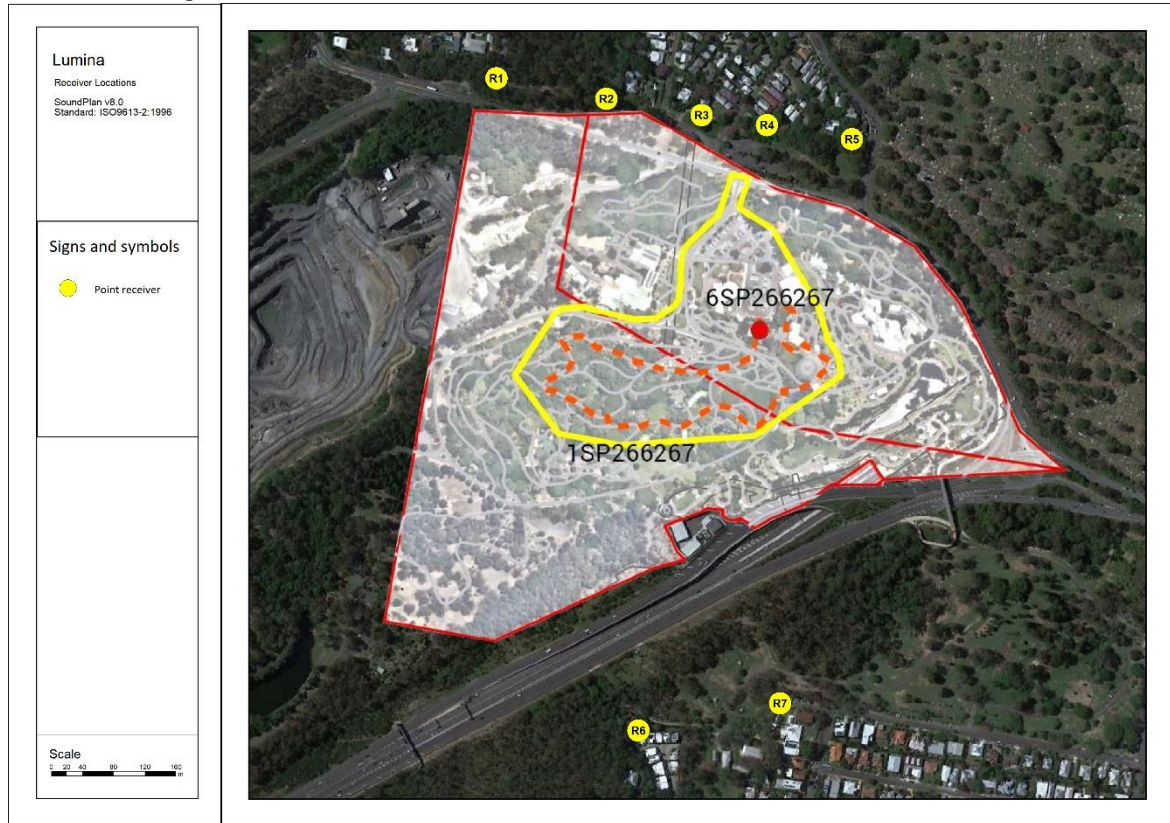


Table B2: Showing sensitive receivers R1 to R7 by Universal Transverse Mercator (UTM)

Receiver	Address	Coordinates		Zone
		Easting	Northing	
R1	47 Old Mt Coot-Tha Road	497432	6961149	EM
R2	360 Birdwood Terrace	497573	6961123	CN1
R3	7 Old Mt Coot-Tha Road	497695	6961102	CR1
R4	26 Ada Street	497695	6961102	CR1
R5	8 Horrocks Street	497888	6961071	CR1
R6	Unit 7, 111 Elizabeth Street	497614	6960312	LDR
R7	257 Broseley Road	497796	6960347	CF4

Weather Conditions

Noise modelling has been made using the prediction methodology *ISO9613-2: 1996* which, by default, presents noise levels at the receiver for meteorological conditions which are favourable for propagation from the sound source to the receiver.

The predicted noise levels are considered to represent the average propagation under meteorological conditions including wind and temperature inversion.

Calculation of Noise Levels

Forecast noise emissions from all sources are presented in **Table B3** below. Visual noise contours are presented in the following **Plates**.

Table B3: Noise emissions forecast (all sources), levels are free-field.

Receiver	Forecast Noise Level		
	$L_{Aeq,adj,T}$	$L_{Ceq,adj,T}$	L_{max}
R1	32	48	37
R2	37	53	44
R3	41	55	52
R4	42	56	53
R5	43	56	47
R6	30	48	22
R7	41	55	34

Plate B3: Noise contours at 1.5m, all sources, levels are in dB(A) Leq.

