PLANS AND DOCUMENTS
referred to in the PDA
DEVELOPMENT APPROVAL

Approval no: DEV2024/1502

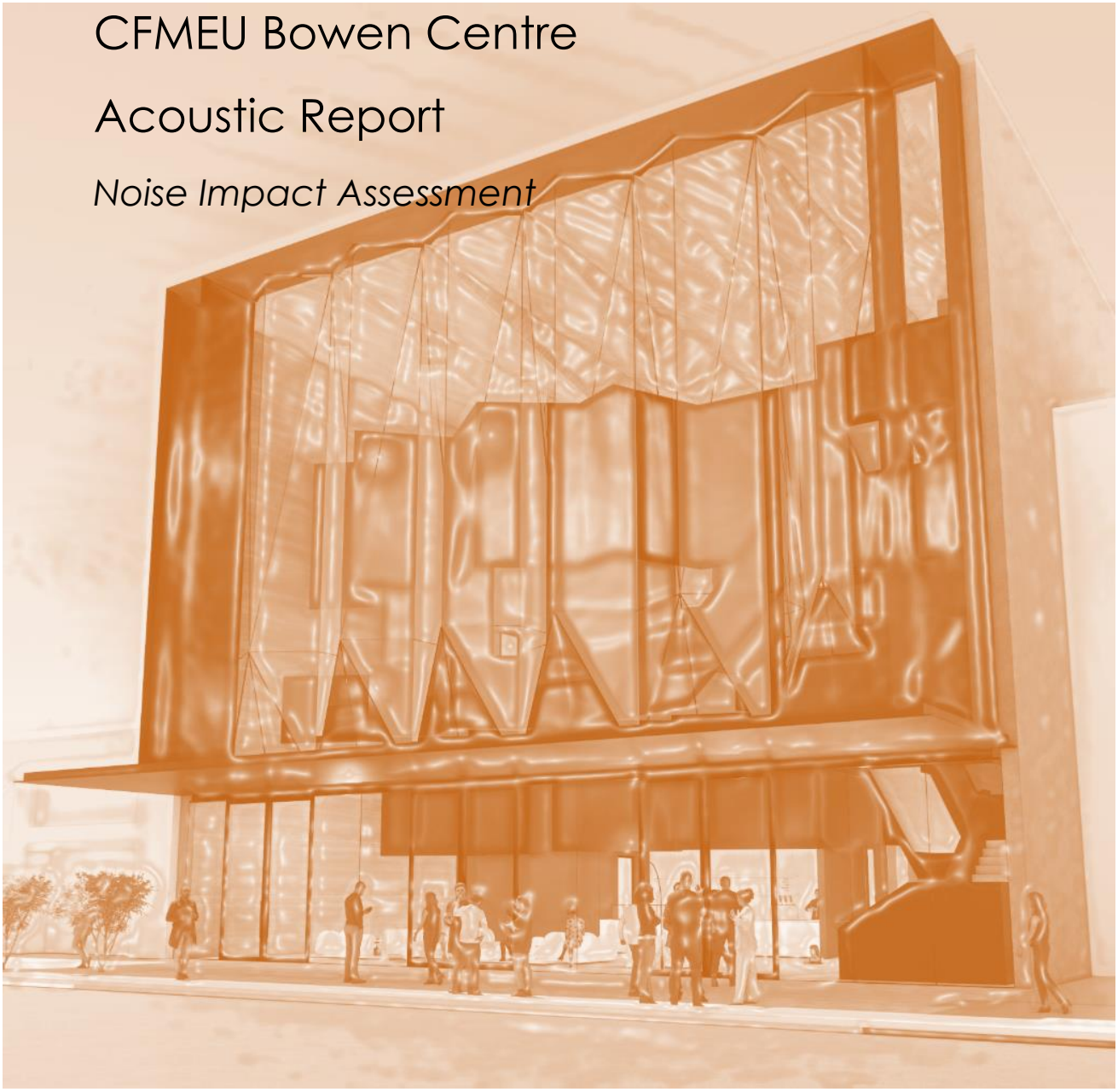
Date: 22 November 2024

Queensland Government

CFMEU Bowen Centre

Acoustic Report

Noise Impact Assessment



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Revision Schedule

Revision No.	Date	Description	Prepared by	Quality Reviewer
001	14/03/2024	NIA – Draft for comment	MK	MLL
002	12/04/2024	NIA – Final	MK	MLL

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Contents

1. Introduction

Stantec Australia Pty Ltd (Stantec) have been engaged by CFMEU to undertake a noise impact assessment for a proposed conference centre. The project site is located at 10-12 Campbell Street, Bowen Hills QLD 4006 and is within the Bowen Hills Priority Development Area.

The purpose of this study is to assess all potential noise impacts associated with the operations of the proposed development against State requirements, and to demonstrate feasibility of the project from an acoustic perspective.

This acoustic services report:

- describes the project site in context with surrounding land uses.
- provides details and results of noise monitoring undertaken for the project.
- establishes environmental noise limits (based on State Legislation and noise monitoring conducted by Stantec in the project area) applicable to noise emissions from the proposed development.
- identifies all assessable noise sources / activities associated with the operations of the project.
- outlines acoustic modelling and calculations undertaken for the project to determine noise impacts on surrounding noise sensitive uses.
- where applicable, provides preliminary recommendations for noise control which are to be further investigated / refined during later design phases of the project.

Acoustic assessment has been informed by existing noise surveying conducted by Stantec in the area, application of relevant Queensland Regulations, Australian Standards and relevant Technical Design Guidelines, as well as Stantec's professional experience within the acoustics field.

A glossary of acoustic terms used in this report a glossary is included in **Appendix A**.

The recommendations made in this report are specific to the building design at the date of issue of this report. The building design is subject to change during the following stages. Where this occurs, the assumptions made to inform the recommendations in the report may no longer be valid; therefore, further advice should be sought to ensure that the acoustic outcomes presented in this report are achieved.

The performance of products referred to in this report are made to meet the acoustic requirements only. It does not consider other aspects, including but not limited to thermal, wind, impact, structural, mechanical, national construction code, security and fire requirements. Relevant discipline reports, drawings and specifications should be referred to for conformance.

This report relates to this specific project and must not be applied to any other project without prior consultation with Stantec. Designs and conditions can vary between projects causing significant variations in acoustic performance and relevant subsequent advice to one project may not apply to another.

This report shall not be relied upon as providing any warranties or guarantees of construction quality regarding acoustics.

2. Referenced Documentation

2.1 Applicable Regulations, Policies, and Standards

The following documents detailed in **Table 1** are relevant to the project and are referred to throughout this report.

Table 1: Applicable Regulations, Policies, and Standards referenced in this report

Title / Document	Abbreviation
REGULATIONS AND LOCAL COUNCIL POLICIES	
Bowen Hills Priority Development Area Development Scheme (Amended 9th December 2022)	Bowen Hills PDA
Brisbane City Council – City Plan 2014 (V29.00 / 2023)	BCC 2014
Office of the Queensland Parliamentary Counsel – Queensland Environmental Protection Act 1994	EPA 1994
Office of the Queensland Parliamentary Counsel – Queensland Environmental Protection (Noise) Policy 2019	EPP 2019
AUSTRALIAN AND INTERNATIONAL STANDARDS	
Australian / New Zealand Standard AS/NZS 2107:2016 – *Acoustics – Recommended design sound levels and reverberation times for building interiors*	AS 2107
Australian Standard AS 1055:2018 – *Acoustics - Description and measurement of environmental noise*	AS 1055

2.2 Study Inputs

Acoustic assessment and the preparation of this report have been conducted based on the following received documentation detail in **Table 2**.

