Liverpool Civic Place Phase B&C

Noise Impact Assessment

Stage 2 Development Application

Prepared for: Built Pty Ltd

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Date: 09 September 2021

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Revision

Revision	Date	Comment	Prepared By	Approved By
001	3/12/2020	For Comment	Tatum Mackey	Brandon Notaras
002	10/12/2020	Final	Tatum Mackey	Brandon Notaras
003	3/09/2021	Revise Section 5.3 to include Phase A and B/C traffic noise generation	Tatum Mackey	Elle Hewett

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1. Introduction

This noise impact assessment is submitted to Liverpool City Council (Council) on behalf of Built Development Group in support of a Stage 2 Development Application (DA) for Phase B and Phase C of the Liverpool Civic Place development located at 40-42 Scott Street, Liverpool. It follows the approval of a Concept Proposal / Stage 1 DA (DA-585/2019) for the broader Liverpool Civic Place master plan that has determined land uses, building envelopes, public domain and a multi-level common basement across the site. The full Liverpool Civic Place site, subject to the Concept Proposal / Stage 1 DA approval is illustrated at Figure 1, however the scope of this Stage 2 DA is limited to Phase B and C, (refer to Figure 2) with the exception of embellishments to the Terminus Street pocket park.

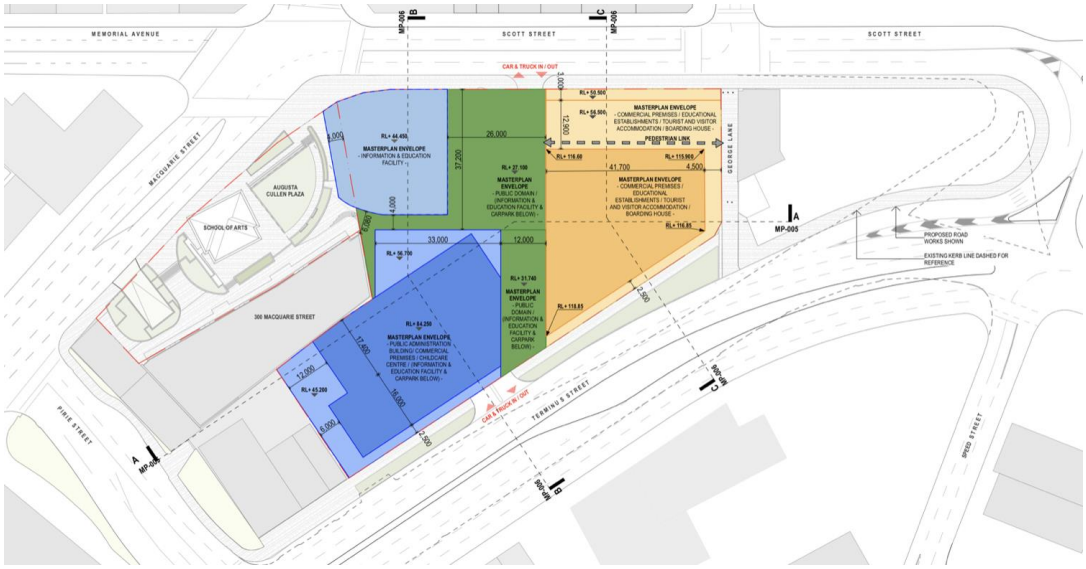


Figure 1 Liverpool Civic Place Master Plan site

Source: FJMT

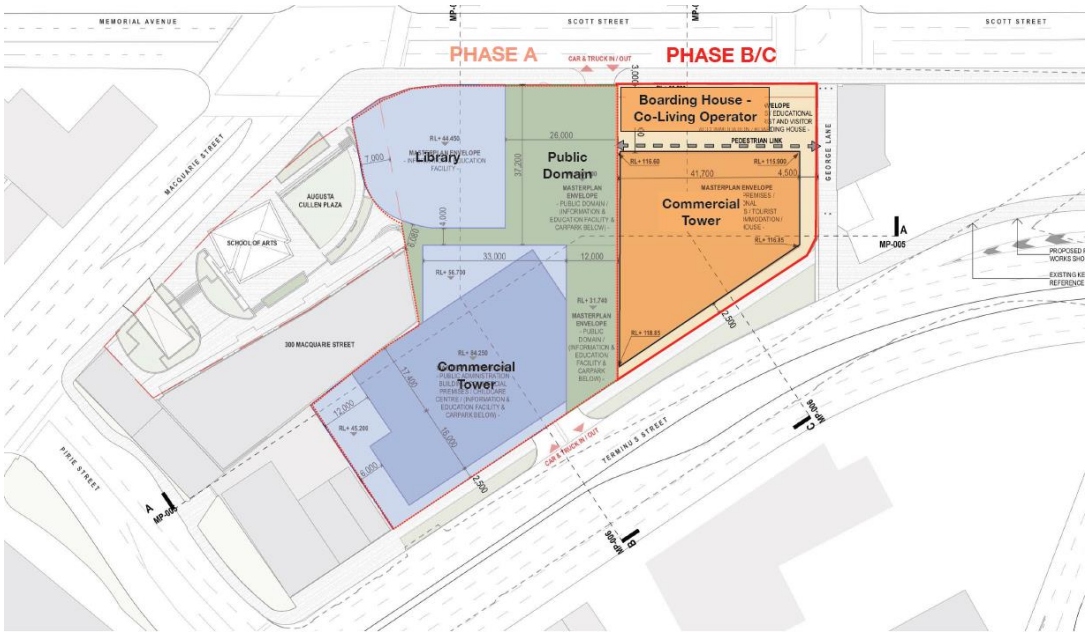


Figure 2 Liverpool Civic Place Phase B/C site (subject site)

Source: FJMT

This Stage 2 DA seeks approval for:

- Construction and use of a nine (9) storey boarding house to be operated as a co-living facility, comprising;
  - ground floor lobby and retail tenancies;
  - eighty-four (84) rooms;
  - communal facilities including living, kitchen and dining areas, a gym, rooftop terrace and a laundry.
- Construction and use of a twenty-two (22) storey commercial office building, comprising:
  - ground floor lobby and retail tenancies;
  - nineteen (19) commercial office levels; and
  - mid-level and rooftop plant.
- Construction and use of four basement levels;
- Landscaping and public domain works including:
  - provision of a pocket park fronting Scott Street and George Lane;
  - embellishment of the elevated pocket park fronting Terminus Street; and
  - provision of a through-site link, connecting George Lane to the central public plaza.
- Extension and augmentation of services and infrastructure as required.

This DA reflects the staged planning approval pathway for the Liverpool Civic Place redevelopment which has included two previously approved DAs and a third DA currently under assessment, as outlined below:

Concept DA DA-585/2019:

The planning approval pathway for the Liverpool Civic Place development commenced in in 2019, with the submission of a Concept Proposal / Stage 1 DA for the Liverpool Civic Place master plan. On 31 August 2020, the Concept Proposal / Stage 1 DA (DA-585/2019) was approved by the Sydney Western City Planning Panel. The Concept Proposal / Stage 1 DA consent sets out the future development concept of the site, including the approved land uses, building envelopes, an expanse of public domain and a common basement. The Concept Proposal / Stage 1 DA did not approve any physical works.

Early Works DA DA-906/2019:

DA-906/2019 was approved by the Sydney Western City Planning Panel on 29 June 2020. The development consent relates to demolition of all structures, select tree removal and bulk earthworks including shoring through the use of piles. Early works commenced on site in September 2020 and are scheduled for completion in August 2021.

Phase A Stage 2 DA DA-836/2020:

DA-836/2020 was submitted to Council on 8 October 2020 and is currently under assessment (at the time of writing). The proposed development relates to Phase A of the Liverpool Civic Place redevelopment for the construction and use of a public library, as well as a mixed-use building containing commercial office floor space, and public administration floor space to be occupied by Council. The proposal also comprises significant public domain works, including a public plaza and part of the site's five level common basement.

1.1 Reference Documents

The assessment has been prepared considering the following documents:

- Liverpool Development Control Plan (LDCP), 2008.
- Liverpool Local Environmental Plan (LLEP), 2008.
- NSW Road Noise Policy, 2011 (RNP 2011)
- AS/NZS 2107:2016: “Acoustics – Recommended design sound levels and reverberation times for building interiors”
- NSW Environment Protection Authority (EPA) Noise Policy for Industry, 2017 (NPI 2017)
- NSW Environment Protection Authority (EPA) Interim Construction Noise Guideline (ICNG July 2009).
- Assessing Vibration – A Technical Guideline (NSW AV-TG), issued February 2006 by the Department of Environment and Conservation NSW, now part of the NSW EPA.
- Liverpool Civic Place – Phase B & C Stage 2 Development Application, Traffic Impact Assessment (Issue 2) prepared by Ptc. Dated 11 December 2020

1.2 Acoustic Considerations

The acoustic considerations relating to the proposed development are as follows:

- Noise emissions from mechanical plant servicing the buildings within Phase B&C to the surrounding noise-sensitive receivers
- Increased traffic noise generated by Phase B&C affecting the surrounding residential receivers
- Traffic noise intrusion into co-living units
- Noise impact from the retail premises to the co-living units
- Construction noise emissions for the proposed development and the impact on Phase A

2. Site Analysis

2.1 Site Location and Context

The site is located at 40-42 Scott Street, Liverpool within the Liverpool City Council Local Government Area (LGA) as illustrated at Figure 3. The site is located at the southern fringe of the Liverpool CBD. The site is approximately 300m south west of the Liverpool Railway Station and is also in the vicinity of a number of regionally significant land uses and features including Liverpool Hospital, Westfield Liverpool, Western Sydney University Liverpool Campus, the Georges River and Biggie Park public open space as illustrated at Figure 3.

