61-71 Goulburn Street, Liverpool

Noise and Vibration Impact Assessment

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E-LAB Consulting

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Document QA and Revisions

ISSUE	DATE	COMMENTS	ENGINEER	REVIEWER
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Acoustics & Vibration

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1 EXECUTIVE SUMMARY

This noise and vibration report has been prepared by E-LAB Consulting to accompany a Planning Proposal for Liverpool Private Hospital located at 61-71 Goulburn Street, Liverpool.

This report concludes that the proposed hospital is acceptable and warrants approval subject to the implementation of the mitigation measures outlined in 10.3.

Following implementation of the mitigation measures, the remaining impacts are appropriate.

2 INTRODUCTION

This report has been prepared to accompany a Planning Proposal for Liverpool Private Hospital located at 61-71 Goulburn Street, Liverpool.

The purpose of this report is to:

- Identify surrounding noise-sensitive receivers;
- Identify relevant standards and guidelines and to establish noise and vibration project requirements for the construction and operation of the site;
- Provide a noise and vibration assessment for the construction of the site, which discusses the expected construction stages, expected machinery / activities involved;
- Provide a noise and vibration assessment for the operation of the site, which discusses both noise emissions from the proposed hospital (including traffic generation), and noise intruding into the hospital from road / rail / helicopter; and
- Outline mitigation measures and recommendations to ensure project noise and vibration requirements are satisfied.

3 PROJECT SITE

The project site is located at 61-71 Goulburn Street, Liverpool and sits within the Liverpool City Council's Local Government Area (LGA). The site is generally a rectangular shaped allotment with an overall site area of approximately 4,670m^2.

Surrounding the site to the north, west and south are predominantly residential flat buildings with a small mix of retail and commercial. Bounding the site to the east is Goulburn Street, whereby Liverpool Hospital lies directly opposite this street.

The site comprises of the following allotments and legal description at the date of this report:

- 61 Goulburn Street (SP18729)
- 63 Goulburn Street (Lot 8 DP758620)
- 63 Goulburn Street (Lot 20 DP1113807)
- 63 Goulburn Street (Lot 1 DP25642)
- 67-69 Goulburn Street (Lot 2 DP610334)
- 71 Goulburn Street (Lot 1 DP610334)

The boundaries of the overall site are presented with a red, dashed line in Figure 1.

Figure 1: Aerial image and boundaries of site

4 PROPOSED DEVELOPMENT

The planning proposal seeks development consent for the design, construction and operation of a new 24-storey private hospital, which is proposed to comprise of the following:

- 4 levels of basement, whereby Basement 2 – 4 will accommodate car parking spaces and Basement 1 will accommodate for hospital plant / services, waste storage and a loading dock.
- Access to basement and hospital drop off / pick up will be via Goulburn Street;
- Ground Floor is proposed to comprise of 7 retail tenancies, entry lobby, end of trip facilities, amenities and storage; and
- Level 1 to 23 is proposed to comprise of various rooms and areas for patients and staff (e.g. wards, private offices, consultation rooms, staff dining areas, etc.).

5 METHODOLOGY

To assess the noise and vibration impacts of the proposed development, the following process was carried out:

- Identify and classify the surrounding noise and vibration sensitive receivers surrounding the proposed development;
- Identify and classify the noise and vibration sources generated by the proposed development, together with external noise and vibration sources impacting on the proposed development;
- Carry out site noise investigations to quantify the background noise levels local to the proposed development;
- Determine the project noise and vibration criteria applicable to the proposed development in accordance with relevant standards and guidelines;
- Assess the operational and construction noise and vibration impacts of the noise and vibration sources generated by the proposed development to the surrounding noise-sensitive receivers, together with any impacts on the occupants of the proposed development; and
- Provide details of mitigation measures required to alleviate noise and vibration impacts to achieve the project noise and vibration criteria.

The following operational noise and vibration assessments were conducted as part of this noise and vibration impact assessment:

- Noise impact from helicopter flight movement to and from Liverpool Hospital on the proposed development;
- Noise and vibration impact of mechanical plant and equipment serving the proposed development on surrounding noise and vibration sensitive receivers; and
- Noise impacts of additional traffic on surrounding local roads generated by the proposed development.

The following construction noise and vibration assessments were conducted as part of this noise and vibration impact assessment:

- Noise generated during the construction of the proposed development and associated impacts on the surrounding noise sensitive receivers; and
- Vibration generated during the construction of the proposed development and associated impacts on the surrounding vibration sensitive receivers.

The noise and vibration assessments conducted as part of this report have been assessed to the noise and vibration criteria established in the following guidelines, standards and policies:

- NSW Health Engineering Services Guideline (dated 6 August 2021);
- AS/NZS 2107:2016 “Acoustics - Recommended design sound levels and reverberation times for building interiors”;
- Development Near Rail Corridors and Busy Roads – Interim Guideline;
- NSW Road Noise Policy (RNP), 2011;
- NSW Noise Policy for Industry (NPI) 2017;
- Interim Construction Noise Guideline (ICNG) 2009;
- Assessing vibration: A Technical Guideline 2006;
- British Standard BS5228 – Part 1:1997 “Noise and Vibration Control on Construction and Open Sites.”;
- British Standard BS7358:1993 “Evaluation and Measurement for Vibration in Buildings”;
- German Standard DIN4150 – Part 3: “Structural vibration in buildings – Effects on structures”; and
- ASHRAE Handbook on Noise and Vibration.

6 SITE NOISE INVESTIGATIONS

Site surveys have been conducted by E-LAB Consulting to obtain current background noise levels. It should be noted that the site surveys were conducted during the COVID-19 pandemic. Please refer to Section 6.1 for further discussion surrounding consideration given to noise monitoring results affected by COVID-19.

Long-term noise surveys were carried out on and around the proposed development site to characterise the noise generated by nearby traffic noise sources (Goulburn Street), and background and ambient noise representative of the surrounding noise-sensitive receivers.

6.1 COVID-19 PANDEMIC AND EFFECTS ON NOISE SURVEYS

These noise surveys were carried out under noise-subdued circumstances as a result of the COVID-19 pandemic. For background and ambient noise, the noise statistics obtained will be lower than that of a typical day to day operation and hence can be considered as more conservative.

For the traffic noise measurements, the noise statistics obtained will not be representative of typical traffic noise on Goulburn Street. As a result, the traffic noise measured on-site has been adjusted using comparisons between COVID-19 and standard peak hour traffic volumes on these roads.

8.2.2 Instrumentation

The following equipment was used for the noise surveys:

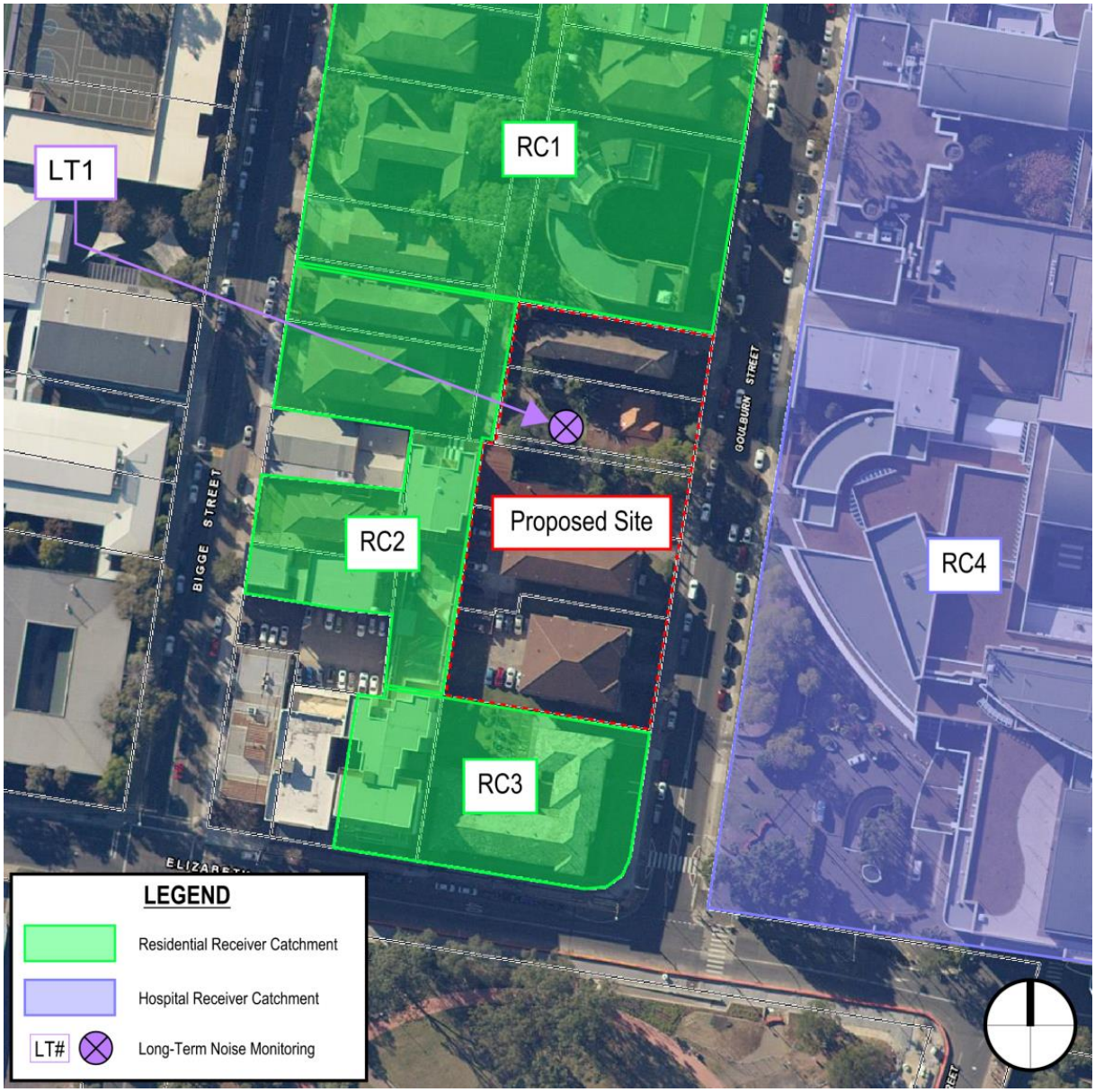
- ARL Environmental Noise Logger, EL-215, S/N 194638