Table 2: Received documentation

Date Received	Detail / Description	Issue / Date Prepared	Prepared by	Format
05/04/2024	Architectural plans: • *13190 Bowen Centre - Architectural Plans for DA 240405*	05/04/2024	Nettletontribe Architects	pdf

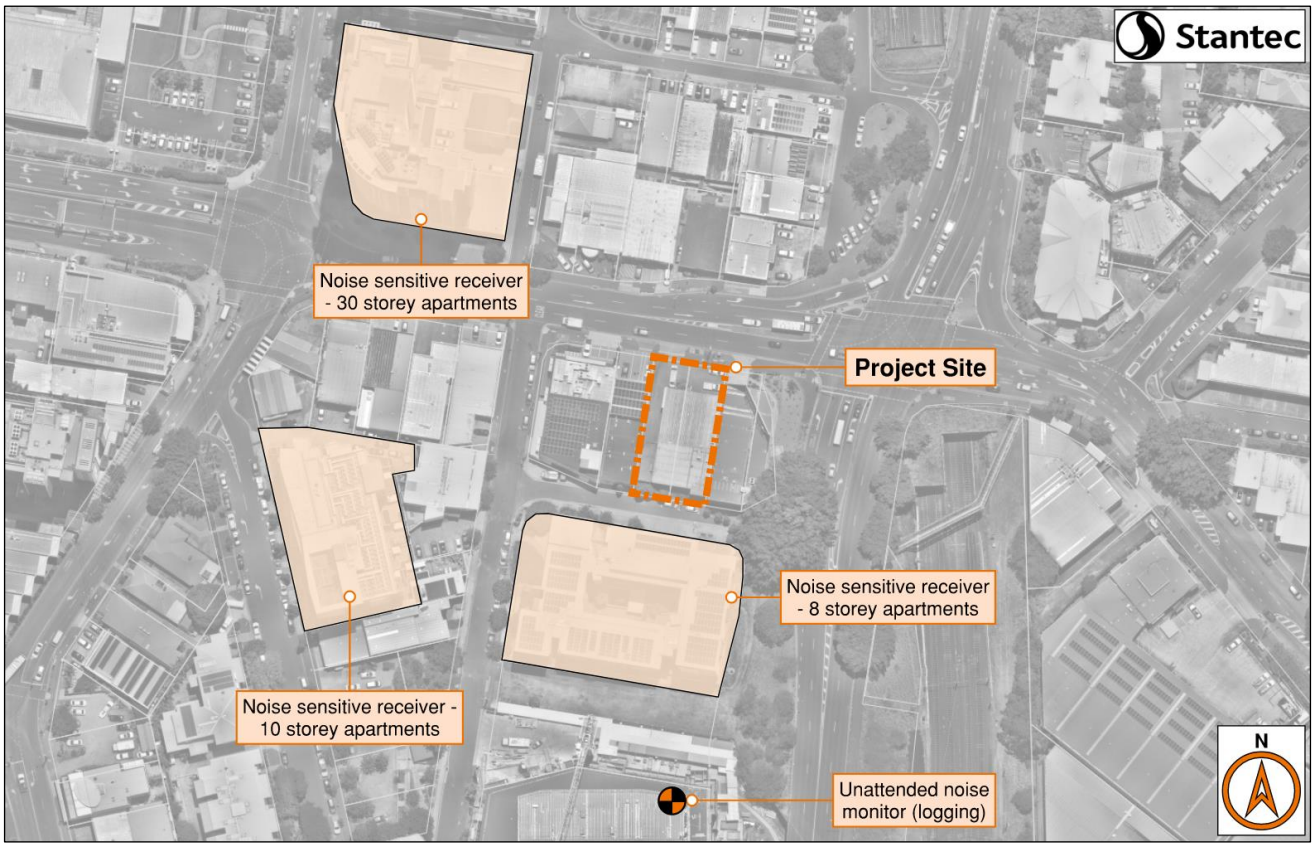
3. Project Details

3.1 Site Description

3.1.1 Project Location

The project site is located at 10 -12 Campbell Street (Lots 4 and 5 on RP10074), Bowen Hills QLD 4006 and is within Bowen Hills Priority Development Area (PDA). The project site has been shown in context with nearest noise sensitive receptors (residential) and noise monitoring locations (conducted by Stantec) in **Figure 1**.

Figure 1: Project site, nearest noise sensitive receptors and noise monitoring locations



Source: Nearmap (image dated 31/10/2023, accessed 06/02/2024)

3.1.2 Surrounding Land Uses / Zoning

The Bowen Hills PDA (link) was accessed and reviewed on the 12th April 2024 to determine existing and proposed land-uses and zoning of the areas surrounding the site (see **Figure 2**). In addition, the Brisbane City Council City Plan 2014 interactive mapping tool (online) was accessed and reviewed on the 6th February 2024 to determine noise corridors impacting the site (see **Figure 3**). The following was identified:

- The project site is zoned Mixed Use;
- Existing land use zones surrounding the proposed site generally consist of:
  - Mixed use;
  - Open space;
  - High density residential.

- The nearest existing noise sensitive residential receptors to the project site are located at;
  - 8 Hurworth St (Lot 0 on SP187495), Bowen Hills 4006;
  - 8 Jeays St (Lot 0 on SP247766), Bowen Hills 4006; and
  - 35 Campbell Street (Lot 0 on SP241573), Bowen Hills 4006.

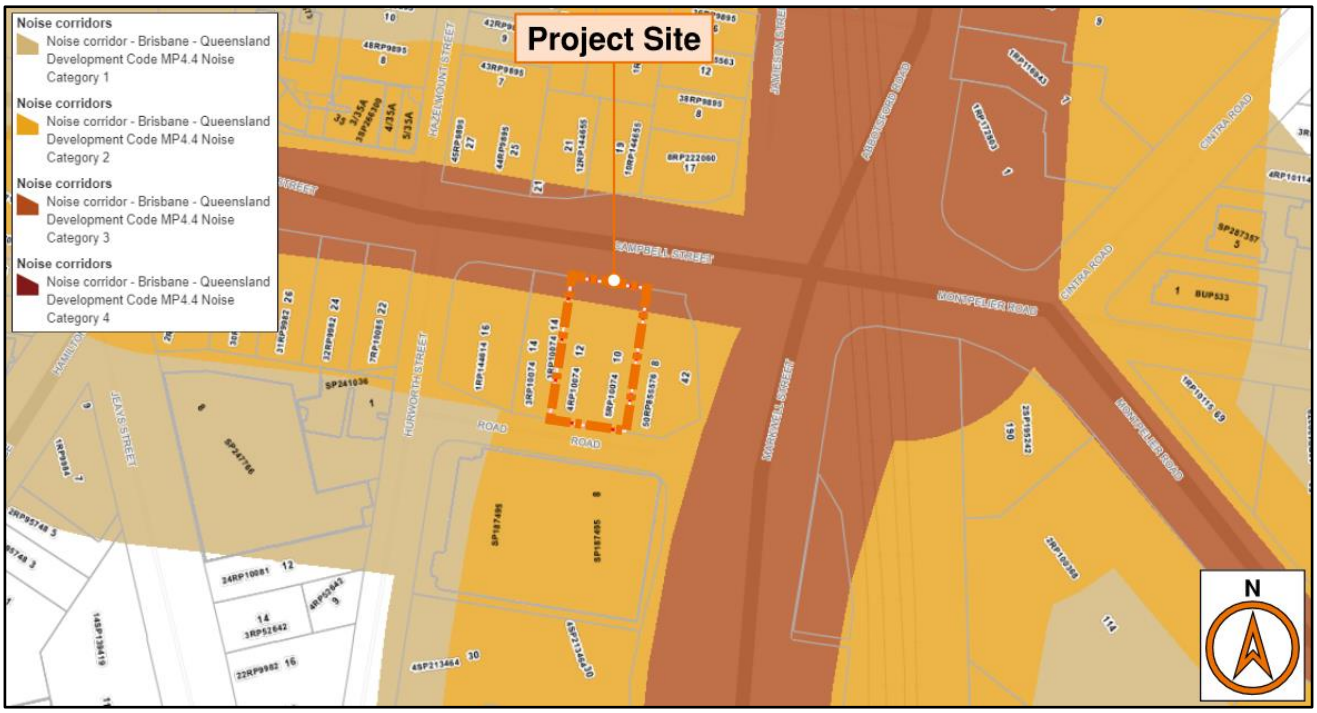
- The project site is not situated within the following noise contour categories;
  - Aircraft Noise Exposure Forecast (ANEF);
  - State designated noise corridor – state controlled road.