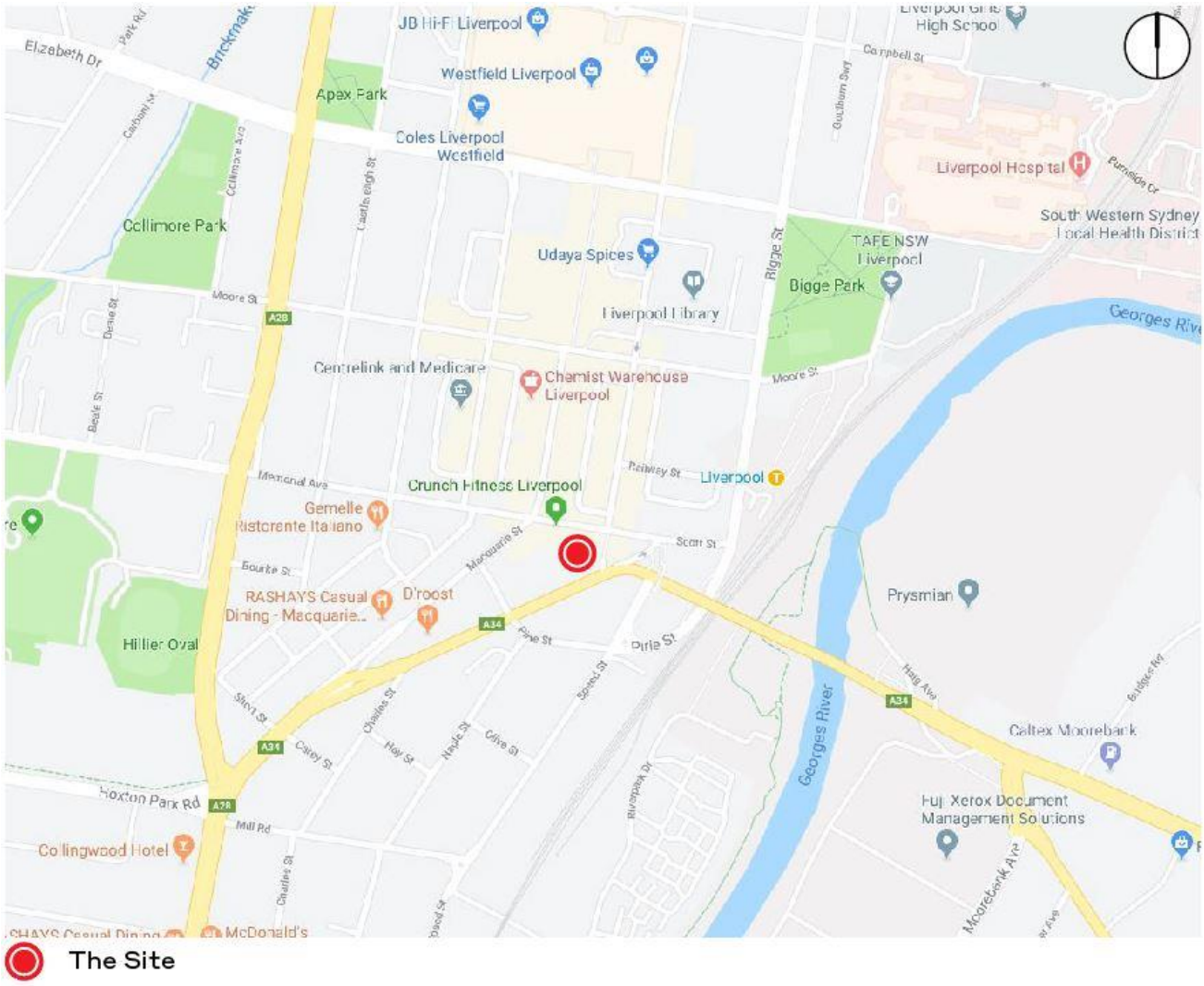


Figure 3 **Site Location**

Source: Google Maps & Ethos Urban

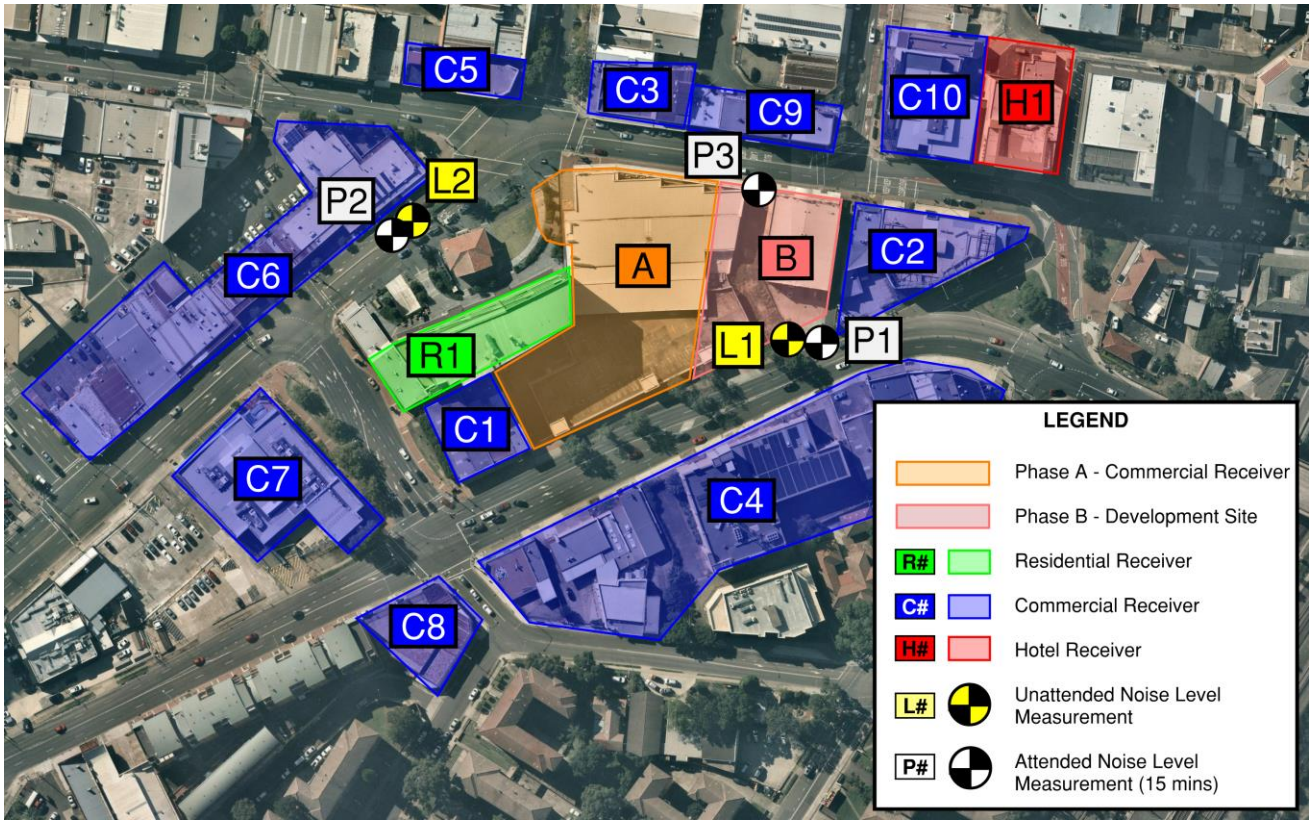
2.2 Noise Sensitive Receivers

The site location, noise measurement positions and surrounding residential, hotel and commercial receivers are shown in Figure 1. The nearest Hotel receiver (H1) is located at 39 Scott Street.

Noise monitor L2 (and attended monitoring at P2) was placed in this location to obtain background noise levels relevant to surrounding noise sensitive receivers such as R1, C5 and C6. These background noise levels will be characteristic of the environment for each of these receivers. In addition to this, the monitor was placed in this location to obtain traffic noise levels also characteristic of the precinct and any receivers facing Scott St.

It should be noted that the background noise levels measured are typical of an urban environment (see Table 3 for measured RBL). The background noise levels (Intrusiveness criteria, refer to Section 4.2) did not drive the external noise emissions limits at surrounding receivers for this precinct, and instead the Amenity criteria was the driver for this criterion.

Figure 1: Aerial photo - Overview of the site, measurement locations and surrounding sensitive receivers



Source: nearmap.com

3. Noise Survey

3.1 Existing Noise environment

The existing noise environment is dominated by road traffic noise on the surrounding local roads. Typical to such an environment is for the daytime traffic volumes to increase at approximately 6:30am and to decrease at approximately 7:30pm in the evening. Additionally, the rooftop mechanical equipment on the surrounding buildings can contribute to the noise levels at higher elevations.

The existing background noise is typical of an urban area and has continuous traffic flows, is within close proximity to commercial districts and exudes a continuous “urban hum” as defined in the NSW Environment Protection Authority (EPA) Noise Policy for Industry, 2017 (NPI 2017). During the evening and night-time periods there is evidently a decrease in ambient noise levels due to reduced traffic volume and foot traffic around the site and within the nearing surroundings. The existing noise is assessed using three given time periods as shown in the NPI.

3.2 Instrumentation

The equipment used for the noise survey was the following:

- Bruel & Kjær Type 2250 hand-held sound spectrum analyser, S/N 3027679
- Bruel & Kjær Type 4231 calibrator, S/N 1944752
- ARL Environmental Noise Logger Rion NL-42EX S/N-00521656
- ARL Environmental Noise Logger Rion NL-42EX S/N -00810713

All equipment was calibrated before and after the measurements and no significant drift was found. All equipment carries current traceable calibration certificates that can be provided upon request.

3.3 Attended Noise Survey

Attended noise measurements of 15-minute duration were conducted on site on 28th July 2019 between 12 noon and 1:00pm in order to gain an understanding of the existing noise levels emanating from the busy streets near the site.

A summary of the attended noise measurements taken along the nearby streets and at the site are shown in Table 1, including comments on the noise environment during the process. Refer to Figure 1 for measurement locations.

Table 1: Attended noise measurement results.

Measurement Location	Measurement Time	$L_{A90,15min}$ dB(A)	$L_{Aeq,15min}$ dB(A)	$L_{Amax,15min}$ dB(A)	Notes
P1	28/07/2019 – 12:18	62	75	87	Traffic noise on Terminus Street. with some pedestrian noise in the background. Occasional heavy vehicle circulation
P2	28/07/2019 – 12:18	58	66	86	Occasional traffic mainly bursts from traffic lights. General traffic hum from surrounding roads. Some birds on the nearby trees
P3	28/07/2019 – 12:18	56	70	92	Continuous traffic, including a low proportion of buses. pedestrian noise in the background

3.4 Unattended Noise Survey

Two noise loggers were placed at positions L1 and L2 as shown in Figure 1 to measure the background and ambient noise that is representative of the surrounding residential receivers. Logger L1 was installed from the 28th of June to the 20th of June 2019 and Logger L2 was installed from the 28th of June to the 4th of July 2019.

To ensure monitoring data obtained during adverse weather conditions does not affect the noise levels used to establish acoustic criteria, any rain-affected data during the period of logging has been excluded from the calculations. Where the amount of excluded data within a period exceeds a set limit, the whole period has been left out of the assessments.

3.4.1 Traffic Noise

A summary of the results of the traffic noise monitoring is provided in Table 2, with day and night noise level ranges provided. Day is defined as the period between 7:00am to 10:00pm, whereas Night is defined as the period between 10:00pm – 7:00am.

Table 2: Results of unattended traffic noise monitoring

Location	Equivalent Continuous Noise Level $L_{Aeq,period}$ dB(A)		Noisiest 1 hour $L_{Aeq,1h}$ dB(A)	
	Day (15h)	Night (9h)	Day	Night
L1	70	67	72	69
L2	66	61	68	65

3.4.2 Background Noise

The resulting equivalent noise levels and Rated Background Level (RBL) for each period have been outlined in Table 3 for logger L2. The noise data from logger L2 is considered to represent the existing noise environment and forms the basis for establishing the operational noise criteria at the residential receivers.

Table 3: Results of unattended background noise monitoring

Location	Equivalent Continuous Noise Level $L_{Aeq,period}$, dB(A)			Background Noise Level RBL, dB(A)		
	Day	Evening	Night	Day	Evening	Night
L2	66	65	61	55	54	46

4. Noise & Vibration Criteria

4.1 Internal Noise Levels

4.1.1 Australia/New Zealand Standard AS/NZS 2107:2016

Australian Standard AS/NZS 2107:2016 – *'Acoustics- Recommended design sound levels and reverberation times for building interiors'* will be used to specifies target noise levels for internal spaces to the development for noise sources and particular spaces that are not covered in the other standards. Refer to Table 4 for the values corresponding to residential spaces near major roads.

Table 4: Recommended design internal noise level range (AS/NZS 2107:2016)

Type of occupancy/activity	Design sound level range LeqT, dB (A)
Hostels, residential halls and barracks (Applicable to Co-Living)	
Hostels, residential halls and barracks in inner city areas or entertainment districts or near major roads	35 to 40
Common rooms	40 to 45
Office Buildings (applicable to Commercial)	
General Office areas	40 to 45
Corridors and lobbies	45 to 50
Toilets	45 to 55

For any additional notes in Table 4, refer to AS/NZS 2107:2016 page 14 Table 1.

Concerning the appropriate design sound level range, the following explanation note is found in AS/NZS 2107:2016:

> *"Sound levels within the given ranges have been found to be acceptable by most people for the space under consideration. When the sound level is greater than the upper level of the range, most people occupying the space will become dissatisfied with the level of sound. When the sound level is below the lower level of the range, the inadequacy of background sound to provide masking sound can become problematic, for example, by allowing other intermittent noise sources to cause distraction, annoyance, or lack of privacy."*

4.2 External Noise Emissions

The external noise emissions from the proposed development (Phase B&C) together with Phase A (in the context of the masterplan) have been considered when developing the noise emissions limits. The noise criteria developed in the ensuing subsections is consistent with the criteria developed for the masterplan.

4.2.1 NSW EPA Noise Policy for Industry (NPI)

In the absence of noise emission criteria in the Liverpool City Council DCP, the NPI sets out noise criteria to control the noise emission from industrial noise sources from activities listed in Schedule 1 of the POEO Act and regulated by the EPA. The external noise due to mechanical services from the proposed development is also addressed following the guideline in the NSW EPA's NPI.

The calculation is based on the results of the unattended ambient and background noise monitoring, addressing two components:

- Controlling intrusive noise into nearby residences (Intrusiveness Criteria)
- Maintaining noise level amenity for particular land uses (Amenity Criteria)

Once both criteria are established, the most stringent for each considered assessment period (day, evening, night) is adopted as the project-specific noise level (PSNL).

Intrusiveness Criteria

The NSW EPA NPI states the following:

> *"The intrusiveness of an industrial noise source may generally be considered acceptable if the equivalent continuous (energy-average) A-weighted level of noise from the source (represented by the L_{Aeq} descriptor), measured over a 15-minute period, does not exceed the background noise level measured in the absence of the source by more than 5 dB(A)."*

The intrusiveness criterion can be summarised as follows:

$L_{Aeq,\ 15minute} \leq$ RBL background noise level + 5 dB(A)

The intrusiveness criterion for the closest residential receivers is presented in Table 5 below. Note the values from L2 have been used in this assessment as they are the most relevant to define the background and ambient noise level of the residential receivers.