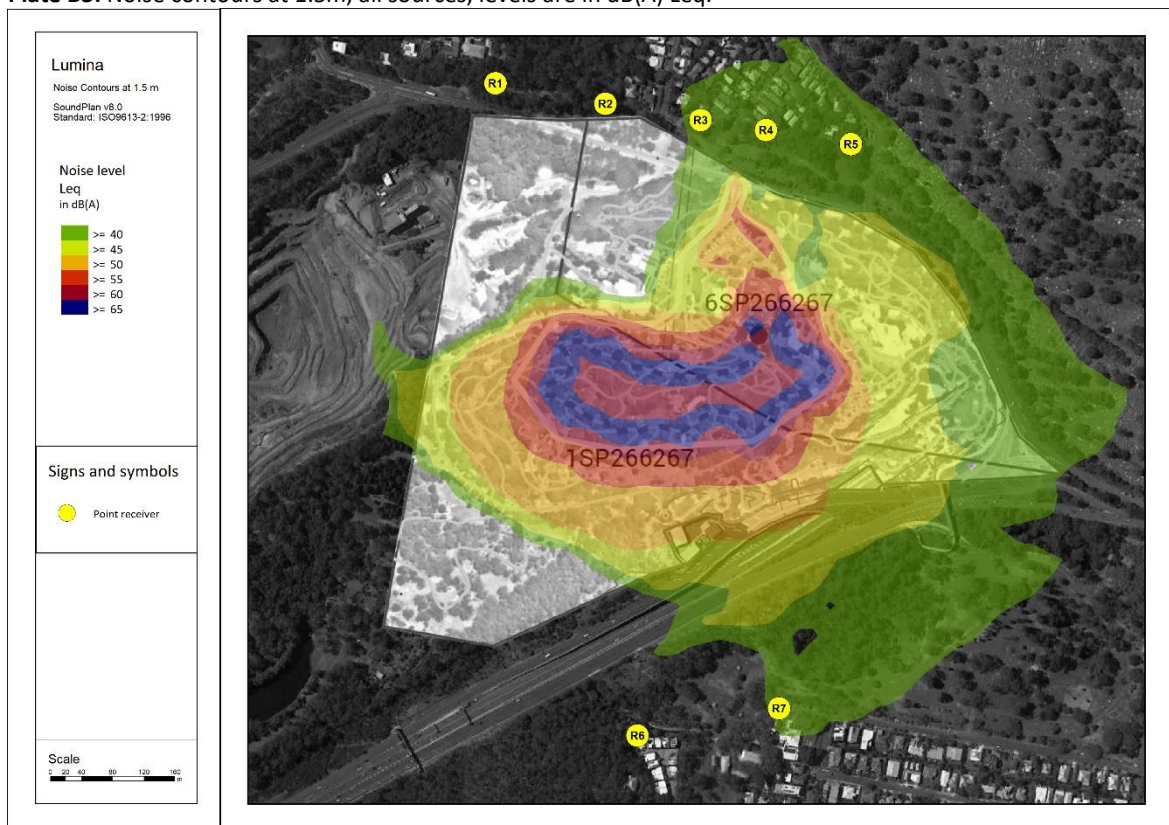


Plate B4: Noise contours at 1.5m, all sources, levels are in dB(C) Leq.