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.

6.2 LOCATIONS

The site location, measurement positions and surrounding noise and vibration sensitive receivers are shown in Figure 2

Figure 2: Overview of the site, surrounding noise-sensitive receivers and measurement locations conducted by E-LAB



6.3 LONG-TERM (UNATTENDED) NOISE SURVEYS

6.3.1 Background Noise

A noise monitor was placed at position LT1 as shown in Figure 2 to measure the background and ambient noise that is representative of the surrounding noise-sensitive receivers. The noise monitor was installed from the 26th of August to the 4th of September 2021. The results of the unattended background and ambient noise survey are shown in Table 1 below (for the day, evening and night periods).

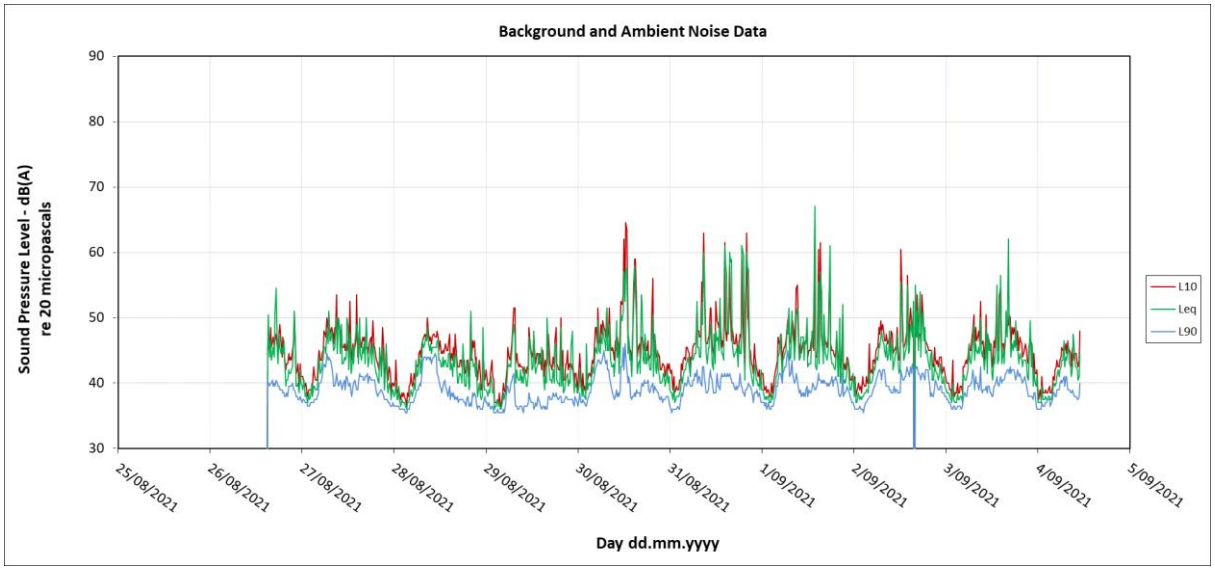
Table 1: Unattended noise monitoring results – LT1

LOCATION	MEASURED EQUILAVENT CONTINUOUS NOISE LEVEL - dB(A)			MEASURED RATING BACKGROUND NOISE LEVELS - dB(A)		
	DAY	EVENING	NIGHT	DAY	EVENING	NIGHT
LT1	50	48	42	39	38	36

The local ambient noise environment is generally dominated by traffic noise from Goulburn Street throughout the majority of the day, evening and night periods. Note that any rain affected data during the period of logging has been excluded from the calculations.

Refer to Figure 3 for the noise data for the total period of measurement.

Figure 3: Long-term noise monitoring data - LT1



7 PROJECT NOISE AND VIBRATION CRITERIA

7.1 RELEVANT NOISE AND VIBRATION ASSESSMENT DOCUMENTS

The project noise and vibration criteria has been established considering the following documents:

- NSW Health Engineering Services Guideline (dated 6 August 2021);
- AS/NZS 2107:2016 "Acoustics - Recommended design sound levels and reverberation times for building interiors";
- Development Near Rail Corridors and Busy Roads – Interim Guideline;
- NSW Road Noise Policy (RNP), 2011; and
- NSW Noise Policy for Industry (NPI) 2017.

7.2 OPERATIONAL NOISE CRITERIA

7.2.1 Internal Noise Levels

AS/NZS 2107:2016

AS/NZS 2107:2016 "Acoustics - Recommended design sound levels and reverberation times for building interiors" provides recommended design sound levels within occupied spaces for various building types and usages. Table 2 below provides design sound levels for health buildings.

Table 2: AS/NZS 2107:2016 design sound levels for health buildings

TYPE OF OCCUPANCY / ACTIVITY	DESIGN SOUND LEVEL - L_{Aeq} dB(A)
Audiological Test Rooms	See AS/NZS 1269.4 and AS ISO 8253
Emergency Areas	40 – 45
Control Rooms	40 – 50
Corridors and Lobby Spaces	< 50
Consulting Rooms	40 – 45
Delivery Suites	45 – 50
Dental Clinics	40 – 45
Dining Areas	40 – 45
Geriatric Rehabilitation	40 – 45
Intensive Care Wards	40 – 45
Kitchens, Sterilizing and Service Areas	< 55
Laboratories	40 – 50
Maintenance Workshops	< 60
MRI / CT Scan / X-Ray / Ultra sound Areas	45 – 50
Nurseries	35 – 45
Nurses' Stations	40 – 45
Office Areas	35 – 45

TYPE OF OCCUPANCY / ACTIVITY	DESIGN SOUND LEVEL - L_{Aeq} dB(A)
Operating Theatres	40 – 50
Patient Lounge	40 – 45
Post-Op, Pre-Op, Recovery Rooms	40 – 45
Pharmacies	45 – 50
Staff Rooms	40 – 45
Sterilizing Areas in Operating Theatres	40 – 45
Surgeries / Treatment / Procedure Rooms	40 – 45
Utility Rooms	50 – 60
Single Bed Ward	35 – 40
Multi Bed Ward	35 – 40
Waiting Rooms, Reception Areas	40 – 50

NSW Health Engineering Services Guideline

Similarly, NSW Health Engineering Services Guideline (dated 6 August 2021) also provides recommended design sound levels for various spaces within a patient care hospital and outpatient facilities. Table 3 below provides design sound levels as presented in the ESG.