Table 5: EPA NPI Intrusiveness Criteria

Period	Noise Descriptor – dB(A)	Noise Criteria – All residential receivers $L_{Aeq,15mins}$
Daytime 7am – 6pm	$L_{Aeq,15min} \leq$ RBL + 5	60
Evening 6pm – 10pm	$L_{Aeq,15min} \leq$ RBL + 5	59
Night 10pm – 7am	$L_{Aeq,15min} \leq$ RBL + 5	51

Amenity Criteria

The NSW NPI states the following:

> *"To limit continuing increases in noise levels from application of the intrusiveness level alone, the ambient noise level within an area from all industrial noise sources combined should remain below the recommended amenity noise levels specified in Table 2.2 where feasible and reasonable. The recommended amenity noise levels will protect against noise impacts such as speech interference, community annoyance and some sleep disturbance. The recommended amenity noise levels have been selected on the basis of studies that relate industrial noise to annoyance in communities (Miedema and Voss, 2004)."*

To ensure that industrial noise levels (existing plus new) remain within the recommended amenity noise levels for an area, a project amenity noise level applies for each new source of industrial noise as follows "Project amenity noise level for industrial developments = recommended amenity noise level (Table 2.2) minus 5 dB(A)"

> *"The level of transport noise, road traffic noise in particular, may be high enough to make noise from an industrial source effectively inaudible, even though the LAeq noise level from that industrial noise source may exceed the project amenity noise level. In such cases the project amenity noise level may be derived from the LAeq, period(traffic) minus 15 dB(A)."*

The applicable parts of Table 2.2: Amenity noise levels which are relevant to the project are reproduced below:

Table 6: NSW NPI Table 2.2 amenity criteria for external noise levels

Type of Receiver	Noise Amenity Area	Time of Day	L_{Aeq} , dB(A) Recommended amenity noise level	Project amenity noise level $L_{Aeq, 15min}$
Residential	Urban*	Day	60	53
	Urban*	Evening	50	48
	Urban*	Night	45	44
Hotels	Urban*	Day	65	58
	Urban*	Evening	55	48
	Urban*	Night	50	44
Commercial premises	All	When in use	65	58

*Urban area as defined in EPA NSW NPI Table 2.3

'Modifying Factor' Adjustments

The NSW NPI also states:

> *"Where a noise source contains certain characteristics, such as tonality, intermittency, irregularity or dominant low-frequency content, there is evidence to suggest that it can cause greater annoyance than other noise at the same noise level."*

In order to take into account, the potential annoying character of the noise an adjustment of 5 dB(A) for each annoying character aspect and cumulative of up to a total of 10 dB(A), is to be added to the measured value to penalise the noise for its potentially greater annoyance aspect.

Table C1 of Fact Sheet C of the NSW NPI (see Table 7 below) provides procedures for determining whether an adjustment should be applied for greater annoyance aspect.

Table 7: Table C1 from the NSW NPI – Modifying factor corrections

Factor	Assessment / Measurement	When to Apply	Correction[1]	Comments
Tonal Noise	One-third octave band analysis using the objective method for assessing the audibility of tones in noise – simplified method *(ISO1996.2-2007 – Annex D)*.	Level of one-third octave band exceeds the level of the adjacent bands on both sides by: • 5 dB or more if the centre frequency of the band containing the tone is in the range 500–10,000 Hz • 8 dB or more if the centre frequency of the band containing the tone is in the range 160–400 Hz • 15 dB or more if the centre frequency of the band containing the tone is in the range 25–125 Hz.	5 dB[2,3]	Third octave measurements should be undertaken using unweighted or Z-weighted measurements. **Note**: Narrow-band analysis using the reference method in *ISO1996-2:2007, Annex C* may be required by the consent/regulatory authority where it appears that a tone is not being adequately identified, e.g. where it appears that the tonal energy is at or close to the third octave band limits of contiguous bands.
Low Frequency Noise	Measurement of source contribution C-weighted and A-weighted level and one-third octave measurements in the range 10–160 Hz	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 15dB or more and: • where any of the one-third octave noise levels in Table C2 are exceeded by up to and including 5 dB and cannot be mitigated, a 2dB(A) positive adjustment to measured/predicted A-weighted levels applies for the evening/night period • where any of the one-third octave noise levels in Table C2 are exceeded by more than 5 dB and cannot be mitigated, a 5-dB(A) positive adjustment to measured/predicted A-weighted levels applies for the evening/night period and a 2dB(A) positive adjustment applies for the daytime period.	2 or 5 dB[2]	A difference of 15 dB or more between C- and A-weighted measurements identifies the potential for an unbalance spectrum and potential increased annoyance. The values in Table C2 are derived from Moorhouse (2011) for DEFRA fluctuating low-frequency noise criteria with corrections to reflect external assessment locations.
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(A) and the intermittent nature of the noise is clearly audible.\	5 dB	Adjustment to be applied for **night-time only.**
Duration	Single-event noise duration may range from 1.5 min to 2.5 h	One event in any assessment period.	0 to 20 dB(A)	The project noise trigger level may be increased by an adjustment depending on duration of noise (see Table C3).
Maximum Adjustment	Refer to individual modifying factors	Where two or more modifying factors are indicated	Maximum correction of 10dB(A)[2] (excluding duration correction)	

1. Corrections to be added to the measured or predicted levels, except in the case of duration where the adjustment is to be made to the criterion.

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.

3. Where narrow-band analysis using the reference method is required, as outlined in column 5, the correction will be determined by the ISO1996-2:2007 standard.

Sleep Disturbance

The NPI establishes sleep disturbance criteria for residential receivers in close proximity to industrial noise sources during the night-time period, such as vehicle movements and car door slams on private roads. The criteria for protecting the amenity of surrounding residential receivers in regard to sleep disturbance is:

- $L_{Aeq,15min}$ 40 dB(A) or prevailing RBL plus 5dB, whichever is greater, and/or
- L_{AFmax} 52 dB(A) or prevailing RBL plus 15dB, whichever is greater

Table 8 summarises the sleep disturbance criteria for the proposed development.

Table 8: Sleep Disturbance Criteria

Period	Sleep Disturbance Criteria	
	L_{AFmax} – dB(A)	$L_{Aeq,15min}$ – dB(A)
Night (10:00pm to 7:00am)	60	51

4.2.2 Project Noise Trigger Levels

The project noise trigger levels for industrial noise sources such as mechanical plant etc. are provided in Table 9. These noise levels have been derived from the Noise Policy for Industry 2017 and will satisfy the requirements of the Liverpool City Council.

Table 9: Project noise trigger levels for industrial noise emissions

Period	Descriptor	Project Specific Noise Emission Levels dB(A)
Residential Receivers		
Day (7:00am to 6:00pm)	$L_{Aeq,15min}$	53
Evening (6:00pm to 10:00pm)	$L_{Aeq,15min}$	48
Night (10:00pm to 7:00am)	$L_{Aeq,15min}$	44
	L_{AFmax}	60
Hotel Receivers		
Day (7:00am to 6:00pm)	$L_{Aeq,15min}$	58
Evening (6:00pm to 10:00pm)	$L_{Aeq,15min}$	48
Night (10:00pm to 7:00am)	$L_{Aeq,15min}$	44
Commercial Receivers		
When in use	$L_{Aeq,15min}$	58

4.3 Traffic Noise Generation

The L_{Aeq} noise level or the "equivalent continuous noise level" correlates best with the human perception of annoyance associated with traffic noise.

Road traffic noise impact is assessed in accordance with the introduced NSW Road Noise Policy (Office of Environment and Heritage July 2011) which supersedes the *NSW Environmental Criteria for Road Traffic Noise* (ECRTN, Department of Environment Climate Change and Water 1999). The criterion (Table 3 – Road Traffic Noise Assessment Criteria for Residential Land Uses) divides land use developments into different categories and lists the respective criteria for each case. The category that is relevant to the proposed use of the site is shown below in Table 10.

Table 10: NSW Road Noise Policy – Traffic noise assessment criteria

Road Category	Type of project/land use	Assessment Criteria – dB(A)	
		Day (7am – 10pm)	Night (10pm – 7am)
Local roads	Existing residences affected by additional traffic on existing local roads generated by land use developments	$L_{Aeq,1\ hour}$ 55 (external)	$L_{Aeq,1\ hour}$ 50 (external)
Sub-arterial	Existing residences affected by additional traffic on existing sub-arterial roads generated by land use developments	$L_{Aeq,1\ hour}$ 60 (external)	$L_{Aeq,1\ hour}$ 55 (external)

In the event that the traffic noise at the site is already in excess of the criteria noted above, the NSW RNP states that the primary objective is to reduce the existing level through feasible and reasonable measures to meet the criteria above.

If this is not achievable, Section 3.4.1 Process for applying the criteria – Step 4 states that for existing residences affected by additional traffic on existing roads generated by land use developments, any increase in the total traffic noise should be limited to 2 dB above that of the corresponding 'no build option'.

4.4 Construction Noise

Noise criteria for construction sites are established in accordance with the Interim Construction Noise Guideline (ICNG July 2009) by the NSW Environment Protection Authority (EPA). It is important to note that the recommended criteria are for planning purposes only. Numerous other factors need to be considered when assessing potential noise impacts from construction works.

However, in undertaking the assessment of potential noise intrusion associated with the proposed construction activities, Chapter 4 of the NSW EPA ICNG (July 2009) were specifically referenced. The limits presented in Table 11 apply.

Table 11: NSW EPA ICNG Construction Noise Criteria

Time of Day	Management Level $L_{Aeq,15min}$ *	How to Apply
Recommended Standard Hours: Mon – Fri (7am – 6pm) Sat (8am – 1pm) No work on Sunday & Public Holidays	Noise Affected RBL + 10dB(A)	The noise affected level represents the point above which there may be some community reaction to noise. • Where the predicted or measured **$L_{Aeq,15min}$** 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 residences of the nature of works to be carried out, the expected noise levels and duration as well as contact details.
	Highly Noise Affected 75 dB(A)	The highly noise affected 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 restricting the hours that the very noisy activities can occur in, taking into account: • 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) • If the community is prepared to accept a longer period of construction in exchange for restrictions on construction times.
Outside Recommended Standard Hours	Noise Affected RBL + 5dB(A)	• 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 practices have been applied and noise is more than 5 dB(A) above the noise affected level, the proponent should negotiate with the community. • For guidance on negotiating agreements see section 7.2.2.

Note: Noise levels apply at the property boundary that is most exposed to construction noise, and at a height of 1.5 m above ground level. If the property boundary is more than 30 m from the residence, the location for measuring or predicting noise levels is at the most noise-affected point within 30m of the residence. Noise levels may be higher at upper floors of the noise affected residence.

Source: Chapter 4 (Table 2 Sec 4.1.1) of NSW DECCW ICNG

4.5 Construction Vibration

The NSW Environment Protection Authority (EPA) developed a document, "Assessing vibration: A technical Guideline" in February 2006 to assist in preventing people from exposure to excessive vibration levels within buildings. The guideline does not however address vibration induced damage to structures or structure-borne noise effects. Vibration and its associated effects are usually classified as continuous, impulsive or intermittent.

4.5.1 Human Comfort – Continuous and Impulsive Vibration Criteria

Structural vibration in buildings can be detected by occupants and can affect them in many ways including reducing their quality of life and also their working efficiency. Complaint levels from occupants of buildings subject to vibration depend upon their use of the building and the time of the day.

Maximum allowable magnitudes of building vibration with respect to human response are shown in Table 12. It should be noted that the human comfort for vibration are more stringent than the building damage criteria.

Table 12: RMS values for continuous and impulsive vibration acceleration (m/s^2) 1-80Hz

Location	Assessment period[1]	Preferred values		Maximum values	
		z-axis	x- and y-axis	z-axis	x- and y-axis
Continuous vibration					
Residences	Daytime	0.010	0.0071	0.020	0.014
	Night time	0.007	0.005	0.014	0.010
Offices, schools, educational institutions and place of worship	Day or night time	0.020	0.014	0.040	0.028
Impulsive vibration					
Residences	Daytime	0.30	0.21	0.60	0.42
	Night time	0.10	0.071	0.20	0.14
Offices, schools, educational institutions and place of worship	Day or night time	0.64	0.46	1.28	0.92

4.5.2 Human Comfort – Intermittent Vibration Criteria

Disturbance caused by vibration will depend on its duration and its magnitude. This methodology of assessing intermittent vibration levels involves the calculation of a parameter called the Vibration Dose Value (VDV) which is used to evaluate the cumulative effects of intermittent vibration. Various studies support the fact that VDV assessment methods are far more accurate in assessing the level of disturbance than methods which is only based on the vibration magnitude.