- The project site is situated within the following published noise contour categories;
  - Brisbane road noise corridor – up to Queensland Development Code MP4.4 (QDC MP4.4) Noise Category 2 (see **Figure 3**. Note: contours are provided to demonstrate noise exposure levels to road traffic sources of significance. The acoustic requirements set by QDC MP4.4 apply to habitable rooms of Class 1, 2, 3 and 4 (i.e., residential) buildings located in a transport noise corridor and are not considered applicable to this project.
  - State designated noise corridor – rail network, up to Category 0: <70 dB(A). The site is not located within 25m of the rail corridor and does not require assessment under SDAP. In addition, The acoustic requirements set by State Development Assessment Provisions (v3.0) State Code 2 Development in a railway environment apply to accommodation activities, childcare centres, educational establishments and hospitals and are not considered applicable to this project.

Figure 2: Land use / zoning surrounding the project site

Source: Bowen Hills PDA Development Scheme (link) | Map 6: Zone Plan

Figure 3: Noise corridor (road) – Brisbane



Source: Brisbane City Council City Plan 2014 interactive mapping tool (online) | Noise corridor – Brisbane overlay

3.2 Proposed Development

Based on the received architectural plans detailed in **Table 2**, the following architectural volumes and proposed uses detailed in **Table 3** have been identified.

Table 3: Proposed building layout and associated uses

Floor	Proposed Uses	
Lower Ground	• 18 carparks	• Loading Bay
Upper Ground	• Conference Hall • Back of House • Store / AV control • Bar	• Foyer • Kitchen • Male/Female Toilets
Level 1	• Control Room • Corporate Box • Private/Parents Room • Store Room	• Event Office • Mezzanine • PWD
Roof Terrace	• Roof Terrace Lobby • Outdoor Roof Terrace • Amenities	• Kitchen • Roof Plant / Store Room

3.3 Site Noise Survey (Noise Monitoring)

To quantify the existing noise environment on site and specify noise limits, data from previous unattended noise monitoring (noise logging) conducted by Stantec from Thursday 9th to Wednesday 15th September 2021 (inclusive). The indicative location of the noise monitoring location has been shown in **Figure 1**. Although this data is 2 years old it provides a conservative representation of the existing noise climate at the site.

Noise measurements were conducted following guidance from Australian Standard AS 1055:2018 – *Acoustics – Description and measurement of environmental noise*, and the instruments were configured as follows:

- A-weighting frequency response;
- FAST time response; and
- 15-minute intervals.

The sound level meter was calibrated before and after the measurement period. The instrument showed a drift less than ±1 dB during the course of monitoring; therefore, measurements are considered valid according to AS 1055:2018.

A summary of relevant of the average unattended noise levels recorded at the measurement location from Thursday 9th to Wednesday 15th September 2021 (inclusive) are presented in **Table 4**. For further details and full measured results, refer to **Appendix B**. This data was deemed suitable for assessment of the project as the built environment has not changed significantly since the original logging was completed. In addition, background noise levels are likely higher closer to the project site due to the proximity to Campbell Street, therefore utilising this data results in a conservative assessment of noise emissions from the project.

Table 4: Summary of relevant noise descriptors used to determine noise limits and inform acoustic assessment

Monitoring location	Measurement parameter	Sound level measured during the period [1] dB(A)			
		Day	Evening	Night	18-hour
001	Equivalent continuous noise level – $L_{Aeq,T}$	58	57	54	—
	Equivalent maximum continuous noise level over a 1 hour period – $L_{Aeq,max(1hr)}$	60	58	58	—
	Loudest 10% of period (traffic noise) – L_{A10}	60	59	53	60
	Background noise level – L_{A90}	51	49	45	—
	Rating background level – RBL	50	49	42	—

NOTES:

1) Day – 7am-6pm | Evening – 6pm-10am | Night – 10pm-7am | 18-hour – 6am-12am

4. Acoustic Criteria

4.1 Bowen Hills PDA - Development Scheme Requirements

The Bowen Hills Priority Development Area (PDA) Development Scheme December 2022 provides requirements for acoustic assessment of developments within the Bowen Hills PDA.

In relation to the impacts from railways, Section 2.5.9.1 of the Development Scheme PDA states:

> *vi. "Development ensures the community is protected from significant adverse impacts resulting from environmental emissions generated by a railway (refer to the Queensland Government Development Assessment mapping system and the State Development Assessment Provisions – State Code 2: Development in a railway environment)."*

In relation to noise from transport noise corridors, the requirements in Section 2.5.9.3 of the Development Scheme are reproduced below:

> *"Development is oriented, designed and constructed to:*
>
> *i. Reduce the exposure to noise impacts from designated transport noise corridors (refer to the Brisbane City Plan Transport Noise overlay map); and*
>
> *ii. Reduce the exposure of residential uses to noise impacts from lawfully operating entertainment venues (A building is designed and constructed to achieve a minimum reduction in sound pressure level between the exterior of the building and the bedroom or living room, of $L_{eq,T}$ 20dB at 63Hz where adjoining a law fully operating entertainment venue. Residents living near lawfully operating entertainment venues also need to be aware that noise levels will be relatively higher both inside and outside of residences.*

Based on the above, the following would apply:

- **Rail traffic:** Queensland Government Development Assessment mapping system and the State Development Assessment Provisions – State Code 2: Development in a railway environment. As the development is impacted by Noise Category 0 rail noise no further assessment is deemed necessary;
- **Road traffic:** The project site is not located inside a State designated noise corridor (i.e. state controlled road). Whilst located within a Brisbane Noise corridor, BCC requirements only apply for the protection of residential buildings through application of Queensland Development Code MP4.4. Residential uses are not proposed for the Bowen Centre; therefore, a road traffic impact assessment is not a mandatory requirement.

As the PDA does not provide criteria for environmental noise emissions. It is proposed that noise limits are applied using the Brisbane City Plan 2014 and QLD Environmental Protection Act 1994 as applied by other similar PDA Development Schemes.

4.2 Environmental Noise Emissions

4.2.1 Brisbane City Council – City Plan 2014

As noted in **Section 3.1.2** and in accordance with the Bowen Hills PDA, the proposed development is zoned Mixed use with surrounding receivers also zoned Mixed use. Hence, it would be required to comply with any acoustic requirements set under 7.2.2.2 Bowen Hills neighbourhood plan code and 9.3.3 Centre or mixed use code.

The Bowen Hills neighbourhood plan code does not provide a specific noise criteria so the criteria provided in 9.3.3 Centre or mixed use code have been adopted in order to avoid impacting environmental values and mitigate acoustic impacts on adjacent developments.

Noise (planning) criteria

The applicable noise planning criteria from the *centre or mixed-use zone code* (Table 9.3.3.3.F) has been reproduced in **Table 5**.

Table 5: Noise (planning) criteria (Table 9.3.3.3.F, City Plan 2014)

Criteria Location	Intrusive Noise Criteria	Acoustic Amenity 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	Day, evening and night $L_{Aeq,adj,T}$ are not greater than the values in the columns below for the relevant criteria location, where T equals: • day – 11hr • evening – 4hr • night – 9hr		
		Day	**Evening**	**Night**
At a sensitive use in the Mixed use zone	5 dB(A)	60 dB(A)	55 dB(A)	50 dB(A)

Low frequency noise criteria

Low frequency noise emissions from the proposed development shall comply with the acoustic performance criteria outlined in **Table 6**.

Table 6: Low frequency noise criteria (Table 9.3.3.3.G, City Plan 2014)

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
At a sensitive use in the Mixed use zone	75 dB(C)	75 dB(C)	70 dB(C)

Night-time noise criteria

The relevant night-time noise criteria outlined by *Table 9.3.3.3.H* of the City Plan 2014 has been reproduced in **Table 7**.