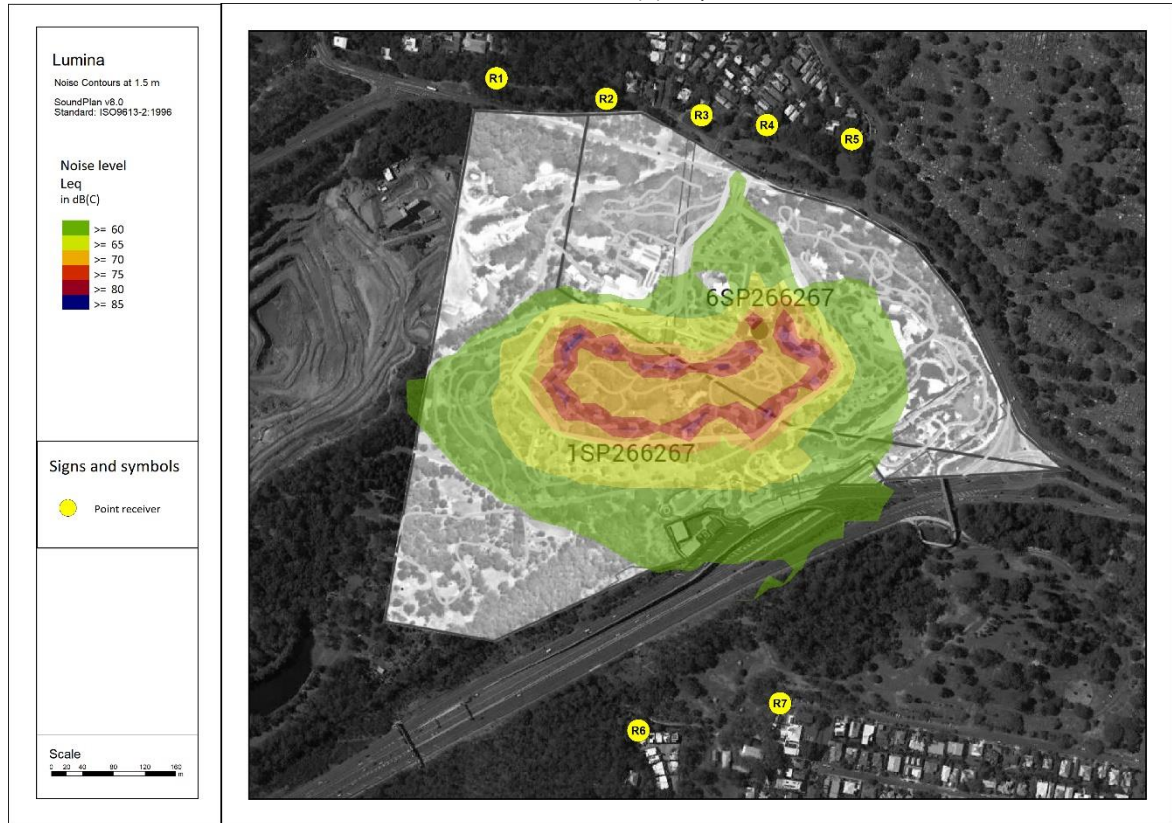
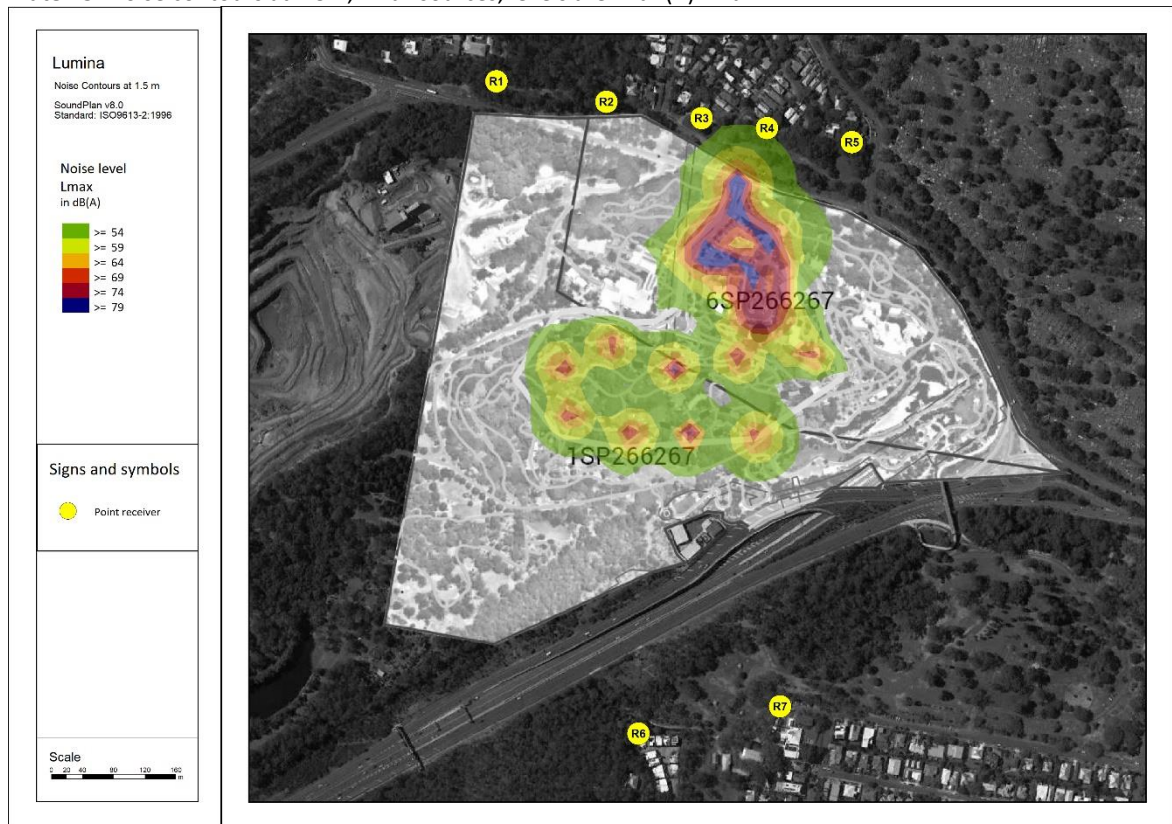