Table 13: Acceptable Vibration Dose Values for Intermittent Vibration (m/s$^{1.75}$)

Location	Daytime (7:00am to 10:00pm)		Night-time (10:00pm to 7:00am)	
	Preferred value	Maximum value	Preferred value	Maximum value
Residences	0.20	0.40	0.13	0.26
Offices, schools, educational institutions and place of worship	0.40	0.80	0.40	0.80

4.5.3 Structural Damage – Vibration Criteria

Ground vibration criteria is defined in terms of the levels of vibration emission from the construction activities which will avoid the risk of damaging surrounding buildings or structures. It should be noted that human comfort criteria are normally expressed in terms of acceleration whereas structural damage criteria are normally expressed in terms of velocity.

Most commonly specified structural vibration levels are defined to minimize the risk of cosmetic surface cracks and are set below the levels that have the potential to cause damage to the main structure. Structural damage criteria are presented in German Standard DIN4150-Part 3 “Structural vibration in buildings – Effects on structures” and British Standard BS7385-Part 2: 1993 “Evaluation and Measurement for Vibration in Buildings”. Table 14 indicates the vibration limits presented in DIN4150-Part 3 to ensure structural damage doesn’t occur.

Table 14: Guideline value of vibration velocity, vi, for evaluating the effects of short-term vibration

Line	Type of Structure	Vibration velocity, vi, in mm/s			
		Foundation			Plane of floor of uppermost full storey
		At a frequency of			
		Less than 10Hz	10 to 50Hz	50 to 100*Hz	All Frequencies
1	Buildings used for commercial purposes, industrial buildings and buildings of similar design	20	20 to 40	40 to 50	40
2	Dwellings and buildings of similar design and/or use	5	5 to 15	15 to 20	15
3	Structures that, because of their particular sensitivity to vibration, do not correspond to those listed in lines 1 and 2 and are of great intrinsic value (e.g. buildings that are under a preservation order)	3	3 to 8	8 to 10	8
*For frequencies above 100Hz, at least the values specified in this column shall be applied					

Table 15 presents guide values for building vibration, based on the lowest vibration levels above which cosmetic damage has been demonstrated as per BS7385-Part 2:1993.

Table 15: Transient vibration guide values for cosmetic damage

Type of Building	Peak Particle Velocity in frequency range of predominant pulse (PPV)	
Residential or light commercial type buildings	4 Hz to 15 Hz	15 Hz and above
	15mm/s at 4Hz increasing to 20mm/s at 15Hz	20mm/s at 15Hz increasing to 50mm/s at 40Hz and above

5. Noise and Vibration Impact Assessment

The external noise emissions from the proposed development (Phase B&C) together with Phase A (in the context of the masterplan) have been considered when developing the noise emissions limits.

The noise emissions from mechanical plant and equipment, the retail impact assessment and traffic noise generation assessment have been conducted in accordance with the methods outlined in the noise and vibration impact assessment prepared for the masterplan. This has been achieved by providing a 3 dB(A) reduction in the allowable noise limit, allowing the total noise level from Phase A, B & C to be limited to the cumulative masterplan noise limit.

5.1 Mechanical Noise Emissions

Noise sources from general operations at the site typically include mechanical services noise from air-conditioning equipment and exhaust fans etc. servicing the proposed development. These noise sources have been used to predict the worst-case scenario noise impact of the proposed use of the site to the following noise-sensitive receivers:

- Hotel Receiver – H1
- Residential Receiver – R1
- Commercial Receiver – C1 to C9
- Phase A Receivers

The proposed development has the following mechanical noise sources:

- Co-living Plant (L07)
- Commercial Chillers (L08)
- Commercial AHUs (L08)
- Commercial Heating (L08)
- Commercial Cooling Towers (L20)

In order to assess the worst-case scenario, it was assumed that the mechanical plant serving the proposed development is running at any time throughout a 24hr period. With all, night-time is the most stringent period for the noise generated by the operation of the mechanical plant, therefore this criterion was used as the noise target at the boundary of the nearest sensitive receivers for the project.

5.1.1 Maximum Sound Power Levels

Table 16 presents the proposed maximum sound power levels estimated at the discharge and intake louvres to the each of the plantrooms within the proposed development to achieve the noise criteria shown at the nearest sensitive receiver of the site. Typical mechanical plant spectra have been implemented in the calculations and will need to be amended once specific units have been selected later in the design stage.

Table 16: Proposed maximum sound power levels of mechanical plant/equipment

Item	SWL re 10^{-12} W, dB(A)							
	63 Hz	125 Hz	250 Hz	500 Hz	1 kHz	2 kHz	4 kHz	Overall dB(A)
Co-Living Plant (L07)	88	88	85	82	78	75	72	84
Commercial Chillers (L08)	80	81	82	83	82	79	75	86
Commercial AHUs (L08)	91	91	88	85	81	78	75	88
Commercial Heating (L08)	90	89	84	78	77	75	73	83
Commercial Cooling Towers (L20)	97	95	93	92	90	91	85	96

5.1.2 Noise Mitigation Measures

Mitigation measures for the mechanical plant will be considered during the design development phase so as to comply with the outlined criteria at the nearest sensitive receivers, and to assist in meeting the proposed maximum acoustic power at the discharge/intake louvres for each of the plantrooms. These amelioration measures could include but not limited to the following:

- Positioning mechanical plant away from nearby receivers
- Acoustic attenuators fitted to duct work
- Screening around mechanical plant
- Acoustic insulation within duct work

Note that these are potential solutions and subject to detailed assessment in the detailed design. A detailed acoustic assessment will be conducted during the detailed design stage as more information becomes available regarding performance data of specific mechanical equipment or any further mechanical design information. Acoustic treatment will be proposed to ensure compliance with the project noise trigger levels established in Section 4.2.2.

5.2 External Glazing

In order to provide acoustic amenity to occupants of the proposed development and comply with the project specific internal noise levels, the acoustic performance of the building facades was assessed.

The general limiting factor of the performance of a building façade in term of noise attenuation is the glazing. The façade noise levels have been predicted based on a SoundPLAN model that has been calibrated to the noise monitoring level. Note that no attenuation was considered through any external façade components such as louvres etc. and as such the R_W values represent what is required from the outside to the internal spaces through all components.

In order to achieve the internal noise levels established in AS2107 and the DoP Guideline, the minimum recommended glazing types for the facades of the proposed development are presented in Table 17 below. These glazing types correspond to the figures in Appendix B showing the locations on the façade that we require each glass performance type. The glazing types presented below should be considered as the minimum to achieve the required internal noise levels. Greater glazing thicknesses may be required for structural loading, wind loading, thermal requirements etc.

Table 17: Recommended glazing façade systems and acoustic performance

Glazing Type	Glazing Make-Up	Required Acoustic Rating of Glazing Assembly, R_w
Single Glazed	6mm glass	30
Single Glazed	6.38mm laminated glass	32
Single Glazed	8.38mm laminated glass	34

The glazing system proposed above has been provided as a high-level analysis only. The acoustic performance of the glazing facade may be reduced at certain locations within the development during the detailed design phase of the project.

5.3 Traffic Noise Generation Assessment

For the road traffic noise assessment, the traffic generation was based on the predictions for both Phase A and Phase B/C of the development from the Liverpool Civic Place – Phase B & C Stage 2 Development Application, Traffic Impact Assessment (Issue 2) prepared by Ptc. Dated 11 December 2020. This data has been used to calculate the expected noise increase due to traffic associated with the Liverpool Civic Place development onto the surrounding streets.

The assessment has been conducted for residential receivers as per the Road Noise Policy's requirements. The only traffic noise impacted residential receiver is R2 (refer to Figure 1) and is situated on Scott Street, North-East of the Scott St entry to the proposed concept. The results are summarized in Table 18.

Table 18: Existing and predicted traffic noise generation (peak hour) from Phase A and Phase B/C

Location	Existing vehicles AM	Existing vehicles PM	Predicted Increase AM	Predicted Increase PM	Noise Level Increase dB AM	Noise Level Increase dB PM
Scott Street	233	249	Phase A 79	Phase A 68	1.3	1.0
			Phase B&C 81	Phase B&C 70	1.3	1.1
			Total 160	Total 138	2.3	1.9

As the traffic noise at the site (Table 1 and Table 2) is already in excess of the NSW RNP criteria stated in 4.3, Table 10, the NSW RNP states that the primary objective is to reduce the existing level through feasible and reasonable measures to meet the criteria above.

If this is not achievable, *Section 3.4.1 Process for applying the criteria – Step 4* of the NSW RNP states that, *for existing residences affected by additional traffic on existing roads generated by land use developments, any increase in the total traffic noise should be limited to 2 dB above that of the corresponding 'no build option'*.

Based on the results of the assessment, there is predicted to be a 2.3 dB and 1.9dB increase in traffic noise levels during the AM and PM peak periods respectively along Scott Street. The NSW RNP criterion is exceeded by 0.3dB for the AM peak period. However, a 0.3dB Increase in noise level will be imperceptible to the human ear and acoustic amenity will not be impacted. Therefore, the NSW RNP criterion is considered to be met for both the AM and PM peak periods.

5.4 Retail Impact Assessment

An assessment of noise emissions from the operation of the retail tenancies to the co-living units has been conducted. The assessment has been conducted to the requirements outlined in Section 4.1.

The following assumptions and mitigation measures formed the basis of this assessment:

- The noise levels used have been based on measurements conducted and typical speech noise levels for raised voice
- Music has been included indoors with a sound power level of 83 dB(A)
- A conservative number of people within retail facility was used for assessment – Music and 80 people indoors, 10 people outdoors.
- Construction separating the retail and co-living units achieves minimum transmission loss values shown in Table 20.
- There is an awning above the retail premises between people outdoors and the co-living units.

Table 19: Noise source sound power levels

Item	Frequency (Hz) dB									Overall dB(A)
	31.5	63	125	250	500	1000	2000	4000	8000	
1 person raised voice	60	60	58	64	74	69	65	57	43	74
Music	84	84	82	80	78	75	69	67	57	83

Table 20: Transmissions loss requirements of construction separating retail and co-living units

Item	Transmission Loss (dB)							
	63 Hz	125 Hz	250 Hz	500 Hz	1 kHz	2 kHz	4 kHz	8 kHz
Floor-Ceiling Construction 152mm concrete / 500mm airgap / 13mm standard plasterboard	40	53	58	58	57	55	55	50

Based on these assumptions, the noise during the worst case 15-minute period has been predicted. The results are shown in Table 21.

Table 21: Predicted noise intrusion from retail into co-living units

Noise Intrusion	Predicted Noise Level $L_{A10,15min}$ - dB(A)	Internal Noise Criterion dB(A)	Compliance (Yes/No)
Noise intrusion through floor/ceiling	32	35 - 40	Yes
Noise intrusion through façade	21		
Total	32		

The noise intrusion from the retail premises is expected to have less of an impact on the co-living units than the traffic noise from Scott Street and complies with the internal noise criteria stipulated in AS2107:2016.

6. Construction Noise Emissions

6.1 Qualitative Assessment

To date, a construction noise and vibration impact assessment and subsequent construction noise and vibration management plan was prepared for the submission of the Early Works Development Application (DA-906/2019). This noise and vibration assessment (and management plan) is within the "Liverpool Civic Place - Early Works DA Submission Construction Noise & Vibration Management Plan" prepared by Stantec Australia dated 9th September 2020 (*ref. AC-RE-CNVMP_004*)

The noise and vibration impact assessment recommended noise and vibration mitigation measures as part of the management plan. In principle mitigation measures for Phase B&C have been outlined below.

An in-detail Construction Noise & Vibration Management Plan for the construction of Phase B&C should be prepared in detailed design once the construction methodology, construction equipment and programme are finalised.

6.2 Project Specific Recommendations

Project specific recommendations and required mitigation methods have been listed below within Section 0. For general noise and vibration mitigation and management measures, refer to Section 6.3 of this report.

6.2.1 Noise

The use of a standard A-class hoarding of the following materials and construction will suffice to mitigate the impact of the highest predicted noise levels, installed to the extent illustrated in Figure 2:

- The A-class hoarding should be impervious of gaps and cracks which would compromise its performance
- it should be comprised of acoustically suitable materials such as 17 mm plywood

The barrier shall reduce the noise levels experienced at the commercial premises directly across Scott Street. Locating site amenities towards the site boundaries further increases the shielding of construction noise.

Figure 2: Acoustic Barrier

6.3 General Acoustic Recommendations for Construction

According to AS 2436 – 2010 *Guide to noise and vibration control on construction, demolition and maintenance sites* the following techniques could be applied to minimize the spread of noise and vibrations to the potential receivers.