Table 7: Night-time noise criteria (Table 9.3.3.3.H, City Plan 2014)

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
Mixed use zone	Not applicable	65 dB(A)	70 dB(A)

4.2.2 Queensland Environmental Protection Act 1994

The objective of the Queensland Environmental Protection Act 1994 (EPA 1994) is *"to protect Queensland's environment while allowing for development that improves the total quality of life, both now and in the future, in a way that maintains the ecological processes on which life depends."*

To uphold this intent, and of relevance to acoustic assessment for the project, the EPA 1994 defines a series of noise-related standards in Chapter 8, Part 3B Offences relating to noise standards. The following sections are considered applicable:

Section 440R Building work

(1) A person must not carry out building work in a way that makes an audible noise—
- *(a) on a business day or Saturday, before 6.30a.m. or after 6.30p.m; or*
- *(b) on any other day, at any time.*

(2) The reference in subsection (1) to a person carrying out building work—
- *(a) includes a person carrying out building work under an owner-builder permit; and*
- *(b) otherwise does not include a person carrying out building work at premises used by the person only for residential purposes.*

Section 440U Air-conditioning equipment

(1) This section applies to premises at or for which there is air-conditioning equipment.

(2) An occupier of the premises must not use, or permit the use of, the equipment on any day:
- *(a) before 7am, if it makes a noise of more than 3dB(A) above the background level [1]; or*
- *(b) from 7am to 10pm, if it makes a noise of more than 5dB(A) above the background level; or*
- *(c) after 10pm, if it makes a noise of more than 3dB(A) above the background level.*

[1] *NOTE: According to the EPA 1994:*
- *Background level means the background A-weighted sound pressure level under the prescribed standard measured as $L_{A90,\,T}$.*
- *$L_{A90,T}$ means the A-weighted sound pressure level obtained using time weighting 'F' that is exceeded for 90% of the measuring period (T).*

4.2.3 Summary of Environmental Noise Emission Limits

The noise criteria for the Project detailed in **Section 4.2** applies to all forms of noise emissions from the proposed development. The applicable noise limits at sensitive receptors are obtained when the noise criteria is combined with the measured noise levels as summarised in the tables below.

Table 8: Operational environmental noise limits

Location	Noise Criteria, dB(A)	Noise limit at the receptor, dB(A)		
		Day (7 AM – 6 PM)	Evening (6 PM – 10 PM)	Night (10 PM – 7 AM)
City Plan 2014 – Intrusive Noise (planning) Criteria				
At a sensitive use in the Mixed use zone	Measured RBL	50	49	42
	Permitted increase above RBL	+5	+5	+5
	Noise limit external to sensitive use, $L_{Aeq,T}$	**55**	**54**	**47**
City Plan 2014 – Acoustic Amenity Criteria				
At a sensitive use in the Mixed use zone	Noise limit external to sensitive use, $L_{Aeq,T}$	60	55	50
Most Stringent Noise Limits				
Noise limit external to sensitive use, $L_{Aeq,T}$		**55**	**54**	**47**

Table 9: Night-time noise criteria

Criteria location	$L_{Aeq,9hr\ night}$	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
Mixed use zone	N/A	65 dB(A)	70 dB(A)

Table 10: Mechanical noise limits

Location	Noise Criteria, dB(A)	Noise limit at the receptor, dB(A)		
		Day (7 AM – 6 PM)	Evening (6 PM – 10 PM)	Night (10 PM – 7 AM)
EPA 1994 – Mechanical Plant Noise Limits				
Sensitive use not associated with the development	Measured L_{90}	51	49	45
	Permitted increase above L90	+5	+5	+3
	Noise limit external to sensitive use, $L_{Aeq,T}$	**56**	**54**	**48**

5. Acoustic Assessment

5.1 Onsite Carpark Noise Emissions

Noise from carpark activities has the potential to affect the acoustic amenity for offsite sensitive receivers, therefore, assessment of car park movements was completed to determine acoustic treatments required to comply with the applicable criteria. Assessment to 35 Campbell Street was deemed unnecessary as the carpark is enclosed on the east, north and west sides blocking these noise sources to this receiver.

Point source calculations of carpark noise included the following inputs and assumptions:

- The site will operate 24 hours a day.
- The shortest distance along the travel path for each point source to the receiver was used.
- To assess worst case, it is assumed that the entire carpark will fill and empty each hour.
- Source noise levels based on the inputs provided in **Table 11**.

Table 11: Carpark noise calculation inputs

Noise Source	L_{max} Sound Pressure dB(A) @1m	L_{eq} Sound Pressure dB(A) @1m	Duration	Events / Hr
Car passby	81	75	10 seconds	18
Car door close	86	80	1 second	36
Car start	84	78	2 seconds	18

5.1.1 Intrusive Noise and Acoustic Amenity Criteria Assessment (L_{eq})

A noise emissions assessment was conducted based on the inputs outlined above with the predicted noise levels at the nearest sensitive receiver provided in **Table 12** and compared against the strictest criteria across all time periods ($L_{Aeq,adj,T}$ 45dB(A)).

Table 12: Predicted L_{eq} noise impacts to offsite receivers from onsite carpark movements

Receptor	Noise source	Individual noise impacts dB(A)	Combined Noise impact dB(A)	Complies with BCC 2014 strictest applicable noise criteria for all time periods - $L_{eq,adj,t}$ 47 dB(A)?
8 Hurworth Street	Car passby	40	41	Yes
	Car door close	31		
	Car start	29		
8 Jeays Street	Car passby	23	26	Yes
	Car door close	20		
	Car start	18		

The carpark is predicted to comply with BCC intrusive noise and acoustic amenity criteria without the need for additional acoustic treatment.

5.1.2 Nighttime Noise Criteria Assessment (L_{max})

Assessment of L_{max} events was conducted based on the inputs provided in **Table 11** with the predicted noise levels at the nearest sensitive receivers provided in **Table 13**. Note that L_{max} for door closures is greater than car starts with the same separation distances to the receiver, therefore, provided door closures comply then car starts will also comply.

Table 13: Predicted L_{max} noise impacts to offsite receivers from onsite carpark movements

Receptor	Noise source	Noise impacts L_{max} dB(A)	Complies with BCC 2014 night noise criteria - L_{max} 65 dB(A)?
8 Hurworth Street	Car passby	59	Yes
	Car door close	57	Yes
8 Jeays Street	Car passby	42	Yes
	Car door close	46	Yes

The carpark is predicted to comply with the nighttime L_{max} criteria without the need for additional acoustic treatment.

5.2 Noise Emissions – Loading Bay

5.2.1 Assessment Inputs

Noise emissions from the loading bay will be required to comply with the environmental noise limits outlined in the acoustic criteria section of this document. Based on the current architectural layouts, the loading dock opens to the south, with residential receivers south and west of the opening.

The following inputs were included in acoustic assessment of loading dock impacts to nearby sensitive receivers:

- Deliveries will occur Monday to Sundays during day hours only (i.e. 7am – 10pm).
- Based on the advice from the client Medium Rigid Vehicles will be accommodated within the loading dock. Given the proposed use of the development, it is expected that trucks with refrigeration will deliver to the site for catering purposes.
- Delivery vehicles will arrive to the site with the trucks main motor operating for no longer than 30 seconds before being shut off.
- Vehicle fridge motors are expected to continue running for up to 5 minutes to assist in keeping food cool while unloading.
- Up to three (3) deliveries expected to occur during the day and one (1) in the evening.
- Unloading of vehicles will occur by manual handling over a 15 minute period (i.e. no forklifts).

Typical noise levels (overall sound power levels – Lw, dB(A)) associated with loading dock activities are provided in **Table 14**.

Table 14: Loading dock modelling noise levels

Loading Dock Activity	Sound Power Level – Lw dB(A)
Truck MRV	94
Refrigeration Motor (1)	94
Hand unloading (no forklifts)	80

NOTES:

(1) Based on previous measurements completed by Stantec of a semi-trailer refrigeration truck motor.

5.2.2 Predicted Noise Levels – Loading Dock

A noise emissions assessment was conducted based on the inputs outlined above with the predicted noise levels at the nearest sensitive receiver provided in **Table 15** and compared against the day and evening criteria.