Table 3: NSW Health ESG design sound levels

AREA DESIGNATION	CONTINUOUS INTERVAL NOISE LEVELS - L_{Aeq} dB(A)	
	SATISFACTORY	MAXIMUM
CLINICAL		
Operating Theatre	40	45
Birthing Room & Delivery Suite	45	50
Intensive Care	40	45
Patient Room / Single Room Ward	35	40
Multi Bed Ward	35	40
Toilet / Ensuite	50	55
Patient Corridor	40	50
Counselling / Bereavement / Interview Room	40	45
Consultation Room	40	45
Speech and Language Therapy	35	40
Treatment / Medication / Examination Rooms	40	45
PUBLIC AREAS		
Corridors and Lobby Spaces	40	50

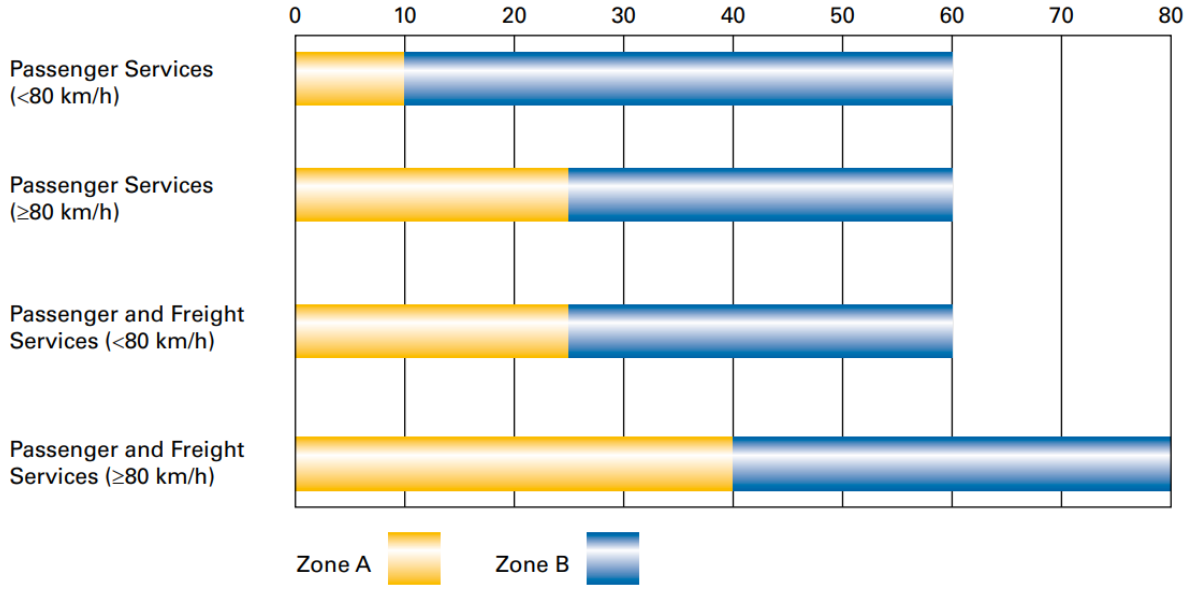
AREA DESIGNATION	CONTINUOUS INTERVAL NOISE LEVELS - L_{Aeq} dB(A)	
	SATISFACTORY	MAXIMUM
Cafeterias / Dining	45	50
Toilets	45	55
Waiting Room, Reception Areas	40	50
Multi Faith / Chapel	30	35
STAFF BACK-OF-HOUSE AREAS		
Meeting Room	35	40
Board / Conference Room (Large)	30	35
Open Plan Offices	40	45
Private Offices	35	40
Multi Person Offices	40	45
Locker Room	50	55
Rest Room	40	45
Classrooms, Training Rooms	35	40
Lecture Theatre	30	35
Library	40	45
Work Shops	45	50
Plant Rooms	N/A	< 85
Laboratories	45	50

Development Near Rail Corridors and Busy Roads – Interim Guideline

Rail Noise

Figure 4 has been extracted from the Interim Guideline, and provides a guide as to the level of assessment required when noise sensitive developments are located in the vicinity of existing rail lines. Zones A and B are indicative acoustic assessment zones where sensitive land-uses are likely to be adversely affected.

Figure 4: Acoustic assessment zones based on distance (m) of noise-sensitive development from operation track (not corridor)



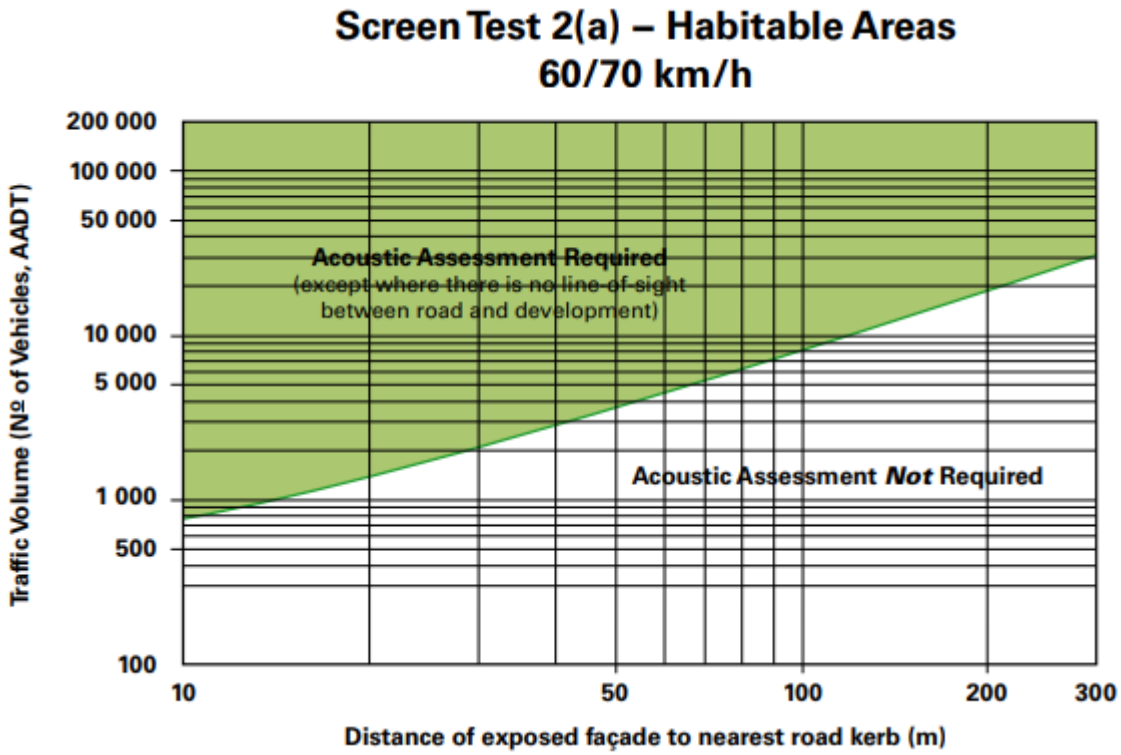
Given the proposed development boundary is located more than 200 metres from the nearest rail corridor, an assessment of rail noise to the facades of the proposed development is not required.

Road Noise

Figure 5 has been extracted from the Interim Guideline, and provides a screening test for noise sensitive developments that takes into account the volume of traffic and the distance between the proposed development and the busy road. Clause 102 of the State Environmental Planning Policy (Infrastructure) 2007, through which the Interim Guideline road noise criteria applies through, only applies for roads with an annual average daily traffic volume of more than 20,000 vehicles, or if the road is a freeway, tollway or transitway. The screen test has been conducted to establish whether or not an acoustic assessment is required.

If the façade of the development does not have direct line of sight to the busy road, an assessment is not required.

Figure 5: Screen tests for habitable areas of multiple dwellings (noting that any exposed facade is direct line-of-sight)



In this case, the closest roads with more than 20,000 AADT are Copeland Street / Hume Highway and Newbridge Road, based on Transport for NSW's Traffic Volume Viewer. The distance from the closest façades within the proposed development to Copeland Street / Hume Highway and Newbridge Road are well more than 300 metres away (approximately 600-800 metres). As such, an acoustic assessment of the road noise emissions to the façade of the proposed development is not required.

7.2.2 External Noise Emissions

NSW EPA Noise Policy for Industry (NPI) 2017 – Industrial Noise (Plant and Equipment)

The NSW EPA's Noise Policy for Industry (NPI) 2017 has been implemented to assess the noise impacts of mechanical plant and equipment, as well as other industrial noise sources on the surrounding receiver catchments.

The NPI sets out a framework for the derivation of project noise trigger levels that are used to assess the potential impacts of noise from industry (and industrial noise sources) and indicate the noise level at which feasible and reasonable noise management measures should be considered.

This policy applies to noise sources from activities listed in Schedule 1 of the POEO Act and those regulated by the EPA. This includes noise sources from mechanical plant and equipment within the proposed redevelopment, for which this policy will be applied.