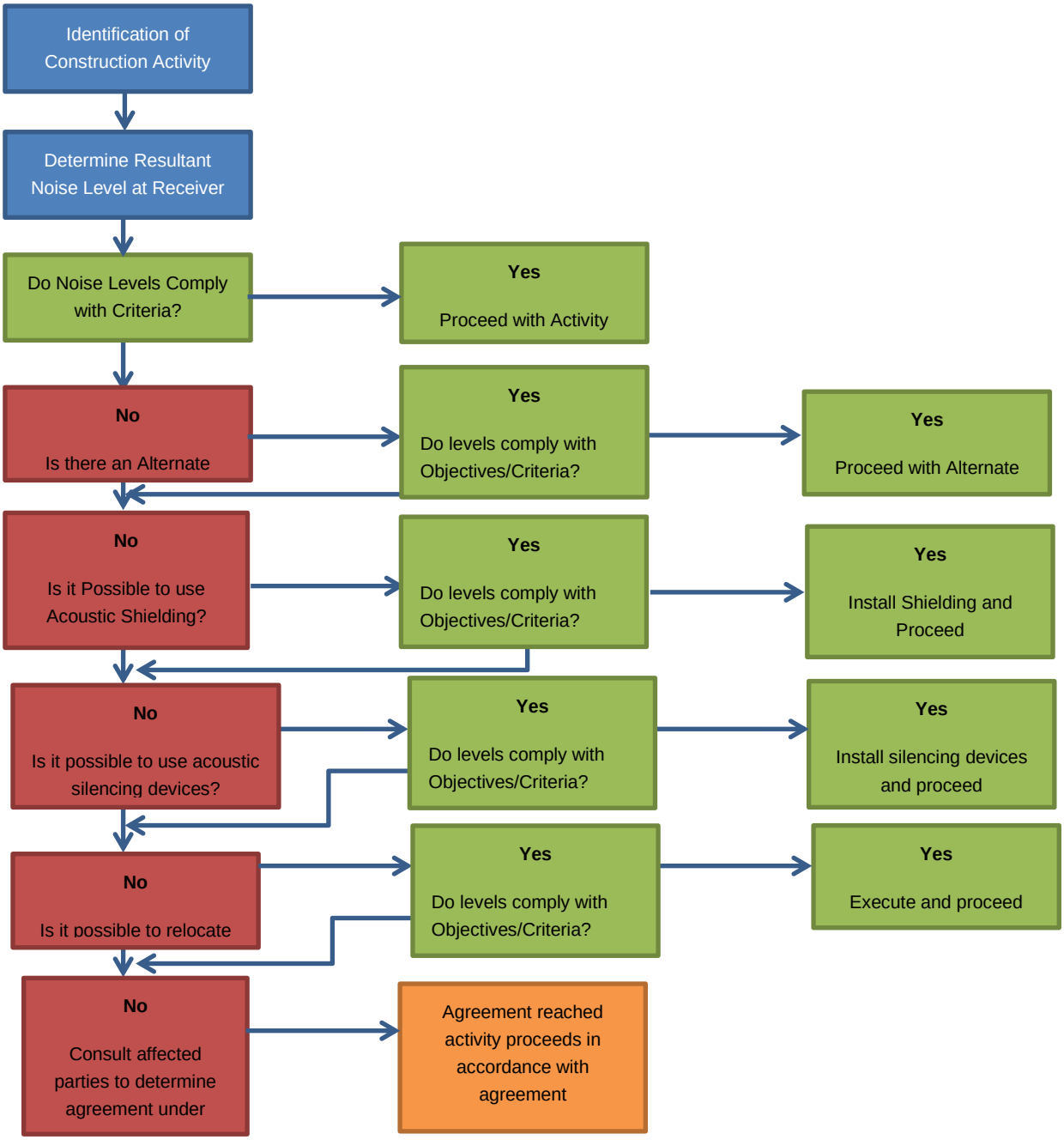
6.3.1 Noise

Figure 3 demonstrates the preferred order of actions taken to mitigate excessive construction noise emissions. If a process that generates significant noise levels cannot be avoided, the amount of noise reaching the receiver should be minimized. Two ways of achieving this are to either increase the distance between the noise source and the receiver or to introduce noise reduction measures such as screens. Practices that will reduce noise from the site include:

- Increasing the distance between noise sources and sensitive receivers.
- Reducing the line-of-sight noise transmission to residences or other sensitive land uses using temporary barriers (stockpiles, shipping containers and site office transportables can be effective barriers).
- Constructing barriers that are part of the project design early in the project to introduce the mitigation of site noise.
- Installing purpose-built noise barriers, acoustic sheds and enclosures.

Physical methods to reduce the transmission of noise between the site works and residences, or other sensitive land uses, are generally suited to works where there is longer-term exposure to the noise. A few of these methods have been introduced below.

Figure 3: Noise Mitigation Management Flow Chart



6.3.2 Screening

On sites where distance is limited, screening of noise may be beneficial or even the only way to reduce construction noise impacts on the nearby receivers. Below, screening options for various situations have been introduced. Constructing and utilising these screening methods should be taken into account already during the planning stages.

Temporary buildings: One option to introduce screening is to position structures such as stores, storage piles, site offices and other temporary buildings between the noisiest part of the site and the nearest dwellings. Due to shielding provided by these buildings, some of the noise emission from the site can be reduced. If the buildings are occupied, however, sound insulation measures may be necessary to protect site workers inside the buildings.

Hoarding: Another way of implementing screening is to build hoarding that includes a site office on an elevated structure. This option offers superior noise reduction when compared with a standard, simple hoarding. The acoustic performance is further enhanced when the hoarding is a continuous barrier.

Equipment operating 24h: When it comes to water pumps, fans and other plant equipment that operate on a 24-hour basis, they may not be an irritating source of noise during the day but can be problematic at night. They should therefore be effectively screened by either situating them behind a noise barrier or by being positioned in a trench or a hollow in the ground. Again, generated reverberant noise must be minimised and adequate ventilation should be ensured.

General remarks:

In many cases, it is not practical to screen earthmoving operations effectively, but it may be possible to partially shield a construction plant at the early stages of the project with protective features required to screen traffic noise.

The usefulness of a noise barrier will depend upon its length, its height, its position relative to the source and the receiver, and the material of which it is made. A barrier designed to reduce noise from a moving source should extend beyond the last property to be protected by at least ten times the shortest distance from the said property to the barrier. A barrier designed to reduce noise from a stationary source should, where possible, extend beyond the direct line of sight between the noise source and the receiver by a distance equal to ten times the effective barrier height, which is the height above the direct line between source and receiver.

If the works are already predominantly located within nominally closed structures, careful consideration should be given to reducing noise breakout at any openings.

6.3.3 Cranes

For the early works construction phases, any cranage will be limited to mobile cranes where the engines are typically enclosed in an acoustically treated housing.

6.3.4 Reversing and warning alarms

Community complaints often involve the intrusive noise of alarms commonly used to provide a safe system of work for vehicles operating on a site. Beeper reversing alarm noise is generally tonal and may cause annoyance at significant distances from the work site.

There are alternative warning alarms capable of providing a safe system of work that are equal to or better than the traditional “beeper”, while also reducing environmental noise impacts. The following alternatives should be considered for use on construction sites as appropriate:

- Broadband audible alarms incorporating a wide range of sound frequencies (as opposed to the tonal-frequency ‘beep’) are less intrusive when heard in the neighbourhood.
- Variable-level alarms reduce the emitted noise levels by detecting the background noise level and adjusting the alarm level accordingly.
- Proximity alarms that use sensors to determine the distance from objects, such as people or structures, and generate an audible alarm in cabin for the driver.
- Spotters or observers.

The above methods should be combined, where appropriate.

6.4 Complaint Handling Procedures and Community Liaison

It is recommended that the builder directly contact adjacent noise sensitive receivers and provide them with the following information:

- The contact details for a nominated representative in order to make noise / vibration complaints.
- Explain the timeframe for the construction works and the proposed activities, i.e. the proposed start / stop dates of work and a description of the noise producing equipment that will be used.
- Notify the noise sensitive receivers and Liverpool City Council in a timely manner should there be any need for an extension to the proposed arrangements.
- Provide them with a copy of this report as approved by the Liverpool City Council.
- Liverpool City Council should be notified of the nature and details of complaints received (time, complainant etc.) and what remedial action has taken place, if any.
- Where noise is demonstrated as being compliant with criteria, this should not limit the proponent in undertaking further additional reasonable and feasible steps to reduce noise emissions.

To assist in the management of noise and vibration complaints various procedures are to be followed. These include:

- Clearly visible signage identifying any key personnel along with their contact details to be erected along the perimeter of the building site including;
    - A 24-hour contact name, phone number and email address provided for the resident to address any complaint. The signage will declare; “For any enquiry, complaint or emergency relating to this site at any time please contact…”
- Give complaints a fair hearing.
- Have a documented complaints process, including an escalation procedure so that if a complaint is not satisfied there is a clear path to follow.
- Call back as soon as possible to keep people informed of action to be taken to address noise problems. Call back at night time only if requested by the complainant to avoid further disturbance.
- Implement all feasible and reasonable measures to address the source of the complaint.
- A register is to be kept by the contractor to keep a record of complaints and detail any information associated with them. The contents of the register will include:
    - The name and the address of the complainant
    - Time and date of the complaint
    - The nature of the complaint (Noise/Vibration)
    - Subsequent details
    - Remedial action undertaken

The contents of the register will be maintained and updated with any new complaint without delay. The complaints will be reported to both Liverpool City Council and the Contractor. The investigation of the complaint and any remedial actions will be performed by the builder and/or client representative.

In the event of noisy works scheduled, the builder will notify residents 5 business days in advance.

6.5 Noise & Vibration Monitoring Strategy

6.5.1 General Methodology

Noise and vibration levels should be monitored from time to time to ensure that noise generated as a result of remediation and construction activities does not disturb local businesses and residents.

Monitoring may be in the form of regular checks by the builder or indirectly by an acoustic consultant engaged by the builder and in response to any noise or vibration complaints. Where noise and vibration criteria are being exceeded or in response to valid complaints, noise and / or vibration monitoring should be undertaken. This would be performed inside the premises of the affected property and on site adjacent to the affected receivers.

Monitoring is to be undertaken by an experienced noise and vibration monitoring professional or an acoustic consultant. The results of any noise or vibration monitoring are to be provided to the relevant party or person in a timely manner allowing the builder to address the issue and respond to the complaints.

Noise and vibration monitoring can take two forms:

- Short-term monitoring
- Long-term monitoring

Both of these approaches are elaborated below.

6.5.2 Short-term Monitoring

Short-term monitoring consists of attended monitoring when critical stages of the construction are occurring. This normally provides real-time assistance and guidance to the subcontractor on site, telling them when the noise and vibration criteria are exceeded. Thus, the selection of alternative method on construction or equipment selection is allowed in order to minimise noise and vibration impacts.

6.5.3 Long-term Monitoring

Similarly, to short-term monitoring, long-term monitoring provides real-time alerts to the builder / site manager when the noise and vibration criteria are exceeded. Instead of someone being on site measuring, noise and vibration loggers are used.

Typically, the noise and vibration loggers stay on site for a period of several months for the critical construction stages of the project, such as the demolition and excavation phases.

Both methodologies are complementary and normally used simultaneously providing a significant amount of data via the long-term monitoring, but also providing information on the sources of noise and vibration generating exceedances via the short-term or attended monitoring.

6.5.4 Noise & Vibration Monitoring Program

A monitoring programme for the early works construction is proposed in Table 22. The monitoring programme is to be carried out during the likely noisiest periods during each construction phase as agreed with the Acoustic engineer and Contractor.

Refer to Figure 4 for the receiver locations corresponding the monitoring locations.