Table 15: Predicted L_{Aeq} noise impacts to offsite receivers from loading dock

Receptor	Noise source	Individual noise impacts dB(A)		Combined Noise impact Day dB(A)		Complies with BCC 2014 noise criteria?	
		Day	Eve	Day	Eve	Day ($L_{Aeq,t}$ 55 dB(A))	Eve ($L_{Aeq,t}$ 54 dB(A))
8 Hurworth Street	Truck MRV	39	38	49	49	Yes	Yes
	Refrigeration Motor (1)	48	48				
	Hand unloading (no forklifts)	39	38				
8 Jeays Street	Truck MRV	21	20	31	30	Yes	Yes
	Refrigeration Motor (1)	30	30				
	Hand unloading (no forklifts)	21	20				

Compliance is predicted for the loading bay provided deliveries occur within the day and evening time periods (7am – 10pm).

5.3 Noise Emissions – Conference Centre

The upper ground floor of the conference centre includes a foyer area with bar and auditorium with the potential to produce noise that could negatively impact nearby sensitive receivers. To assess these spaces the following construction was assumed for façade components and used in calculations of noise travelling from the conference centre and foyer to nearby sensitive receivers.

Table 16: Assessed façade noise attenuation losses

Component	R_w	125 Hz	250 Hz	500 Hz	1kHz	2kHz	4kHz	8kHz
200mm concrete panels	59	44	47	54	61	66	71	65
6.38mm laminate glazing	33	21	25	29	34	35	41	35

The upper ground foyer/bar area is enclosed on the south side by the auditorium with assumed 200mm concrete panel façade shown for the east and west sides. The north façade of the foyer includes fixed glazing with entry doors that are assumed to remain closed while events are occurring.

The auditorium enveloped was assessed as 200mm thick concrete panels on the south and east with the west side enclosed by a corridors and rooms. Worst case noise emissions from the conference hall are predicted to emanate from the south and east façade walls.

5.3.1 Crowd Noise Levels

Calculation of noise from crowds in the foyer and on the rooftop terrace was completed using the following formulae. Source noise levels for presenters within the auditorium utilises the average noise spectra from **Table 17** normalised to a sound power level of 100 dB(A) to represent sound through amplified speakers.

Maximum Sound Power Levels

Crowd noise generally consists of two acoustic components: steady-state noise (L_{Aeq}) of patrons in various groups talking, and the occasional increase in noise due to patrons laughing or calling-out (L_{A1} or L_{Amax}). Generally, the impact of the latter tends to be drowned out as patron numbers increase and, based on an Australian published research paper on crowd noise by Hayne et al. (Nov 2011) [2], it is anticipated that the noise emission levels from laughs and exclamations will only be marginally above the steady noise of conversations.

Hayne et al. details the methods for determining the maximum sound power level associated with various patron numbers, summarised below;

Equation 1:

$$L_{WAeq} = 15logN + 64\ dB(A)$$

Equation 2:

$$L_{WA01} = 11logN + 77\ dB(A)$$

Whilst Hayne et al. states that the formulated source noise levels are attributable to crowds of ≤ 100 patrons, similar source noise level estimates are determined using alternative methods, such as those published by Rindel [3].

Crowd Noise Spectra

Crowd noise spectra compositions shown in **Table 17** included in the noise model were based on the values presented in Figure 2 of Hayne et al. (based on Pearsons et al. 1977 [4]). For each assessment scenario, 50% male and 50% female were considered. The spectral values were then normalised to Equation 1 above.

Table 17: Crowd noise spectra compositions based on gender and vocal effort

Gender and Vocal Effort	Octave band sound pressure levels, dB(A)					
	250 Hz	500 kHz	1 kHz	2 kHz	4 kHz	8 kHz
Male – loud	58	62	65	69	70	70
Female – loud	51	53	58	61	63	64

Reverberant Room Effects on Source Noise Levels

For noise within the indoor dining, the reverberant sound pressure levels occurring within the space was calculated based on Equation 3 below:

Equation 3:

$$L_{p(rev)} = L_w + 14 - 10\log(V) + 10log(T)$$

Reverberant sound pressure levels used for calculation of noise emissions are provided in **Table 18**.

[2] *Prediction of Noise from Small to Medium Sized Crowds* (AAS Paper No. 133), M.J. Hayne et al., AAS Conference November 2011.

[3] *The Acoustics of places for social gatherings*, J.H. Rindel Conference: EuroNoise 2015, Maastricht, Netherlands, June 2015.

[4] *Speech Levels in Various Noise Environments* (EPA-600/1-77-025), Pearsons et al., U.S. Environmental Protection Agency, May 1977.

Table 18: Reverberant sound pressure levels

Location	Source	Linear Octave Band Reverberant Sound Pressure Level (L_{eq}, dB)						Total Reverberant Sound Pressure Level – L_{eq} dB(A)
		250 Hz	500 Hz	1kHz	2kHz	4kHz	8kHz	
Foyer	100 person crowd	70	69	69	71	73	75	79
Auditorium	Presenter at podium using microphone into amplified speakers	73	71	71	74	75	78	81

5.3.2 Calculated Noise Impacts

Noise impacts to the nearest sensitive receivers were calculated using the above inputs with the results presented in **Table 19**.

Table 19: Predicted L_{Aeq} noise impacts to offsite receivers from ground floor uses

Receptor	Noise source	Individual noise impacts dB(A)	Combined Noise impact dB(A)	Complies with BCC 2014 strictest noise criteria $L_{eq,adj,t}$ 47 dB(A) for night?
8 Hurworth Street	Auditorium	17	17	Yes
	Foyer	<10		
35 Campbell Street	Auditorium	<10	19	Yes
	Foyer	19		

Noise from the auditorium and foyer is predicted to comply with the noise limits with the foyer entry doors closed during events and the assumed facade construction provided in **Table 16**. Alternative construction may be used on the basis that the façade provides sufficient attenuation to comply with the relevant noise limits.

5.4 Noise Emissions – Roof Terrace

Assessment of the rooftop terrace was completed with patron distribution and proposed treatments as shown in **Figure 4**. Details of the attenuation losses used from different elements in the assessment are provided in **Table 20**. Amplified music has not been proposed for this space.

Figure 4: Patron distribution and treatments used for assessment of rooftop terrace

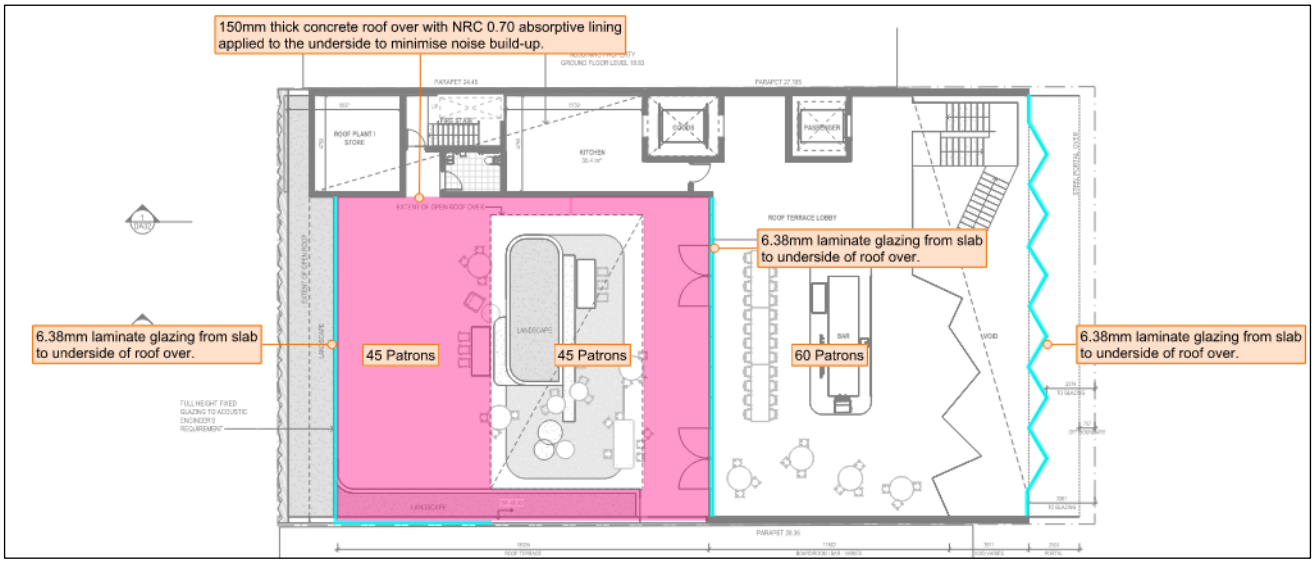


Table 20: Assessed roof and glazed wall noise attenuation losses

Component	R_w	125 Hz	250 Hz	500 Hz	1kHz	2kHz	4kHz	8kHz
150mm concrete roof	54	44	42	49	57	63	68	60
6.38mm laminate glazing	33	21	25	29	34	35	41	35