The project noise trigger level provides a benchmark for assessing a proposal, where if exceeded, indicates a potential noise impact on the community and so triggers a management response such as additional mitigation measures. The project noise trigger level is the lower (the more stringent) value of the project intrusiveness noise level and project amenity noise level determined in Sections 2.3 and 2.4 of the NPI, respectively.

Project Intrusiveness Noise Level

The intrusiveness of an industrial noise source may generally be considered acceptable if the level of noise from the source (in terms of L_{Aeq}) measured over a 15-minute period does not exceed the background noise level by more than 5 dB when beyond a minimum threshold. The project intrusiveness noise level is only applicable to surrounding residential receivers.

To account for the temporal variation of background noise levels, the method outlined in Fact Sheet A of the NPI establishes a method in determining the Rating Background Noise Level (RBL) to be used in the assessment.

The intrusiveness noise level is determined as follows:

$L_{Aeq,15min}$ (Intrusiveness Criteria) = Rating Background Noise Level (RBL) + 5 dB(A)

Where the RBLs established in accordance with Fact Sheet A are lower than the values presented in Table 4 for each assessment period, the values presented in Table 4 shall be used for that particular assessment period. These result in the minimum intrusiveness noise levels provided in Table 4.

Table 4: Minimum assumed RBLs and project intrusiveness noise levels

TIME OF DAY	MINIMUM ASSUMED RBL - dB(A)	MINIMUM PROJECT INTRUSIVENESS NOISE LEVELS - $L_{Aeq,15min}$ dB(A)
Day	35	40
Evening	30	35
Night	30	35

Table 5 provides the project intrusiveness noise levels applicable to each of the surrounding residential noise-sensitive receivers.

Table 5: Project intrusiveness noise level criteria for each residential receiver catchment

RECEIVER CATCHMENT	TIME OF DAY	MEASURED RBL - dB(A)[1]	PROJECT INTRUSIVENESS NOISE LEVELS - $L_{Aeq,15min}$ dB(A)
RC1, RC2 and RC3	Day	39	44
	Evening	38	43
	Night	36	41

Project Amenity Noise Level

The recommended amenity noise levels represent the objective for total industrial noise at a receiver location, whereas the project amenity noise level represents the objective for noise from a single industrial development at a receiver location.

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 = Recommended Amenity Noise Level (see Table 6) – 5 dB(A)

The following exceptions to the above method to derive the project amenity noise level apply:

- In areas with high traffic noise levels. Where the level of transport noise, road traffic noise in particular is high enough to make noise from an industrial source inaudible, the project amenity noise level shall be set at 15 dB(A) below the measured $L_{Aeq,period(traffic)}$ for the particular assessment period
- In proposed developments in major industrial clusters
- Where the resultant project amenity noise level is 10 dB(A) or more lower than the existing industrial noise level. In this case the project amenity noise levels can be set at 10 dB(A) below existing industrial noise levels if it can be demonstrated that existing industrial noise levels are unlikely to reduce over time
- Where cumulative industrial noise is not a necessary consideration because no other industries are present in the area, or likely to be introduced into the area in the future. In such cases the relevant amenity noise level is assigned as the project amenity noise level for the development

The recommended amenity noise level, project amenity noise level, and converted project amenity noise level for comparison with the intrusiveness criteria (from time of day period to 15-minute) is provided for each surrounding receiver catchment in Table 6.

Table 6: Project amenity noise level criteria for each receiver catchment

RECEIVER CATCHMENT	RECEIVER TYPE	TIME OF DAY	RECOMMENDED AMENITY NOISE LEVEL - $L_{Aeq,period}$ dB(A)	PROJECT AMENITY NOISE LEVEL - $L_{Aeq,period}$ dB(A)	PROJECT AMENITY NOISE LEVEL - $L_{Aeq,15min}$ dB(A)
RC1, RC2 and RC3	Residential – Suburban[1]	Day	55	50	53
		Evening	45	40	43
		Night	40	35	38
RC4	Hospital Ward	Noisiest 1-hour	35 Internal 50 External	30 Internal 45 External	33 Internal 48 External

Note 1: Suburban residential as classified in Table 2.3 of the Noise Policy for Industry (NPI) 2017

Sleep Disturbance and Maximum Noise Level Assessment

Where the proposed redevelopment night-time noise levels generated at a residential location exceed either:

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

a detailed maximum noise level event assessment should be undertaken.

Corrections for Annoying Noise Characteristics – Noise Policy for Industry Fact Sheet C

Fact Sheet C contained within the Noise Policy for Industry outlines the correction factors to be applied to the source noise level at the receiver before comparison with the project noise trigger levels established within this report, to account for the additional annoyance caused by these modifying factors.

The modifying factor corrections should be applied having regard to:

- The contribution noise level from the premises when assessed/measured at a receiver location, and
- The nature of the noise source and its characteristics (as set out in Fact Sheet C)

Table C1 within Fact Sheet C sets out the corrections to be applied for any assessment in-line with the NPI. The corrections specified for tonal, intermittent and low-frequency noise are to be added to be added to the measured or predicted levels at the receiver before comparison with the project noise trigger levels. The adjustments for duration are to be applied to the criterion.

Project Noise Trigger Levels

Table 7 presents the project intrusiveness and project amenity noise levels for each period, and each receiver catchment, as well as the resultant project noise trigger levels (PNTLs) that shall be applied for any assessment of impacts of mechanical plant and equipment noise on the surrounding receiver catchments.

Table 7: Project noise trigger levels (PNTL) to be applied to each surrounding receiver catchment

RECEIVER CATCHMENT	RECEIVER TYPE	TIME OF DAY	PROJECT INTRUSIVENESS NOISE LEVEL - $L_{Aeq,15min}$ dB(A)	PROJECT AMENITY NOISE LEVEL - $L_{Aeq,15min}$ dB(A)	SLEEP DISTURBANCE NOISE LEVEL - dB(A)	PROJECT NOISE TRIGGER LEVEL - $L_{Aeq,15min}$ dB(A)
RC1, RC2 and RC3	Residential	Day	44	53	N/A	44
		Evening	43	43	N/A	43
		Night	41	38	40 $L_{Aeq,15min}$ 52 L_{AFmax}	38
RC4	Hospital Ward	Noisiest 1-hour	N/A	33 Internal 48 External	N/A	33 Internal 48 External

7.2.3 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 NSW Road Noise Policy (RNP). 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 8.

Table 8: NSW RNP – Traffic Noise Assessment Criteria

ROAD CATEGORY	TYPE OF PROJECT/LAND USE	ASSESSMENT CRITERIA – dB(A)	
		DAY (7AM – 10PM)	NIGHT (10PM – 7AM)
Freeway/ arterial/ sub-arterial roads	1. Existing residences affected by noise from new freeway/arterial/sub-arterial road corridors	$L_{Aeq, (15\ hour)}$ 55	$L_{Aeq, (15\ hour)}$ 50
	2. Existing residences affected by noise from redevelopment of existing freeway/arterial/sub-arterial roads	$L_{Aeq, (15\ hour)}$ 60	$L_{Aeq, (15\ hour)}$ 55
	3. Existing residences affected by additional traffic on existing freeways/arterial/sub-arterial roads generated by land use developments		
Local Roads	4. Existing residences affected by noise from new local road corridors	$L_{Aeq, (1\ hour)}$ 55	$L_{Aeq, (1\ hour)}$ 50
	5. Existing residences affected by noise from redevelopment of existing local roads		
	6. Existing residences affected by additional traffic on existing local roads generated by land use developments		

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 of the 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'.

Also, the inherent quality of noise from vehicles on public roads arriving to and departing from the site would be indistinguishable from other traffic noise on public roads.

7.3 CONSTRUCTION NOISE CRITERIA

7.3.1 Interim Construction Noise Guideline (ICNG)

The noise criteria outlined within the ICNG has been adopted for the assessment of noise emissions from the construction of the proposed redevelopment.

Airborne Noise – Residential Receiver Catchments

The airborne noise criteria for surrounding residential receiver catchments (RC1, RC2 and RC3) have been extracted from Table 2 in the ICNG and is presented in Table 9 below.

Table 9: NSW ICNG construction noise criteria for surrounding residential receiver catchments (RC1, RC2 and RC3)

TIME OF DAY	MANAGEMENT LEVEL $L_{Aeq,15min}$[1]	HOW TO APPLY
Recommended Standard Hours: Monday – Friday 7am – 6pm Saturday 8am – 1pm No work on Sundays or public holidays	Noise Affected RBL + 10dB	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	▪ 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 1: 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.

Airborne Noise – Hospital Receiver Catchments

The airborne noise criteria for surrounding hospital receiver catchments (RC4) have been extracted from Table 3 in the ICNG and is presented in Table 10 below.