Plate B5: Noise contours at 1.5m, Lmax sources, levels are in dB(A) Lmax.



Appendix C: Indicative Noise Management Plan

Topic	Noise Management
Activity	Lumina Night Walks
Aim of Noise Management Plan	To ensure that noise from the activity does not cause nuisance to the nearby residential areas
Objectives	To minimise noise impacts of the activities carried out on site
Applicable Legislation	<i>Environmental Protection (Noise) Policy 2019</i> <i>Environmental Protection Act 1994</i>
Potential Noisy Activity	Car park activity (vehicle movements/car door ‘slams’) Patron noise (talking/laughing) Lumina zones (amplified music/soundscapes)
Hours of Operation	September to March: 6.00pm – 11.00pm Monday to Sunday (inc. public holidays) April to August: 5:00pm – 11:00pm Monday to Sunday (inc. public holidays).
Performance Indicators	The activities conducted at the premises will not cause adverse impact due to noise on nearby residential uses
Management Measures	Amplified music/soundscapes not exceed a level of 85 dB(A) at 1m from the speakers Abnormally loud patron noise (i.e. shouting) be minimized and actively controlled by event staff Active liaison with potentially affected neighbours be conducted, including contact details for noise complaints
Mitigation Measures	Management shall immediately undertake all mitigation measures if advised of a noise nuisance by either a nearby resident or Council.
Monitoring	Monitoring of sound levels will be carried out at the discretion of management; Monitoring of noise levels will be carried out on an 'on-demand' basis should any complaints be received. A complaints register will be maintained by the responsible person and this register will be made available to the Council if requested.
Reporting of monitoring results	Any necessary monitoring on complaint will be responsive to community concern, and reports will be made available to the Council if requested.
Corrective action	Management shall take appropriate measures as permitted under any tenancy agreement (if in force) should complaints or monitoring results show that a particular occupancy is creating a noise problem.
Responsible Person	The person responsible for the implementation and maintenance of this Plan is the [Manager]. Name:
Review Date	This Noise Management Plan shall be reviewed on a three monthly basis.

Appendix D: Glossary

Ambient sound

All sounds in a locality or “soundscape” from distant and nearby sources or activity including traffic, bird song, vegetation movement in the breeze, and so on.

Assessment Background Level (ABL)

The Assessment Background Level is the single figure background level representing each assessment period (day, evening and night) for each day. It is determined by calculating the 10th percentile (lowest 10th percent) background level (LA90) for each period.

Background sound pressure level (LA90,T), L90

Commonly called the "L90" or "background" level and is an indicator of the quietest times of day, evening or night. The L90 level is calculated as the noise level equalled and exceeded for 90% the measurement time. The level is recorded in the absence of any noise under investigation. The level is not adjusted for tonality or impulsiveness. Also known as the background “noise” level.

Character of the environment

The *character of the environment* is often assessed by third-octave or narrow band analysis of the ambient sound. Sounds may be characterised, for example, as “bangs”, “hum noise”, “plant sounds”, and “high frequency sounds”. The assessment is required to determine intrusive noise, tonality or annoying character.

Equivalent Continuous or time average sound pressure level (LAeq,T), Leq

Commonly called the "Leq" level it is the logarithmic average noise level from all sources far and near and is referenced to a specific measurement time interval; e.g. 15-minutes or 1-hour. The level can be adjusted for tonality.

Immission

The sound energy received at a receptor location. Distinguished from emission, which relates to noise emitted from a location.

LA10

The LA10 level is the noise level which is exceeded for 10% of the sample period. During the sample period, the noise level is below the LA10 level for 90% of the time. The LA10 is a common noise descriptor for environmental noise and road traffic noise.

NMS

Noise Measurement Services Pty Ltd

Rating Background Level (RBL)

The overall, single-figure, background level representing each assessment period (day/evening/night) over the whole monitoring period (as opposed to over each 24-hour period used for the assessment of background level. This is defined as the median value of all the day evening or night assessment background levels.