5.4.1 Intrusive Noise and Acoustic Amenity Criteria Assessment (L_{eq})

The relevant sound power levels used for calculation of noise emissions from the terrace patrons was derived from equation 1 in **Section 5.3.1** and are provided in **Table 21.**

Table 21: Roof terrace sound power levels

Location	Source	Linear Octave Band Sound Power Level (L_{eq}, dB)						Total Sound Power Level – L_{eq} dB(A)
		250 Hz	500 Hz	1kHz	2kHz	4kHz	8kHz	
Roof lobby/bar	60 patrons	82	80	80	83	84	87	91
Open and enclosed portions of roof terrace	45 patrons	80	79	79	81	83	85	89

5.4.2 Calculated Noise Impacts

Noise impacts to the nearest sensitive receivers were calculated using the above inputs with the results presented in **Table 22**.

Table 22: Predicted L_{eq} noise impacts to offsite receivers from roof terrace and bar

Receptor	Noise source	Individual noise impacts day/eve dB(A)	Combined noise impacts dB(A)	Complies with BCC 2014 strictest noise criteria $L_{eq,adj,t}$ 47 dB(A) for night?
8 Hurworth Street	Roof Terrace Lobby	28	46	Yes
	Patrons under roof of outdoor terrace	31		
	Patrons under roof opening of outdoor terrace	46		
35 Campbell Street	Roof lobby/bar	15	35	Yes
	Patrons under roof of outdoor terrace	<10		
	Patrons under roof opening of outdoor terrac	35		

The rooftop terrace and bar is predicted to comply with the Project noise limits on the basis that the roof terrace is partially enclosed as shown in **Figure 4**.

5.4.3 Nighttime Noise Criteria Assessment (L_{max})

Assessment of L_{max} events was conducted based on the worst-case noise source from the intrusive noise and amenity assessment completed in **Section 5.4.2**. For both receivers this was the patrons located in the open outdoor terrace space. The relevant sound power level used for calculation of noise emissions from the open roof terrace patrons was derived from equation 2 in **Section 5.3.1** and are provided in **Table 23**.

Table 23: Open roof terrace L_{max}

Location	Source	Linear Octave Band Sound Power Level (L_{max}, dB)						Total Sound Power Level – L_{max} dB(A)
		250 Hz	500 Hz	1kHz	2kHz	4kHz	8kHz	
Open roof terrace	45 patrons	90	89	89	91	93	95	99

5.4.4 Calculated Noise Impacts

L_{max} noise impacts to the nearest sensitive receivers were calculated using the above inputs with the results presented in **Table 24**.

Table 24: Predicted L_{max} noise impacts to offsite receivers from open roof terrace

Receptor	Noise source	Noise impacts L_{max} dB(A)	Complies with BCC 2014 night noise criteria L_{max} 65 dB(A)?
8 Hurworth Street	Open roof terrace	56	Yes

Receptor	Noise source	Noise impacts L_{max} dB(A)	Complies with BCC 2014 night noise criteria L_{max} 65 dB(A)?
35 Campbell Street	Open roof terrace	45	Yes

The roof terrace is predicted to comply with the nighttime L_{max} criteria on the basis that the roof terrace is partially enclosed as shown in **Figure 4**.

5.5 Noise Emissions – Building Services Plant

5.5.1 Assessment Inputs and Assumptions

Noise emissions from proposed equipment selections are required to comply with the environmental noise limits outlined in **Table 10**.

Given the current stage of the project, the type of mechanical services plant have not been proposed and, therefore, detailed calculations of proposed selections could not be conducted. In lieu of this information, a calculation was conducted based on first principle formulation to estimate the maximum sound power level (L_w) for combined plant which is expected to comply with the applicable noise limits at the closest sensitive receptors.

The following inputs and assumptions were considered, which is considered highly conservative and result in overestimated sound power limits:

- Noise attenuation factors such as sound source directivity, building shielding effects, noise barriers and other noise controls are not applied (this is conservative).
- Standard directivity influences caused by building reflections (a Q-factor of 2 applied, hemispherical propagation).
- Assumed location of plant on the south side of the building to allow for worst case.

5.5.2 Predicted Noise Levels and Recommendations

Based on the above, mechanical plant or air intake/discharge points which are without additional screening, attenuation or other noise mitigation measures shall not exceed **L_w 78 dB(A)** [5]. It is noted that this result is preliminary only, where the only purpose is to assess the viability of the project from a noise emissions perspective. Therefore, a development approval condition **should not** be imposed based on the limiting sound power level stated above.

Instead, noise emissions from mechanical plant shall be assessed in detail during the design stages of the project, when equipment selections and information regarding the source type (e.g., operative periods, sound power levels, designated location, etc.) are established. Necessary details and information for thorough completion of the noise impact assessment shall be requested from and coordinated with the design team. The requirements (if any) and the extent of noise control measures shall be evaluated and specified during such stages to ensure the noise limits defined in this report are met.

Unattenuated plant may exceed the prescribed noise limits if large units are installed on the rooftop; however, the extent of treatments shall be determined by a suitably qualified person (acoustic consultant) once equipment selection details are known. For costing purposes, provisions shall be made for the following:

- Noise barriers or acoustic louvres;
- Acoustic attenuators;
- In-duct linings; and / or
- Quiet equipment selections of selections with custom silencer / attenuation options.

[5] the stated plant limit shall be reduced by a factor of -10*log(*n*); where *n* is the total number of units. For example, if three (3) condensers were provided, the maximum sound power level per unit shall be $L_w \leq 88$ dB(A) (i.e. L_w 92 dB(A) – 10*log(3)).

It is recommended that plant on the southside of the building is minimised given the short separation distances provided to the nearest sensitive receivers (8 Hurworth Street).

6. Conclusions and Recommendations

Stantec Australia Pty Ltd have been engaged by CFMEU to undertake a noise impact assessment for a proposed conference centre at 10-12 Campbell Street, Bowen Hills QLD 4006. This acoustic services report has:

- Established relevant design criteria in accordance with current QLD and Council Regulations;
- Identified potential acoustic-related issues to be addressed during the design stages of the project; and
- Provided the following recommendations and advice in regard to noise emissions control.

6.1 Carpark

Carparking is predicted to comply with the noise limits without additional acoustic treatment.

6.2 Loading Dock

Compliance with the noise limits for deliveries are predicted provided they occur during the day and evening time periods (7am – 10pm) only.

6.3 Conference Centre

Noise from the Foyer and Auditorium are predicted to comply for all time periods provided the foyer doors remain closed during events and the façade construction provides sufficient attenuation. Final façade construction shall be determined in later design stages and provide sufficient transmission losses for onsite activities to comply with the noise limits specified in **Table 8**.

6.4 Roof Terrace/Bar

For the rooftop terrace and bar compliance is predicted based on assumed construction of the lobby façade and provided the roof terrace is covered as shown in **Figure 4**. Final façade and enclosure construction shall be determined in later design stages and should provide sufficient noise attenuation for onsite activities to comply with the noise limits specified in **Table 8**.