Table 10: NSW ICNG construction noise criteria for surrounding hospital receiver catchments (RC4)

LAND USE	MANAGEMENT LEVEL (APPLIES WHEN PROPERTIES ARE BEING USED) $L_{Aeq,15min}$
Hospital wards and operating theatres	Internal noise level 45 dB(A)

Ground-borne Noise – Residential Receiver Catchments

Ground-borne noise is noise generated by vibration transmitted through the ground into a structure, such as an excavator with a hydraulic hammer attachment, or impact/bore piling. The following ground-borne noise levels for residences have been extracted from Section 4.2 of the ICNG and indicate when management actions should be implemented.

- Evening (6pm to 10pm) – Internal Noise Level: $L_{Aeq,15min}$ 40 dB(A); and
- Night-time (10pm to 7am) – Internal Noise Level: $L_{Aeq,15min}$ 35 dB(A).

An assessment of ground-borne noise to these levels is only required when the ground-borne noise levels are higher than airborne noise levels, and for surrounding residential receiver catchments. The ground-borne noise levels are for evening and night-time periods only. The levels shall be assessed at the centre of the most affected habitable room.

7.4 CONSTRUCTION VIBRATION CRITERIA

It is important for vibration emissions from vibration-intensive equipment utilised during the construction works be managed to maintain appropriate levels of human comfort, and to avoid both cosmetic and structural damage. The vibration limits proposed in the ensuing sub-sections aid in achieving this outcome.

7.4.1 Human Comfort

The office of Environment and Heritage (OEH) developed a document, "Assessing vibration: A technical guideline" in February 2006 to assist in preventing people from exposure to excessive vibration levels from construction and operation of a development 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.

Continuous and Impulsive Vibration

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 11. It should be noted that the human comfort for vibration is more stringent than the building damage criteria.

Table 11: Preferred and maximum weighted RMS values for continuous and impulsive vibration acceleration (m/s^2) 1-80 Hz

LOCATION	ASSESSMENT PERIOD[1]	PREFERRED VALUES		MAXIMUM VALUES	
		z-axis	x- and y-axes	z-axis	x- and y-axes
Continuous vibration					
Critical areas[2]	Day- or night time	0.0050	0.0036	0.010	0.0072
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 places 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 places of worship	Day- or night time	0.64	0.46	1.28	0.92

Note 1: Daytime is 7:00am to 10:00pm and night time is 10:00pm to 7:00am

Note 2: Examples include hospital operating theatres and precision laboratories where sensitive operations are occurring. There may be cases where sensitive equipment or delicate tasks require more stringent criteria than the human comfort criteria specified above. Stipulation of such criteria is outside the scope of this policy, and other guidance documents (e.g. relevant standards) should be referred to. Source: BS 6472–1992

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 12: Acceptable vibration dose values for intermittent vibration ($m/s^{1.75}$)

LOCATION	DAYTIME[1]		NIGHT-TIME[1]	
	PREFERRED VALUE	MAXIMUM VALUE	PREFERRED VALUE	MAXIMUM VALUE
Critical areas[2]	0.10	0.20	0.10	0.20
Residences	0.20	0.40	0.13	0.26
Offices, schools, educational institutions and places of worship	0.40	0.80	0.40	0.80

Note 1: Daytime is 7:00am to 10:00pm and night time is 10:00pm to 7:00am

Note 2: Examples include hospital operating theatres and precision laboratories where sensitive operations are occurring. There may be cases where sensitive equipment or delicate tasks require more stringent criteria than the human comfort criteria specified above. Stipulation of such criteria is outside the scope of this policy, and other guidance documents (e.g. relevant standards) should be referred to. Source: BS 6472–1992

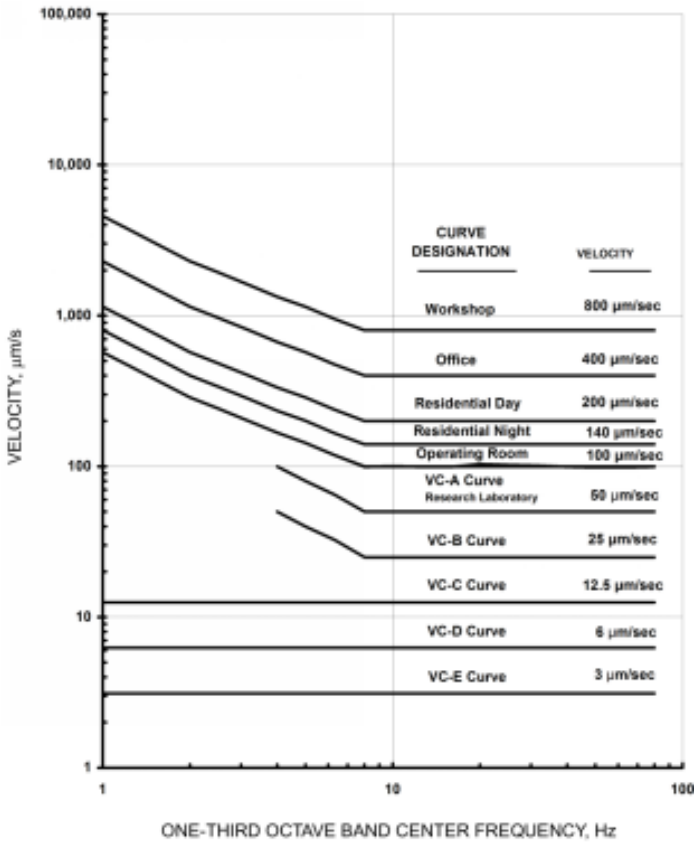
7.4.2 ASHRAE Critical Work Area Vibration Limits

Where sensitive equipment or delicate tasks are located, more stringent criteria than the human comfort criteria specified above may be required. For critical areas where sensitive equipment may be located, Chapter 48 (Noise and Vibration Control) of the ASHRAE Handbook provides vibration limits and curves. These limits are summarised below in Table 13 and the corresponding curves are provided in Figure 6.

Table 13: Critical work area vibration criteria - ASHRAE

CRITICAL WORK AREA TYPE	8 - 80 Hz CURVE mm/s
Hospital operating rooms and other critical work areas	0.102
Microsurgery, eye surgery, neurosurgery; bench microscopes at magnification greater than 400x; optical equipment on isolation tables; microelectronic manufacturing equipment, such as inspection and lithography equipment (including steppers) to 3mm line widths	0.025

Figure 6: Curve designation for vibration criteria - ASHRAE



7.4.3 Cosmetic Damage

Structural vibration thresholds are set to minimize the risk of cosmetic surface cracks and lie below the levels that have the potential to cause damage to the main structure. Table 14 presents guide values for building vibration, based on the vibration thresholds above which cosmetic damage has been demonstrated outlined within BS7385-Part 2:1993. These values are evaluated to give a minimum risk of vibration-induced damage, where minimal risk for a named effect is usually taken as 95% probability of no effect.

Table 14: Transient vibration guide values for cosmetic damage – BS 7385-2:1993

TYPE OF BUILDING	PEAK PARTICLE VELOCITY IN FREQUENCY RANGE OF PREDOMINANT PULSE (PPV)	
	4 Hz TO 15 Hz	15 Hz AND ABOVE
Reinforced or framed structures Industrial or light commercial type buildings	50mm/s	N/A
Unreinforced or light framed structures Residential or light commercial type buildings	15mm/s	20mm/s (50mm/s at 40Hz and above)

7.4.4 Structural Damage

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 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 15 indicates the vibration limits presented in DIN4150-Part 3 to ensure structural damage doesn't occur.

Table 15: Guideline value of vibration velocity, vi, for evaluating the effects of short-term vibration – DIN4150-3

LINE	TYPE OF STRUCTURE	VIBRATION VELOCITY, V_i, IN mm/s			
		FOUNDATION			PLANE OF FLOOR OF UPPERMOST FULL STOREY
		AT A FREQUENCY OF			
		LESS THAN 10HZ	10 TO 50HZ	50 TO 100HZ*	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					

7.4.5 Project Construction Vibration Limits

Table 16 indicates the vibration criteria for the surrounding sensitive receivers to the development.