Figure 4: Proposed monitoring locations

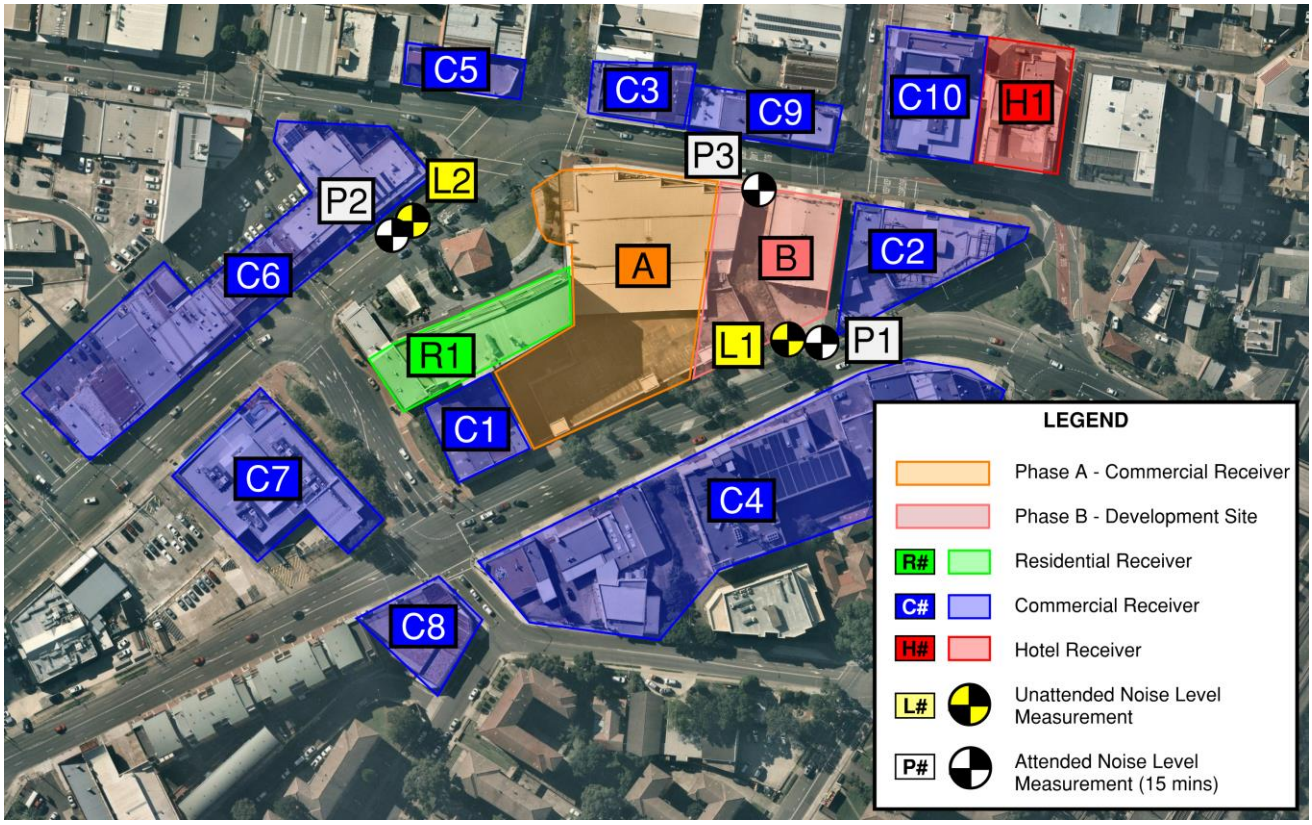


Table 22: Noise and vibration monitoring programme

Construction Phase	Location Reference	Monitoring Required
Superstructure & Facade	Phase A	Noise
	C2	Noise

7. Conclusion

An acoustic assessment has been conducted in support of a Stage 2 Development Application for Phase B&C of Liverpool Civic Place at 40-42 Scott Street, Liverpool.

This report has provided criteria, in-principle treatment and design requirements which aim to achieve the statutory criteria discussed in Section 5. In terms of noise and vibration criteria, we have provided the following:

- Noise criteria for internal noise levels according to AS/NZS 2107:2016, provided in Section 4.1.
- Noise criteria for noise emissions from the development to noise-sensitive receivers in accordance with the NSW NPI, provided in Section 4.2.
- Traffic noise generation criteria for additional vehicle movements on public roads presented in Section 4.3.
- Construction noise criteria provided in Section 4.4.
- Construction vibration criteria for human comfort and structural damage, provided in Section 4.5.

The noise emissions from mechanical plant and equipment, the retail impact assessment and traffic noise generation assessment have been conducted in accordance with the methods outlined in the noise and vibration impact assessment prepared for the masterplan. This has been achieved by providing a 3 dB(A) reduction in the allowable noise limit, allowing the total noise level from Phase A, B & C to be limited to the cumulative masterplan noise limit.

The maximum sound power levels for mechanical plant rooms presented in this report are based on the project noise trigger levels established in Section 5.1.1. Should the plant sound power levels exceed levels presented in this report, additional noise mitigation measures will be required. These measures will be developed and implemented during the detailed design stage.

A traffic impact assessment has been conducted in accordance with the NSW Road Noise Policy and referenced documents. Based on this assessment, there is not expected to be any exceedance in the noise criteria established in the NSW RNP.

Having given regard to the above listed conclusions, it is the finding of this noise and vibration assessment that the proposed development is compliant with the relevant noise and vibration controls for the proposed types of uses, as it is expected to comply with all applicable regulations with regards to noise and vibration, particularly those listed above.

The information presented in this report shall be reviewed if any modifications to the features of the proposed development specified in this report occur, including and not restricted to selection of air-conditioning units, layout of equipment, modifications to the building and introduction of any additional noise sources

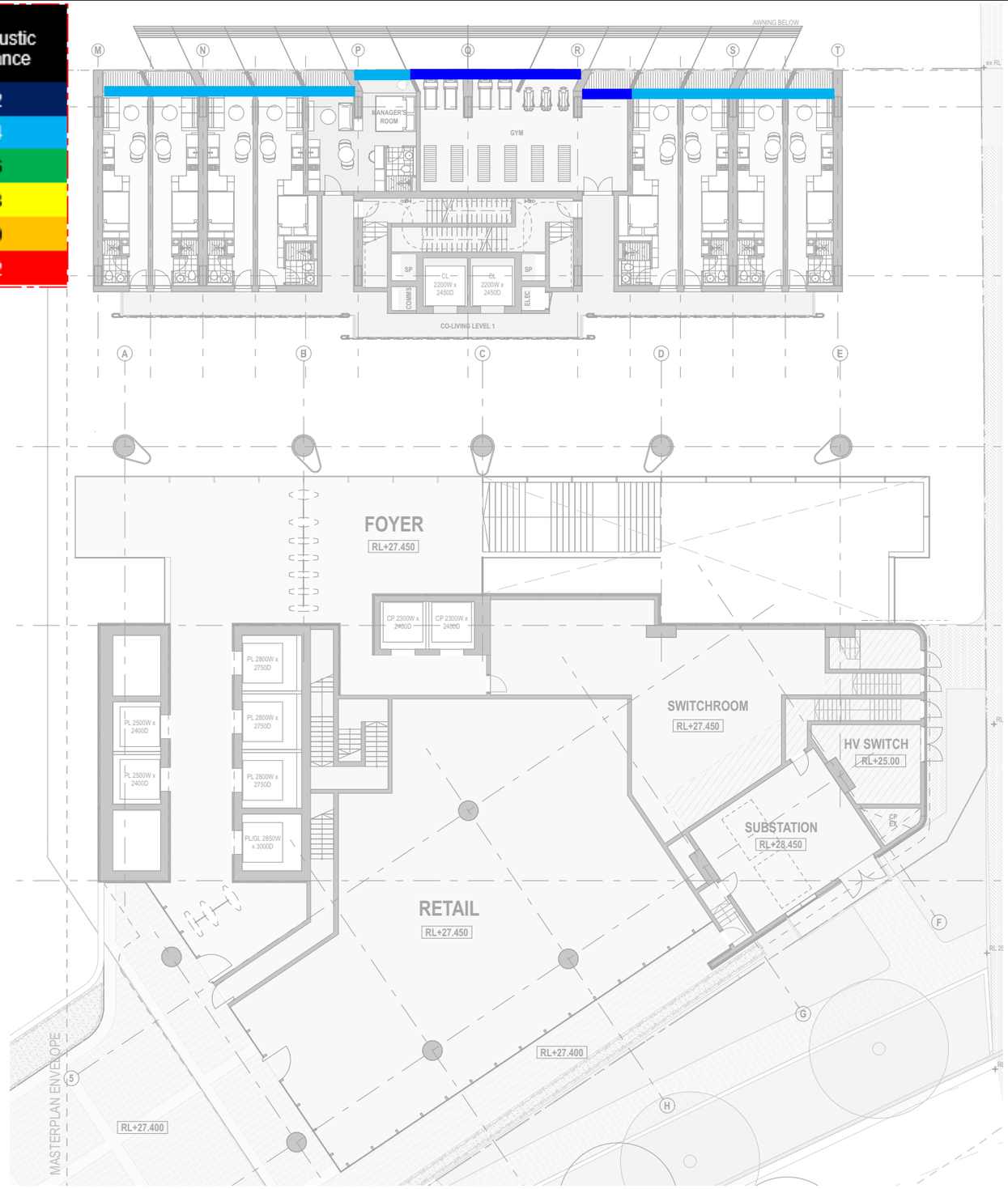
Appendix A Glossary of Acoustic Terms

NOISE	
Acceptable Noise Level:	The acceptable LAeq noise level from industrial sources, recommended by the EPA (Table 2.1, INP). Note that this noise level refers to all industrial sources at the receiver location, and not only noise due to a specific project under consideration.
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).
Acoustic Barrier:	Solid walls or partitions, solid fences, earth mounds, earth berms, buildings, etc. used to reduce noise.
Ambient Noise:	The all-encompassing noise associated within a given environment at a given time, usually composed of sound from all sources near and far.
Assessment Period:	The period in a day over which assessments are made.
Assessment Location	The position at which noise measurements are undertaken or estimated.
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, when extraneous noise is removed. 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 L90 noise level.
Decibel [dB]:	The units of sound pressure level.
dB(A):	A-weighted decibels. Noise measured using the A filter.
Extraneous Noise:	Noise resulting from activities that are not typical of the area. Atypical activities include construction, and traffic generated by holidays period and by special events such as concert or sporting events. Normal daily traffic is not considered to be extraneous.
Free Field:	An environment in which there are no acoustic reflective surfaces. Free field noise measurements are carried out outdoors at least 3.5m from any acoustic reflecting structures other than the ground
Frequency:	Frequency is synonymous to pitch. Frequency or pitch can be measured on a scale in units of Hertz (Hz).
Impulsive Noise:	Noise having a high peak of short duration or a sequence of such peaks. A sequence of impulses in rapid succession is termed repetitive impulsive noise.
Intermittent Noise:	Level that drops to the background noise level several times during the period of observation.
LAmax	The maximum A-weighted sound pressure level measured over a period.
LAmin	The minimum A-weighted sound pressure level measured over a period.
LA1	The A-weighted sound pressure level that is exceeded for 1% of the time for which the sound is measured.
LA10	The A-weighted sound pressure level that is exceeded for 10% of the time for which the sound is measured.
LA90	The A-weighted level of noise exceeded for 90% of the time. The bottom 10% of the sample is the L90 noise level expressed in units of dB(A).
LAeq	The A-weighted “equivalent noise level” is the summation of noise events and integrated over a selected period of time.

LAeqT	The constant A-weighted sound which has the same energy as the fluctuating sound of the traffic, averaged over time T.
Reflection:	Sound wave changed in direction of propagation due to a solid object met on its path.
R-w:	The Sound Insulation Rating R-w is a measure of the noise reduction performance of the partition.
SEL:	Sound Exposure Level is the constant sound level which, if maintained for a period of 1 second would have the same acoustic energy as the measured noise event. SEL noise measurements are useful as they can be converted to obtain Leq sound levels over any period of time and can be used for predicting noise at various locations.
Sound Absorption:	The ability of a material to absorb sound energy through its conversion into thermal energy.
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 Pressure Level:	The level of noise, usually expressed in decibels, as measured by a standard sound level meter with a microphone.
Sound Power Level:	Ten times the logarithm to the base 10 of the ratio of the sound power of the source to the reference sound power.
Tonal noise:	Containing a prominent frequency and characterised by a definite pitch.