We trust that this report to be sufficient for your current requirements; however, should you have any queries, please do not hesitate to contact the undersigned on (07) 3811 4500.

Yours sincerely,

Stantec Australia Pty Ltd

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MAAS 468

Appendix A Glossary of Acoustic Terms

TERM	DEFINITION
Adverse Weather	Weather conditions that affect noise (wind and temperature inversions) that occur at a particular site for a significant period of time. The previous conditions are for wind occurring more than 30% of the time in any assessment period in any season and/or for temperature inversions occurring more than 30% of the nights in winter).
Assessment Location	The position at which noise measurements are undertaken or estimated.
Assessment Period	The period in a day over which assessments are made.
Attenuation	A reduction in the magnitude of sound.
A-weighting	A frequency dependent filter applied to an instrument-measured noise. In its simplest form, the filter is designed to replicate the relative sensitivity to loudness perceived by the human ear.
Background Noise	Background noise is the term used to describe the underlying level of noise present in the ambient noise, measured in the absence of the noise under investigation. It is described as the average of the minimum noise levels measured on a sound level meter and is measured statistically as the A-weighted noise level exceeded for ninety percent of a sample period. This is represented as the LA90 noise level.
Barrier	Solid walls or partitions, solid fences, earth mounds, earth berms, buildings, etc. used to reduce noise.
dB	The abbreviation for decibel.
dB(A)	A-weighted sound level in decibels.
Frequency	Frequency is synonymous to pitch. Frequency or pitch can be measured on a scale in units of Hertz (Hz). Most noise sources typically comprise of a vast, and often complex, range of frequencies.
Frequency Response	This is a characteristic of a system which has a measured response resulting from a known applied input. In a mechanical structure, the frequency response function (FRF) is the spectrum of the vibration of a structure divided by the spectrum of the input force to the system. To measure the frequency response of a mechanical system, one must measure the spectra of both the input force to the system and the vibration response.
Hertz	The frequency of vibration and sound is measured in hertz (Hz) and is representative of the number of cycles occurring per second.
LA1	The A-weighted sound pressure level exceeded for 1 % of the measurement time period.
LA10	The A-weighted sound pressure level exceeded for 10 % of the measurement time period.
LA90	The A-weighted sound pressure level exceeded for 90 % of the measurement time period. Typically represents the background noise level of an environment.
LAeq	The equivalent continuous sound pressure level in dB(A). It is often accompanied by an additional suffix “T”, which is indicative of the measurement time period. (e.g. LAeq,15min, symbolising the measurement is evaluated over 15-minutes).
LAmax	The maximum A-weighted sound pressure level recorded over the measurement period.
Reflection	Sound wave changed in direction of propagation due to a solid object met on its path.
Reverberation	The persistence of a sound within a space, which will naturally decay over time. Most apparent once the source signal has ceased emitting. Reverberation may have effects on speech intelligibility if not adequately controlled. Reverberation time, represented in seconds, can vary depending on the volume and surface finishes of the space.
Rw	Weighted sound reduction index. A single number value which represents the airborne sound insulation performance of a partition or building element that has been determined under laboratory testing conditions.
Sound Level Meter	An instrument consisting of a microphone, amplifier and indicating device, having a declared performance and designed to measure sound pressure levels.
Sound Power Level	The total sound energy radiated by a source, expressed in Watts. The sound power level is ten times the logarithm to the base 10 of the ratio of the sound power of the source to the reference sound power.
Sound Pressure Level	The measured acoustic wave strength in a given environment and at a particular point of interest where the total sound level expressed is relative to a reference pressure, i.e. the threshold of human hearing. Sound pressure level is typically measured using a standard sound level meter with a microphone, expressed in decibels (dB).
Rating Background Level	The Rating Background Level is defined in the Guideline published by the Queensland State Government entitled “Planning for noise control”. The ‘rating background level’ or minLA90,1hour is defined as the median ‘assessment background level’(which is determined over at least a week for each day, evening and night-time period by determining the lowest or tenth percentile value.).

Appendix B Noise Monitoring Details

Previous unattended noise logging was conducted by Stantec from Thursday 9th to Wednesday 15th September 2021 (inclusive) at the location shown in **Figure 1** (coordinates in **Table 25**). This data was deemed suitable for assessment of the project as the built environment has not changed significantly since the original logging was completed. In addition, background noise levels are likely higher closer to the project site due to the proximity to major road corridors, therefore utilising this data results in a conservative assessment of noise from the project.

Table 25: Noise monitoring coordinates

Monitor	Latitude	Longitude
001	-27°26'57"	153°2'14"

The following instrumentation was used:

- NTi Audio XL2 Class 1 sound level meter (S/N A2A-14215-E0, FW4.20), and Pulsar Model 105 Class 1 acoustic calibrator (S/N 72913). The instrument had a current calibration certificate by a certified National Association of Testing Authorities (NATA) acoustics laboratory at the time of measurements.

Noise measurements were conducted in accordance with Australian Standard AS 1055-2018 – *Acoustics – Description and measurement of environmental noise*, and the instruments were configured as follows:

- A-weighting frequency response;
- FAST time response;
- 15-minute intervals;

The sound level meter was calibrated before and checked at the end of the measurement period. The instrument showed a drift less than ±1 dB during the course of monitoring; therefore, measurements are considered valid according to AS1055-2018.

Noise monitoring results

The raw sound level meter files were post-processed to determine relevant long-term noise descriptors, some of which were used to determine the applicable noise limits.

Results and time trace plots of relevant noise descriptors are provided below (see **Table 26** and **Figure 5**). Where data was not measured for a full period (i.e., at the start and end of measurement), the cells are shown dashed in the table. In addition, the noise descriptor averages are presented.

A summary of weather observations by the Bureau of Meteorology (BoM) during the monitoring period is presented in **Table 27**. Where adverse weather (e.g., rain, excessive wind) occurred within the monitoring period, the measured data has been excluded.

Table 26: Summary of measured noise levels (rounded) – Noise Monitor 001

Noise descriptor	Average	09/09/21	10/09/21	11/09/21	12/09/21	13/09/21	14/09/21	15/09/21
$L_{A10(18hr),6am-12am}$	60	—	61	60	59	61	60	—
$L_{A10,7am-6pm}$	60	—	60	60	59	61	60	—
$L_{A10,6pm-10pm}$	59	59	60	60	58	58	59	—
$L_{A10,10pm-7am}$	53	53	55	57	53	50	52	—
$L_{Aeq,7am-6pm}$	58	—	59	58	57	59	58	—
$L_{Aeq,6pm-10pm}$	57	58	58	57	56	56	57	—
$L_{Aeq,10pm-7am}$	54	54	54	54	54	54	54	—
$L_{Aeq,max\ 1hr,7am-6pm}$	60	—	60	59	59	60	60	—
$L_{Aeq,max\ 1\ hr,6pm-10pm}$	58	60	59	58	58	58	58	—
$L_{Aeq,max\ 1hr,10pm-7am}$	58	59	56	56	59	59	59	—

Noise descriptor	Average	09/09/21	10/09/21	11/09/21	12/09/21	13/09/21	14/09/21	15/09/21
$L_{A90,7am-6pm}$	51	—	51	50	50	52	52	—
$L_{A90,6pm-10pm}$	49	50	50	50	49	49	48	—
$L_{A90,10pm-7am}$	45	45	45	45	44	44	44	—