Table 16: Acceptable vibration dose values for intermittent vibration ($m/s^{1.75}$)

RECEIVER	PERIOD	HUMAN COMFORT VIBRATION OBJECTIVES			BUILDING DAMAGE OBJECTIVES mm/s
		CONTINUOUS mm/s (RMS)		INTERMITTENT $m/s^{1.75}$ (VDV)	
		Z-AXIS	X- AND Y-AXIS		
RC1, RC2 and RC3	Day	10 - 20	7 - 14	0.20 – 0.40	5
	Night	7 - 14	5 - 10	0.13 – 0.26	
RC4	At any time	5 - 10	3.6 – 7.2	0.10 – 0.20	3

8 OPERATIONAL NOISE AND VIBRATION ASSESSMENT

8.1 CARPARK, LOADING DOCK AND WASTE COLLECTION

It is proposed that all carparking, loading dock and waste collection will be situated underground, through basement level 1 to 4. As such, it can be reasonably expected that the use of the carparking, loading dock and waste collection services will not have noise impact on the nearest noise sensitive receivers and noise level criteria in Section 7.2.2 will be met.

8.2 RAIL NOISE ASSESSMENT

As discussed in Section 7.2.1, the proposed development boundary is located more than 200 metres from the nearest rail corridor. As a result, an assessment of rail noise to the facades of the proposed development is not required.

8.3 ROAD NOISE ASSESSMENT

As discussed in Section 7.2.1, the distance from the closest façades within the proposed development to Copeland Street / Hume Highway and Newbridge Road are well more than 300 metres away (approximately 600-800 metres). As such, an acoustic assessment of the road noise emissions to the façade of the proposed development is not required.

8.4 MECHANICAL SERVICES

At this stage of the proposed development, mechanical plant and equipment selections have not been made. During the design development stage of the project, the mitigation measures outlined in Section 10.3 should be considered when preparing the mechanical services to design to ensure compliance with the external noise emissions criteria established in Section 7.2.2.

8.5 TRAFFIC NOISE GENERATION

The traffic noise generation assessment has been based on Ason Group's Planning Proposal (Pre-Gateway) report, with reference number P1362r02 and dated 28/09/2021. Goulburn Street is likely to be the most affected street in terms of traffic noise due to the proximity of the development to nearby residential receivers as well as the street being the proposed entry way into the carpark and loading dock. The existing and predicted increase in AM and PM peak hour traffic volumes for Goulburn Street are presented below in Table 17.

Table 17: Existing and increased traffic volumes along Goulburn Street

YEAR	TYPE	PEAK PERIOD	TOTAL TRAFFIC VOLUME (VEHICLES/HOUR)
2019	Existing Traffic	AM	548
		PM	478
2023	Additional Traffic from 61-71 Goulburn St Development	AM	72
		PM	72
	Additional Traffic from Other Developments	AM	77
		PM	76
	Additional Traffic from Other Developments + Existing Traffic	AM	625
		PM	554
2033	Additional Traffic from 61-71 Goulburn St Development	AM	134
		PM	134
	Additional Traffic from Other Developments	AM	100
		PM	100
	Additional Traffic from Other Developments + Existing Traffic	AM	648
		PM	578

The predicted increase in traffic noise has been based on the methodologies given in the UK Department of Transport 'Calculation of Road Traffic Noise' (CoRTN) document. This model describes noise emitted by a constant traffic flow. The model uses standard curves to approximate vehicle noise levels. It also assumes the traffic can be broken into two broad categories: cars, and heavy vehicles. The source sound levels used in this project to model traffic noise levels are contained within the calculation algorithms of the noise model. The values presented in Table 18 compare the existing noise levels estimated by the model with the estimated noise levels expected from an increase in vehicle movements associated with the proposed development.

Table 18: Predicted increase in traffic noise levels (AM/PM peak hours) along Goulburn St

YEAR	PERIOD	TOTAL TRAFFIC VOLUME WITHOUT DEVELOPMENT (VEHICLES/HOUR)	TOTAL TRAFFIC VOLUME WITH DEVELOPMENT (VEHICLES/HOUR)	PREDICTED INCREASE IN TRAFFIC NOISE, dB(A)
2023	AM Peak	625	697	0.5
	PM Peak	554	626	0.5
2033	AM Peak	648	782	0.8
	PM Peak	578	712	0.9

As shown in Table 18, the predicted increase in peak traffic noise due to the development is 0.5 to 0.9dB(A), which is within the limits given in the Road Noise Policy criteria (as shown in Section 7.2.3). For this reason, we understand that the traffic generated by the proposed development will not have an adverse impact on the existing residents.

9 HELICOPTER NOISE

9.1 INTERNAL NOISE LEVEL CRITERIA

9.1.1 NSW Health Engineering Services Guideline

Helicopter operations can exhibit similar noise characteristics to fixed wing aircraft flybys and also generate high levels of short period steady noise levels hovering or idling. Table 10 of NSW Health ESG establishes recommended design noise levels applicable to frequent operations (frequent operations defined as 1 or more missions per day, on average), together with adjustments for infrequent emergency operations as follows:

- Up to 10 dB(A) less stringent if helicopter operations are less than 1 mission per day, but more than 2 missions per week, on average
- Up to 20 dB(A) less stringent if helicopter operations are very infrequent (less than 2 missions per week, on average) and subject to:
- an absolute limit L_{Amax} 80 dB(A) for any occupied room and
- consideration being given to “future-proofing" the building so that, if helicopter operations were to significantly increase in the future, it would be practical to retrofit suitable acoustic treatment to manage noise impacts to an acceptable standard.

Based on the above, the building façade is proposed to be designed in order to meet the internal design noise levels in the presence of helicopter operations (in accordance with the allowable adjustments above) in accordance with Table 19: Design maximum internal noise levels from helicopter operations as per NSW Health ESG

Table 19: Design maximum internal noise levels from helicopter operations as per NSW Health ESG

AREA DESIGNATION	MAXIMUM INTERNAL NOISE LEVEL FROM HELICOPTER OPERATIONS L_{Amax} – dB(A)
	< 2 MISSIONS / WEEK
CLINICAL	
Operating Theatre	75
Birthing Room & Delivery Suite	80
Intensive Care	75
Patient Room / Single Bed Ward	75
Multi Bed Ward	75
Toilet/ Ensuite	90
Patient Corridor	90
Counselling / Bereavement / Interview Room	75
Consultation Room	75
Speech and Language Therapy	75
Treatment / Medication / Examination Room	75
PUBLIC AREAS	
Corridors and Lobby Spaces	90
Cafeterias / Dining	80
Toilets	90

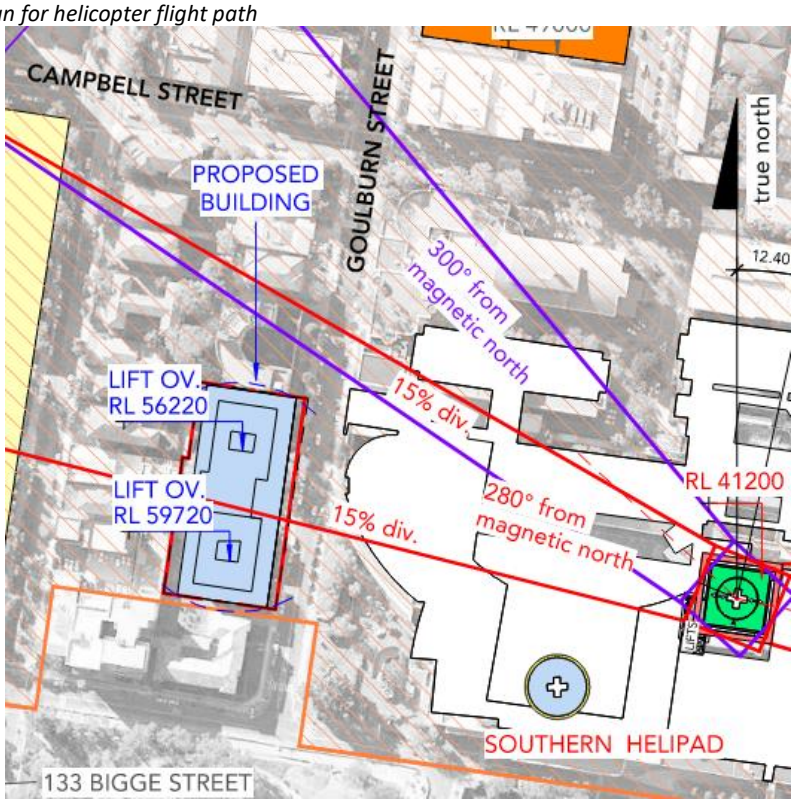
Waiting Rooms, Reception Areas	80
Multi Faith / Chapel	75
STAFF / BACK-OF-HOUSE AREAS	
Meeting Room	80
Board / Conference Room (Large)	80
Open Plan Offices	80
Private Offices	80
Multi Person Offices	80
Locker Room	-
Rest Room	90
Classrooms, Training Rooms	80
Lecture theatre	80
Library	80
Workshops	-
Plant Rooms	-
Laboratories	80

9.2 HELICOPTER NOISE ASSESSMENT

An assessment on the exposure to helicopter noise from Liverpool Hospital (opposite Goulburn Street) has been undertaken. 3D acoustic modelling for external façade noise levels from a helicopter was conducted using the software SoundPlan (Version 8.2). The acoustic modelling was undertaken considering no specific meteorological characteristics such as dominant wind direction and speed or temperature therefore it was considered under neutral conditions.