Appendix B – Glazing Mark-up

Acoustic Demand Rating	SGU Acoustic Performance	DGU Acoustic Performance
1	R_w 30	R_w 32
2	R_w 32	R_w 34
3	R_w 34	R_w 36
4	R_w 36	R_w 38
5	R_w 38	R_w 40
6	R_w 40	R_w 42



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REV	DESCRIPTION	DRAWN	APP'D	DATE
01	DA Stage 2 Issue	TMA	BN	19.11.20

LIVERPOOL CIVIC PLACE - STAGE 2 PHASE B
ARCHITECT/CLIENT

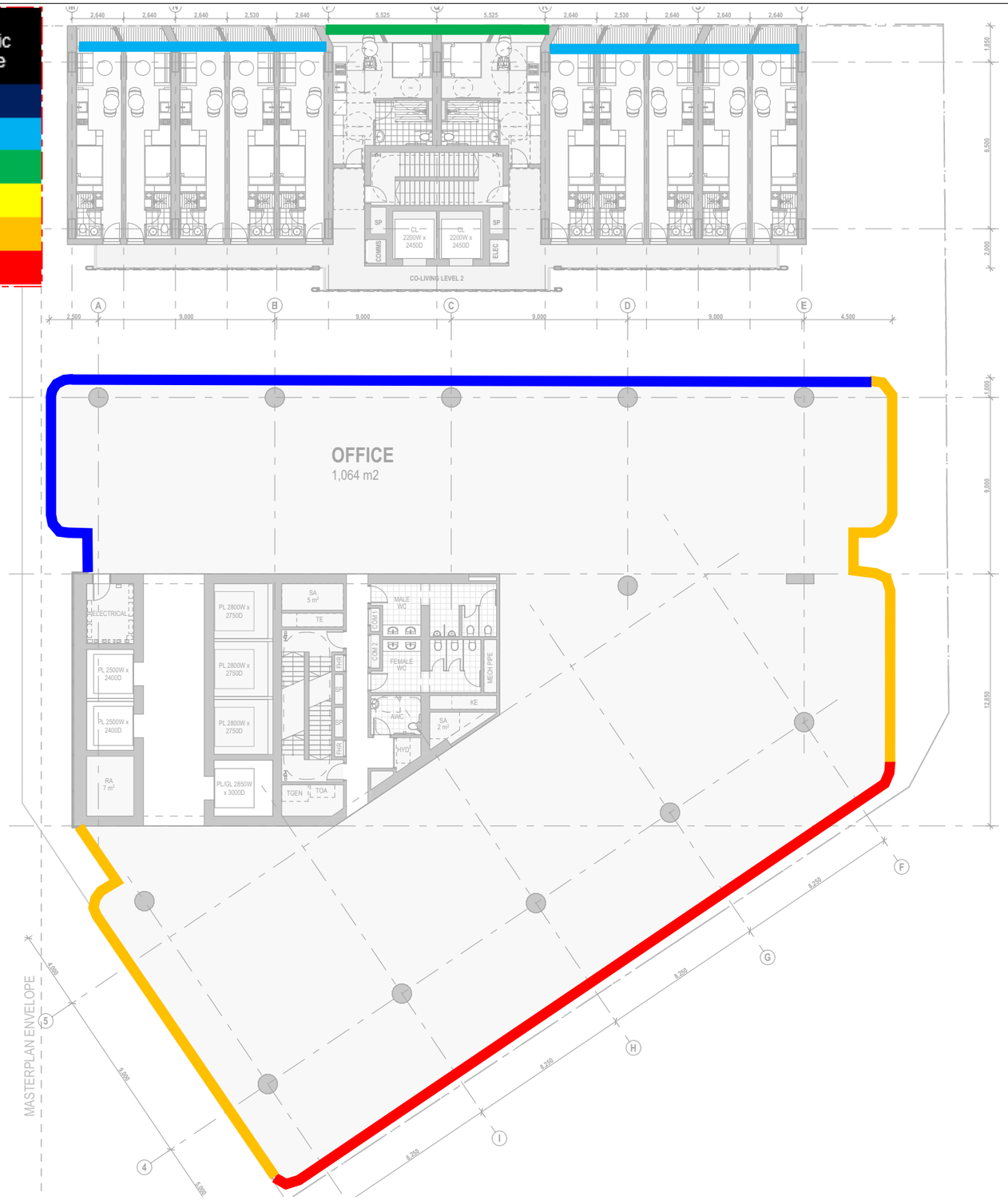
GLAZING PERFORMANCE UPPER GROUND
PROJECT/TITLE

Stantec

PRELIMINARY
NOT FOR CONSTRUCTION
DISCIPLINE

SCALE @ A3	PROJECT No	DRAWING No	REV
1:250	301350001	AC-GL-01	01

Acoustic Demand Rating	SGU Acoustic Performance	DGU Acoustic Performance
1	R_w 30	R_w 32
2	R_w 32	R_w 34
3	R_w 34	R_w 36
4	R_w 36	R_w 38
5	R_w 38	R_w 40
6	R_w 40	R_w 42



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REV	DESCRIPTION	DRAWN	APP'D	DATE
01	DA Stage 2 Issue	TMA	BN	19.11.20

LIVERPOOL CIVIC PLACE - STAGE 2 PHASE B
ARCHITECT/CLIENT

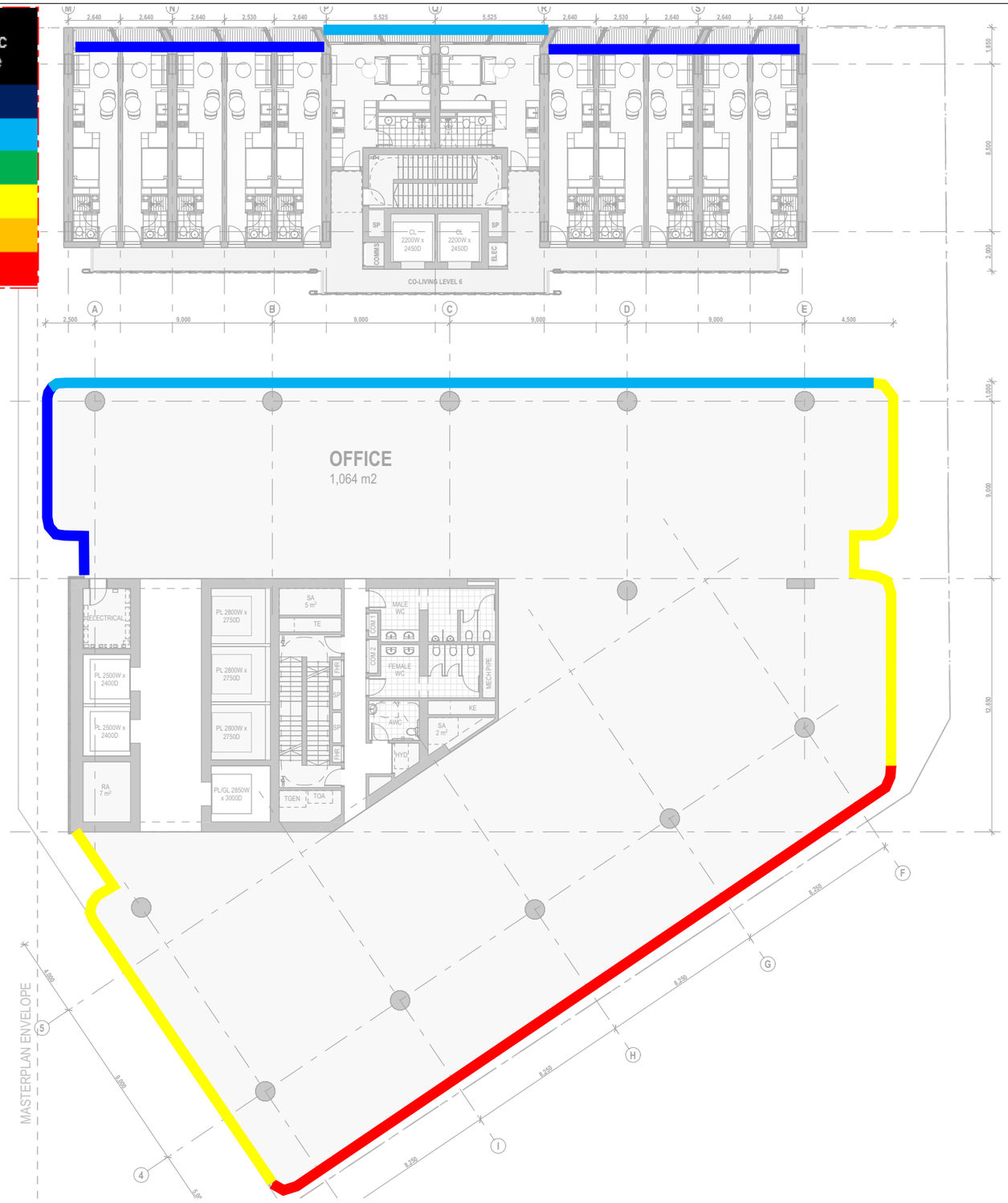
GLAZING PERFORMANCE LEVEL 1-3
PROJECT/TITLE

Stantec

PRELIMINARY
NOT FOR CONSTRUCTION
DISCIPLINE

SCALE @ A3	PROJECT No	DRAWING No	REV
1:250	301350001	AC-GL-02	01

Acoustic Demand Rating	SGU Acoustic Performance	DGU Acoustic Performance
1	R_w 30	R_w 32
2	R_w 32	R_w 34
3	R_w 34	R_w 36
4	R_w 36	R_w 38
5	R_w 38	R_w 40
6	R_w 40	R_w 42



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REV	DESCRIPTION	DRAWN	APP'D	DATE
01	DA Stage 2 Issue	TMA	BN	19.11.20

LIVERPOOL CIVIC PLACE - STAGE 2 PHASE B
ARCHITECT/CLIENT

GLAZING PERFORMANCE LEVEL 4-6
PROJECT/TITLE

Stantec

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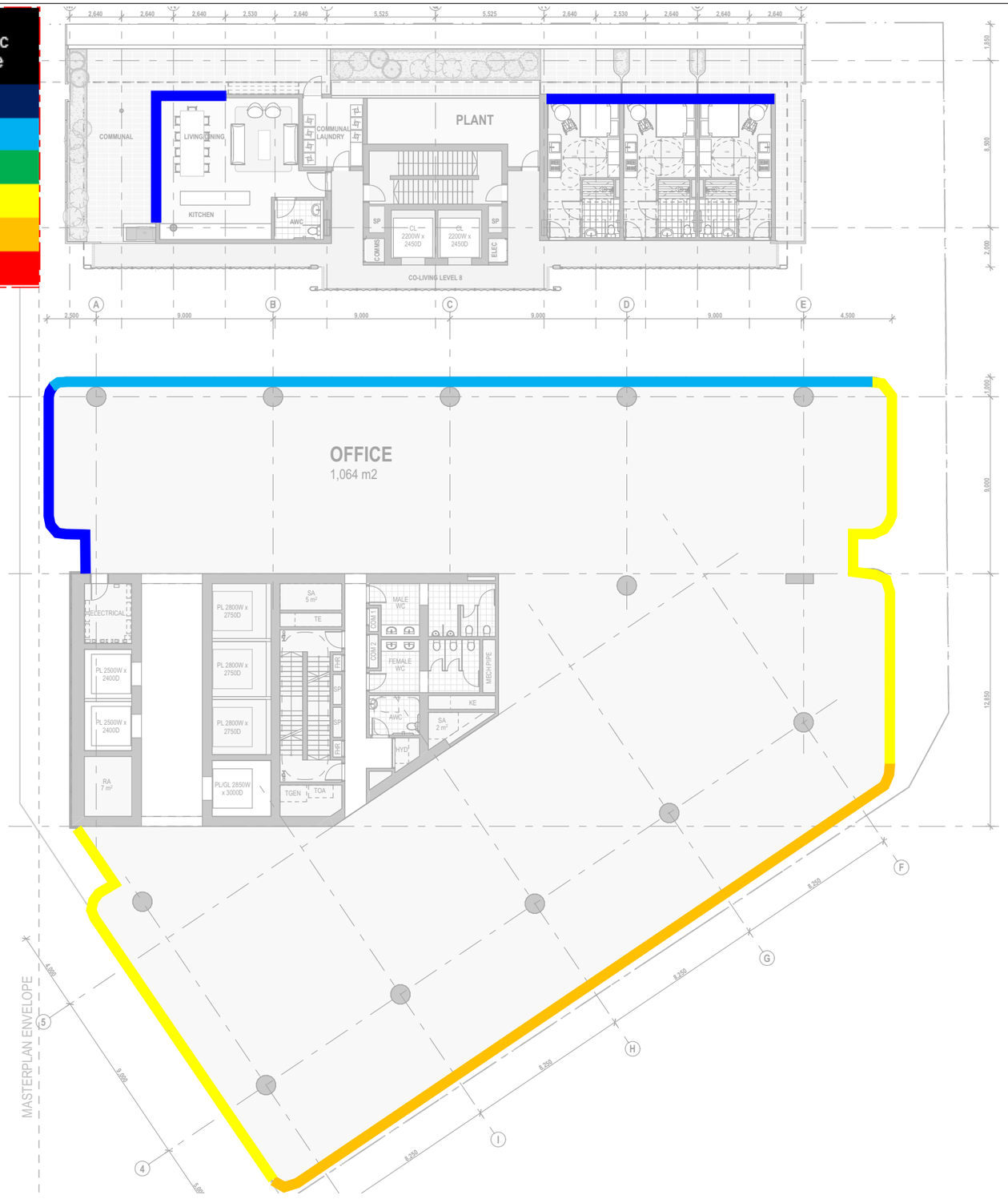
DISCIPLINE