Figure 5: Time trace of relevant noise descriptors – Noise Monitor 001

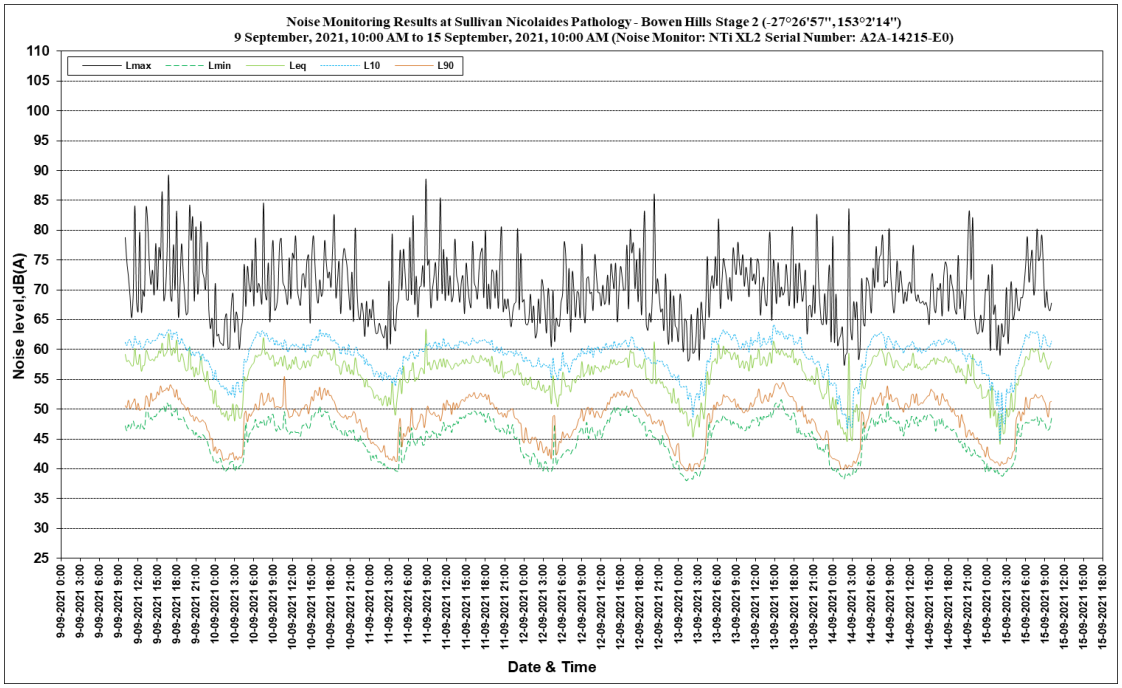

Table 27: Summary of BoM weather observations during unattended monitoring (monitored days highlighted)

Brisbane, Queensland
September 2021 Daily Weather Observations
Most observations from Brisbane City, but some from Brisbane Airport.

Australian Government
Bureau of Meteorology

Date	Day	Temps		Rain	Evap	Sun	Max wind gust			9am						3pm					
		Min	Max				Dirn	Spd	Time	Temp	RH	Cld	Dirn	Spd	MSLP	Temp	RH	Cld	Dirn	Spd	MSLP
		°C	°C	mm	mm	hours		km/h	local	°C	%	eighths		km/h	hPa	°C	%	eighths		km/h	hPa
1	We	16.9	26.8	0		8.3	ENE	22	15:05	21.0	75	4	S	2	1027.4	25.0	53	1	ENE	11	1024.0
2	Th	16.4	23.7	3.4		10.2	ENE	35	12:41	21.1	61	2	E	9	1029.6	21.9	49	1	ESE	13	1026.5
3	Fr	15.2	24.5	0.2			NE	31	10:39	18.6	79	7	WSW	2	1027.0	22.6	54	7	ENE	11	1023.5
4	Sa	14.4	24.3	2.2			NNE	24	14:13	19.4	74	4	SW	4	1024.3	22.1	59	2	NE	11	1019.9
5	Su	15.0	24.4	0		3.0	W	35	20:28	19.2	74	7	WSW	4	1020.0	20.7	77	7	NE	2	1016.4
6	Mo	11.1	23.8	0.2		9.9	WSW	24	00:01	15.7	48	6	SW	7	1024.5	23.4	24	2	WSW	6	1019.9
7	Tu	10.8	24.2	0		11.0	S	30	08:38	18.1	34	0	SSW	11	1028.3	22.9	23	0	SSE	6	1024.5
8	We	9.8	23.9	0			E	22	14:05	17.4	53	1	SW	6	1030.7	23.3	43	2	E	7	1027.5
9	Th	12.3	25.0	0		10.3	N	19	13:39	18.7	62	1	SSW	7	1031.0	23.0	43	1	NNE	9	1026.3
10	Fr	12.1	30.1	0		10.7	WSW	19	12:50	19.9	59	0	S	4	1025.1	29.2	23	0	N	6	1019.7
11	Sa	12.3	25.9	0		11.0	NNE	24	16:08	20.2	54	0	WSW	4	1021.7	24.5	44	1	NNE	9	1017.7
12	Su	12.0	26.1	0		10.7	NNE	33	16:10	21.3	54	1	NW	7	1018.0	24.2	53	1	NNE	13	1013.0
13	Mo	14.7	28.9	0			NE	24	16:28	23.8	55	1	WNW	6	1013.9	24.1	73	7	NNE	7	1009.5
14	Tu	14.2	22.5	0.8			W	44	12:13	18.4	35	1	SW	9	1017.2	21.4	19	2	W	22	1014.2
15	We	10.6	24.9	0		11.1	S	24	09:04	17.8	40	0	S	11	1020.5	23.8	23	1	SE	9	1016.7
16	Th	11.4	24.1	0		10.4	ENE	28	16:16	18.4	48	1	SSW	6	1022.3	21.8	46	1	ENE	11	1018.3
17	Fr	12.0	24.8	0		11.0	ENE	24	14:10	19.1	55	1	SW	6	1024.1	22.7	52	1	NNE	9	1020.5
18	Sa	13.5	25.2	0		8.9	NE	30	15:20	21.4	59	1	W	4	1024.7	23.3	52	4	NE	11	1020.1
19	Su	15.5	28.2	0		10.9	ENE	24	13:42	23.4	51	1	S	6	1023.1	26.4	35	1	ENE	11	1019.3
20	Mo	15.2	26.9	0		10.8	NE	30	14:34	22.7	64	1	NNW	2	1020.9	25.3	60	1	NNE	13	1013.5
21	Tu	16.9	24.7	0		11.1	W	54	13:26	22.3	36	1	WSW	13	1011.7	20.3	20	2	WSW	26	1012.4
22	We			0		11.3				16.7	35	1	WSW	15	1021.3			1			
23	Th					11.4						1				23.8	32	0	NE	9	1019.0
24	Fr		27.0			11.2	NE	28	16:28	20.7	57	0	SW	4	1020.8	24.7	50	1	NNE	11	1014.9
25	Sa	12.1	28.8	0		10.8	NE	22	14:19	22.4	49	6	N	2	1017.4	25.1	47	4	NNE	7	1013.1
26	Su	16.6	26.0	0		4.2	ESE	39	18:58	22.5	59	7	SE	11	1019.2	22.6	57	7	ESE	13	1017.2
27	Mo	15.2	19.8	0.4		0.5	SSE	24	09:47	18.7	68	8	SE	7	1023.9	19.3	53	7	E	13	1020.7
28	Tu	13.9	21.8	0		2.0	ESE	24	11:51	19.5	49	8	E	11	1023.7	20.6	48	8	ENE	11	1020.5
29	We	13.0	23.6	0.2		1.0	NNE	31	12:42	20.7	61	8	NE	7	1022.7	21.4	55	8	NNE	13	1019.4
30	Th	17.1	26.7	3.4		7.0	NNE	28	15:47	20.5	75	7	WNW	9	1018.9	22.9	73	6	NE	9	1012.9
Statistics for September 2021																					
	Mean	13.7	25.2			8.7				20.0	55	2		6	1022.5	23.2	46	2		10	1018.7
	Lowest	9.8	19.8			0.5				15.7	34	0	#	2	1011.7	19.3	19	0	NE	2	1009.9
	Highest	17.1	30.1	3.4		11.4	W	54		23.8	79	8	WSW	15	1031.0	29.2	77	8	WSW	26	1027.5
	Total			10.8		218.7															

Temperature, humidity, wind, pressure and rainfall observations are from Brisbane (station 040913). Cloud, evaporation and sunshine observations are from Brisbane Aero (station 040842)
Brisbane Airport is located about 12 kilometres north east of the Brisbane City site, and closer to the coast. The evaporation, sunshine and cloud values should be used as a guide only.

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