The previous (in red) and new (in purple) helicopter flight path have been presented in Team2 Architect's *Airspace Plan* drawing, with drawing number PP040 (see Figure 7 below). A mid-point between the inner and outer purple line has been adopted in this assessment to determine an average maximum noise level exposure.

Figure 7: Airspace plan for helicopter flight path



The façade noise levels have been predicted based on a SoundPlan model that has been calibrated to the sound power levels provided in Table 20 (refer to Appendix A for acoustic modelling results).

Table 20: Helicopter sound power level and spectrum

NOISE SOURCE	SOUND POWER LEVEL (DB)							
	63Hz	125Hz	250Hz	500Hz	1KHz	2KHz	4KHz	8KHz
AW139	139	136	135	132	131	125	118	113

During the design development stage of the project, the mitigation measures outlined in Section 11.2 should be considered when designing façade construction to ensure compliance with NSW Health ESG internal noise level criteria established in Section 9.1.1.

10 CONSTRUCTION NOISE AND VIBRATION ASSESSMENT

10.1 PROPOSED CONSTRUCTION ACTIVITIES

In this assessment, the noise impact from the construction works are considered, which are expected to comprise of the following stages:

- Early works (demolition and dismantling);
- Civil works (excavation, retention and foundation); and
- Structural works (construction, façade, finishes and services).

The construction works are expected to occur during the following hours (in line with the NSW ICNG):

- Monday to Friday: 7:00am to 6:00pm;
- Saturday: 8:00am to 1:00pm; and
- Sunday and public holidays: no work.

10.2 EXPECTED CONSTRUCTION EQUIPMENT

The noise sources likely to be associated with the works listed in the previous section of this report are presented in Table 21. The equipment noise levels have been extracted from AS2436:2010 “Guide to Noise and Vibration Control on Construction, Demolition and Maintenance Sites”.

Table 21: Cumulative impact – construction equipment noise levels

STAGES	ESTIMATED TIME	EQUIPMENT	QUANTITY	SOUND POWER LEVEL – dB(A)	ACOUSTICAL USAGE FACTOR (%)	USAGE IN 15-MINUTE PERIOD (MINUTES)	TIME CORRECTED SOUND POWER LEVEL– dB(A) $L_{Aeq,15min}$
Early Works – Demolition & Dismantle	5 months	Jackhammer	1	113	20	3	106
		Electric hand tools	5	102	50	7.5	99
		Excavator 30 tonne	1	110	40	6	106
		Excavator breaker	1	115	40	6	111
		Bobcat	1	107	70	10.5	105
		Cherry picker	1	102	50	7.5	99
		Dump truck	2	108	40	6	104
Excavation, Retention and Foundation	7 months	Excavator 30 tonne	1	110	40	6	106
		Excavator breaker	1	115	40	6	111
		Jackhammer	1	113	20	3	106
		Powered hand tool	4	102	50	7.5	99
		Concrete pump	1	109	50	7.5	106
		Mobile crane	2	110	16	2.4	102
		Bored piling	1	110	16	2.4	102
		Generator	1	104	20	3	97

STAGES	ESTIMATED TIME	EQUIPMENT	QUANTITY	SOUND POWER LEVEL – dB(A)	ACOUSTICAL USAGE FACTOR (%)	USAGE IN 15-MINUTE PERIOD (MINUTES)	TIME CORRECTED SOUND POWER LEVEL– dB(A) $L_{Aeq,15min}$
		Truck	2	108	40	6	104
Structural Works & Façade and Finishes	12 months	Powered hand tool	11	102	50	7.5	99
		Concrete pump	1	109	50	7.5	106
		Mobile crane	2	110	16	2.4	102

10.3 NOISE MODELLING AND ASSUMPTIONS

In order to assess the noise impact from the site during the various construction stages, a noise model was prepared using commercial software SoundPLAN v8.2, which is a comprehensive software package for conducting three-dimensional complex noise propagation modelling. Using the software, a 3D model of the site and its surroundings was constructed including the nearby buildings, and the construction plant and equipment were positioned as noise sources. Within the model, the effects of the environment (built and natural) on propagation of sound were considered to reliably estimate the resulting noise effects on the surrounding noise sensitive receivers.

The noise model represents the 'reasonable' worst case periods of construction activities, meaning that all the equipment of each stage is operating simultaneously during a 15-minute observation period.

The assumptions that were made within the assessment include the following:

- The predicted noise levels represent the worst-case scenario for each receiver;
- The mitigation measures outlined in Section 11.3 are implemented; and
- Neutral weather conditions;

10.4 PREDICTED NOISE LEVELS

The predicted noise levels have been presented in Table 22, Table 23, and Table 24 and have been assessed to the construction noise criteria established in Section 7.3. The noise contour maps produced by the three-dimensional noise propagation modelling are provided in Appendix B.

Table 22: Predicted noise levels – scenario 1: early works – demolition & dismantle

RECEIVER	PREDICTED NOISE LEVEL RANGE - WITHOUT MITIGATION dB(A) $L_{Aeq,15min}$	PREDICTED NOISE LEVEL RANGE – WITH MITIGATION dB(A) $L_{Aeq,15min}$	NOISE MANAGEMENT LEVEL dB(A) $L_{Aeq,15min}$	NOISE MANAGEMENT LEVEL EXCEEDANCE dB	EXCEEDS HIGHLY NOISE AFFECTED LEVEL (YES/NO)
R1	59 - 74	54 - 69	49	5 – 20	No
R2	59 - 79	54 - 74	49	5 – 25	No
R3	64 - 79	59 - 74	49	10 - 25	No
R4	59 - 74	54 - 64	55[1]	Up to 9	N/A

Table 23: Predicted noise levels – scenario 2: excavation, retention & foundations

RECEIVER	PREDICTED NOISE LEVEL RANGE - WITHOUT MITIGATION dB(A) $L_{Aeq,15min}$	PREDICTED NOISE LEVEL RANGE – WITH MITIGATION dB(A) $L_{Aeq,15min}$	NOISE MANAGEMENT LEVEL dB(A) $L_{Aeq,15min}$	NOISE MANAGEMENT LEVEL EXCEEDANCE dB	EXCEEDS HIGHLY NOISE AFFECTED LEVEL (YES/NO)
R1	59 - 74	54 – 69	49	5 – 20	No
R2	64 - 79	59 - 74	49	10 – 25	No
R3	64 - 79	59 - 74	49	10 – 25	No
R4	64 - 69	59 - 64	55[1]	Up to 9	N/A

Table 24: Predicted noise levels – scenario 3: structural works & façade and finishes (L13)

RECEIVER	PREDICTED NOISE LEVEL RANGE - WITHOUT MITIGATION dB(A) $L_{Aeq,15min}$	PREDICTED NOISE LEVEL RANGE – WITH MITIGATION dB(A) $L_{Aeq,15min}$	NOISE MANAGEMENT LEVEL dB(A) $L_{Aeq,15min}$	NOISE MANAGEMENT LEVEL EXCEEDANCE dB	EXCEEDS HIGHLY NOISE AFFECTED LEVEL (YES/NO)
R1	64 – 74	49 – 59	49	0 - 10	No
R2	< 49	< 49	49	-	No
R3	54 - 64	49 – 59	49	0 - 10	No
R4	59 - 69	54 - 64	55[1]	Up to 9	N/A

Note 1: Since the noise management level for hospital wards is an internal noise level, based on the ICNG, a 10dB correction has been applied to establish an external noise management level for RC4.

11 MITIGATION MEASURES

11.1 MECHANICAL SERVICES

Mitigation measures for the mechanical plant should be considered during the Design Development stage so as to comply with the noise emission criteria established in Section 7.2.2. and internal noise levels in Section 7.2.1. These amelioration measures could include, but are not limited to the following:

- Positioning mechanical plant away from nearby noise sensitive receivers;
- Acoustic attenuators fitted to duct work;
- Screening around mechanical plant;
- Acoustic insulation within duct work;
- Acoustically insulated bends fitted to duct work; and
- Reselection of mechanical plant.