1:250	301350001	AC-GL-03	01
SCALE @ A3	PROJECT No	DRAWING No	REV

Acoustic Demand Rating	SGU Acoustic Performance	DGU Acoustic Performance
1	R_w 30	R_w 32
2	R_w 32	R_w 34
3	R_w 34	R_w 36
4	R_w 36	R_w 38
5	R_w 38	R_w 40
6	R_w 40	R_w 42



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REV	DESCRIPTION	DRAWN	APP'D	DATE
01	DA Stage 2 Issue	TMA	BN	19.11.20

LIVERPOOL CIVIC PLACE - STAGE 2 PHASE B
ARCHITECT/CLIENT

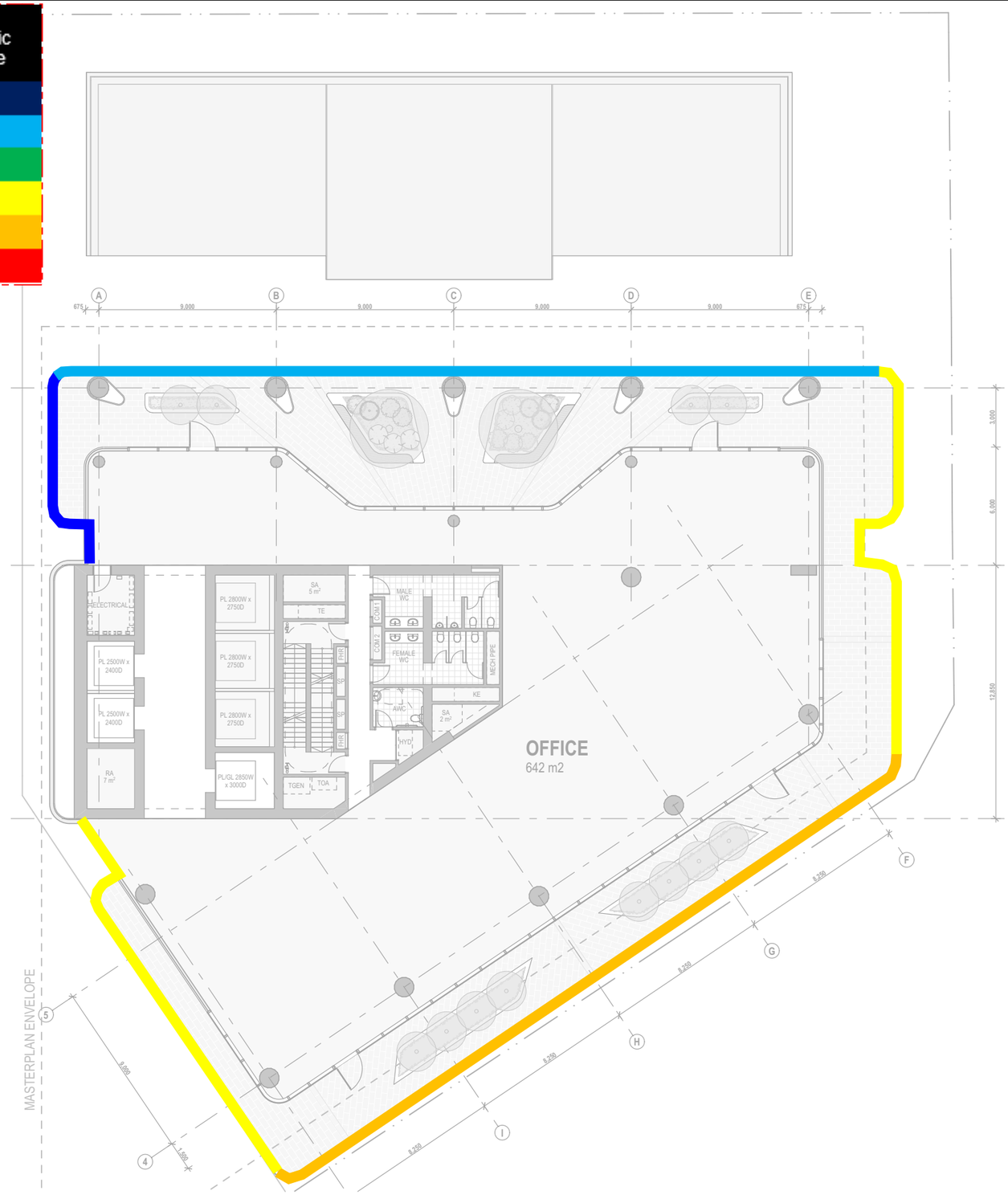
GLAZING PERFORMANCE LEVEL 7
PROJECT/TITLE

Stantec

PRELIMINARY
NOT FOR CONSTRUCTION
DISCIPLINE

SCALE @ A3	PROJECT No	DRAWING No	REV
1:250	301350001	AC-GL-04	01

Acoustic Demand Rating	SGU Acoustic Performance	DGU Acoustic Performance
1	R_w 30	R_w 32
2	R_w 32	R_w 34
3	R_w 34	R_w 36
4	R_w 36	R_w 38
5	R_w 38	R_w 40
6	R_w 40	R_w 42



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REV	DESCRIPTION	DRAWN	APP'D	DATE
01	DA Stage 2 Issue	TMA	BN	19.11.20

LIVERPOOL CIVIC PLACE - STAGE 2 PHASE B

ARCHITECT/CLIENT

GLAZING PERFORMANCE
LEVEL 7 (TERRACE)

PROJECT/TITLE

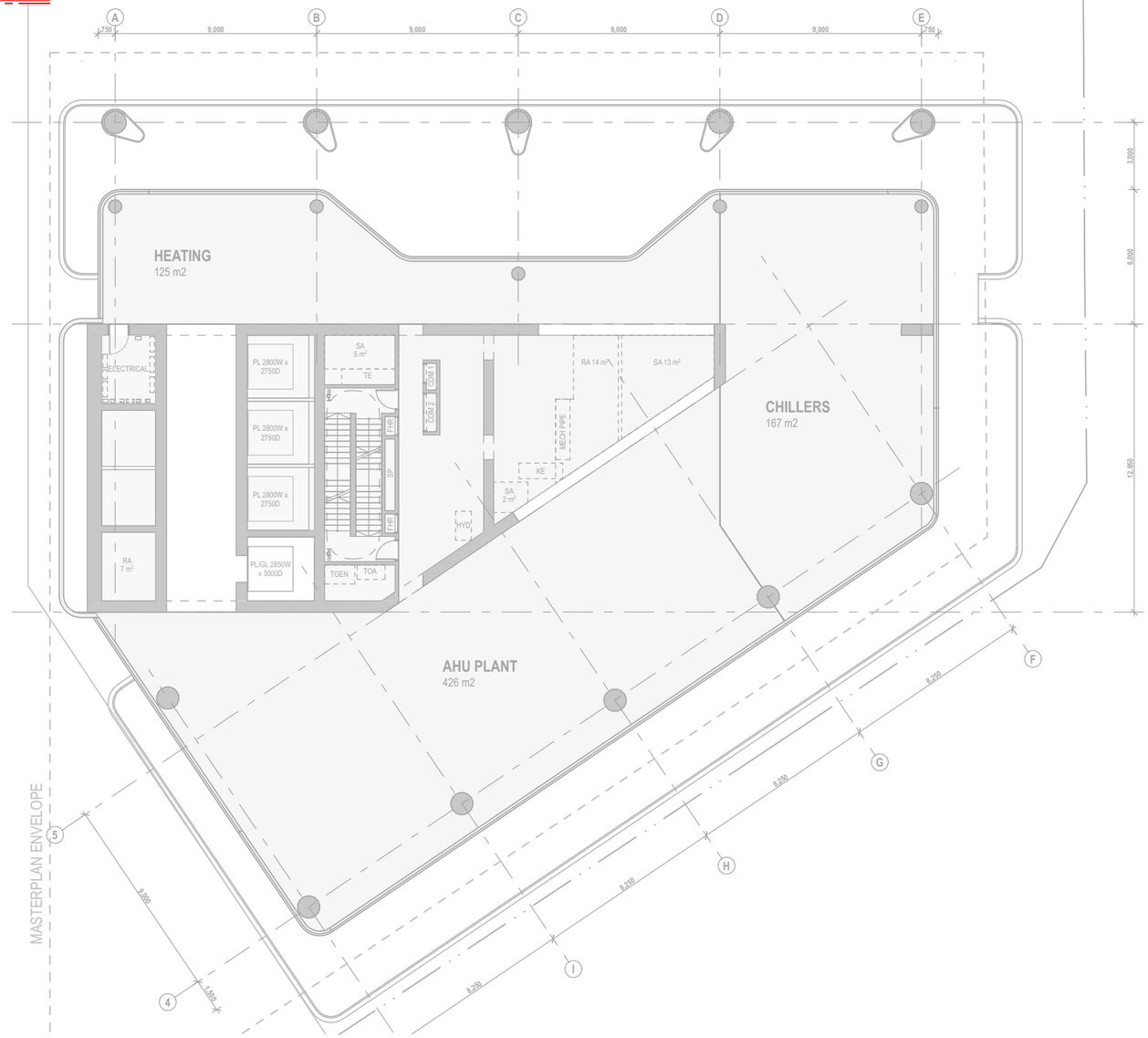
Stantec

PRELIMINARY
NOT FOR CONSTRUCTION

DISCIPLINE

SCALE @ A3	PROJECT No	DRAWING No	REV
1:250	301350001	AC-GL-05	01

Acoustic Demand Rating	SGU Acoustic Performance	DGU Acoustic Performance
1	R_w 30	R_w 32
2	R_w 32	R_w 34
3	R_w 34	R_w 36
4	R_w 36	R_w 38
5	R_w 38	R_w 40
6	R_w 40	R_w 42



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REV	DESCRIPTION	DRAWN	APP'D	DATE
01	DA Stage 2 Issue	TMA	BN	19.11.20

LIVERPOOL CIVIC PLACE - STAGE 2 PHASE B

ARCHITECT/CLIENT

GLAZING PERFORMANCE LEVEL 8 (PLANT)

PROJECT/TITLE

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NOT FOR CONSTRUCTION

DISCIPLINE

SCALE @ A3	PROJECT No	DRAWING No	REV
1:250	301350001	AC-GL-06	01

Acoustic Demand Rating	SGU Acoustic Performance	DGU Acoustic Performance
1	R_w 30	R_w 32
2	R_w 32	R_w 34
3	R_w 34	R_w 36
4	R_w 36	R_w 38
5	R_w 38	R_w 40
6	R_w 40	R_w 42

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REV	DESCRIPTION	DRAWN	APP'D	DATE
01	DA Stage 2 Issue	TMA	BN	19.11.20

LIVERPOOL CIVIC PLACE - STAGE 2 PHASE B
ARCHITECT/CLIENT

GLAZING PERFORMANCE LEVEL 9
PROJECT/TITLE

Stantec

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NOT FOR CONSTRUCTION
DISCIPLINE

SCALE @ A3	PROJECT No	DRAWING No	REV
1:250	301350001	AC-GL-07	01

Acoustic Demand Rating	SGU Acoustic Performance	DGU Acoustic Performance
1	R_w 30	R_w 32
2	R_w 32	R_w 34
3	R_w 34	R_w 36
4	R_w 36	R_w 38
5	R_w 38	R_w 40
6	R_w 40	R_w 42

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REV	DESCRIPTION	DRAWN	APP'D	DATE
01	DA Stage 2 Issue	TMA	BN	19.11.20

LIVERPOOL CIVIC PLACE - STAGE 2 PHASE B
ARCHITECT/CLIENT

GLAZING PERFORMANCE LEVEL 10-19
PROJECT/TITLE

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DISCIPLINE

SCALE @ A3	PROJECT No	DRAWING No	REV
1:250	301350001	AC-GL-08	01

Acoustic Demand Rating	SGU Acoustic Performance	DGU Acoustic Performance
1	R_w 30	R_w 32
2	R_w 32	R_w 34
3	R_w 34	R_w 36
4	R_w 36	R_w 38
5	R_w 38	R_w 40
6	R_w 40	R_w 42

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REV	DESCRIPTION	DRAWN	APP'D	DATE
01	DA Stage 2 Issue	TMA	BN	19.11.20

LIVERPOOL CIVIC PLACE - STAGE 2 PHASE B
ARCHITECT/CLIENT

GLAZING PERFORMANCE LEVEL 20
PROJECT/TITLE

Stantec

PRELIMINARY
NOT FOR CONSTRUCTION
DISCIPLINE

1:250	301350001	AC-GL-09	01
SCALE @ A3	PROJECT No	DRAWING No	REV

Design with
community in mind

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For more information please visit
www.stantec.com

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