11.2 HELICOPTER NOISE

In order to achieve the established internal noise levels outlined in Section 9.1, it is recommended that the modelled external façade noise levels, shown in Appendix A, are considered during the Design Development stage of the project. As part of detailed design, the minimum required acoustic performance of the façade, such as the glazed elements and non-glazed elements, should be determined to meet the internal noise levels outlined in Section 9.1.

It is noted that the greatest exposure to helicopter noise will generally be along the north-eastern corner of the building. Provided that there are noise sensitive internal areas, such as patient rooms and consultation rooms, along the northern and eastern façade, where majority of the façade will be glazing, consideration of double-glazing can be reasonably expected and shall be considered in the subsequent design and approval stages of the project.

11.3 CONSTRUCTION NOISE AND VIBRATION

11.3.1 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.

Noise

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.

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. 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 demountable offices can be effective barriers);
- Constructing barriers that are part of the project design early in the project to introduce the mitigation of site noise; and
- Installing purpose-built noise barriers, acoustic sheds and enclosures.

Screening

On sites where distance is limited, the screening of noise may be beneficial, and this should be taken into account during the planning stages.

If structures such as stores, site offices and other temporary buildings are situated between the noisiest part of the site and the nearest dwellings, some of the noise emission from the site can be reduced. If these buildings are occupied, sound insulation measures may be necessary to protect workers inside the buildings.

A hoarding that includes a site office on an elevated structure offers superior noise reduction when compared with a standard (simple) hoarding. The acoustic performance is further enhanced when the hoarding is a continuous barrier.

Storage of building materials or the placement of shipping containers between the noise source and any noise-sensitive area may also provide useful screening and the same is true of partially completed or demolished buildings. A noisy, stationary plant can be placed in a basement, the shell of which has been completed, provided reverberant noise can be controlled. Where compressors or generators are used in closed areas, it is necessary to ensure that the exhaust gases are discharged directly to the outside air and that there is good cross-ventilation to prevent the build-up of poisonous carbon monoxide fumes and to allow an adequate air supply to maintain efficiency when operating the equipment.

Where such noise barriers are not practical, a worthwhile reduction in noise can be obtained by siting the plant behind and as close as possible to mounds of earth, which may effectively screen any noise-sensitive areas from the plant. These can often be designed into the construction schedule or site arrangement for future landscaping.

Water pumps, fans and other plant equipment that operate on a 24-hour basis may not be an irritating source of noise during the day but may 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 provided this does not generate reverberant noise. In such cases, however, adequate ventilation should also be ensured. Long, temporary earth embankments can provide quite an effective noise screen for mobile equipment moving, for example, on a haulage road. When the earthworks are complete, the earth mounds should be removed, if possible, with smaller, quieter excavators. A noise barrier may be a more reliable method of noise control than the imposition of restrictions on throttle settings.

In many cases it is not be practical to screen earthmoving operations effectively, but it may be possible to partially shield a construction plant or to build-in at the early stages protective features required to screen traffic noise. Where earth noise barriers are not practical due to lack of space, consideration should be given to the possibility of constructing temporary screens from wood or any equivalent material in surface density.

The usefulness of a noise barrier will depend upon its length, its height, its position relative to the source and to the receiver, and the material from which it is made. A barrier designed to reduce noise from a moving source should extend beyond the last property to be protected to a distance of not less than ten times the shortest measurement from the property to the barrier. A barrier designed to reduce noise from a stationary source should, where possible, extend to a distance beyond the direct line between the noise source and the receiver to 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 predominately within nominally closed structures, careful consideration should be given to reducing noise breakout at any openings.

Crane (diesel operated)

An appropriate silencer on the muffler and acoustic screen around the engine bay are recommended to attenuate the noise from it.

Reversing and warning alarms

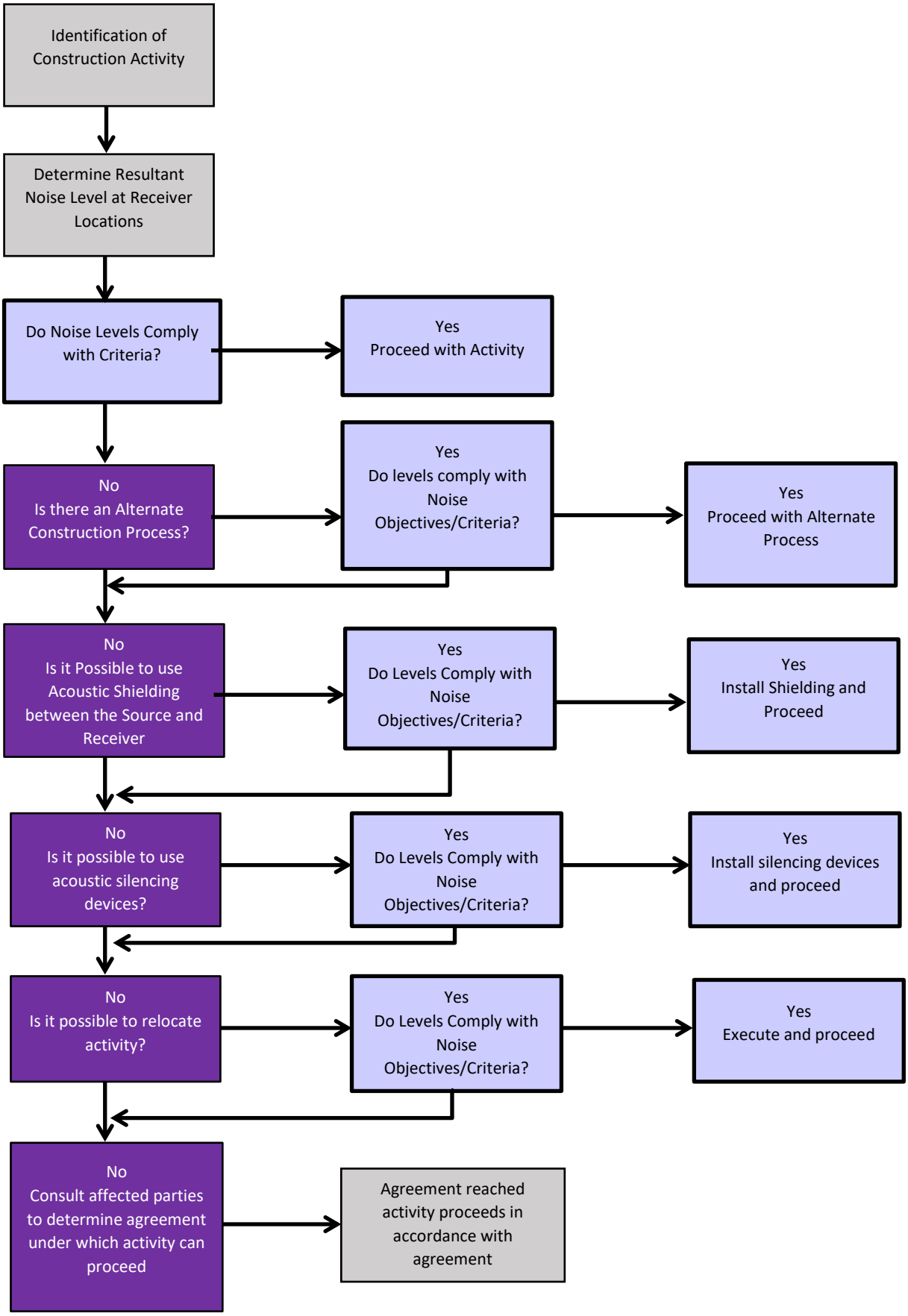
Community complaints often involve the intrusive noise of alarms commonly used to provide a safe system of work for vehicles operating on a site. Beeper reversing alarm noise is generally tonal and may cause annoyance at significant distances from the work site.

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;
- Non-audible warning systems (e.g. flashing lights, reversing cameras) may also be employed, providing safety considerations, are not compromised;
- 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; and
- Spotters or observers.

The above methods should be combined, where appropriate.

Figure 8: Noise mitigation management flow chart



11.3.2 Noise & Vibration Monitoring Strategy

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; and
- Long-term monitoring.

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 letting them know when the noise and vibration criteria are exceeded allowing the selection of alternative method on construction or equipment selection in order to minimise noise and vibration impacts.

Long-term monitoring

Similarly, long-term monitoring uses noise and vibration loggers providing real-time alerts to the builder / site manager when the noise and vibration criteria are exceeded.

Typically, the noise and vibration loggers stay on site for a period of several months for the critical construction stages of the project. Sometimes the period of construction noise and vibration monitoring is dictated by the local authorities through the DA conditions.

Both methodologies are complementary and normally used simultaneously providing a significant of 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.

12 CONCLUSION

This noise and vibration report has been prepared by E-LAB Consulting to accompany a Planning Proposal for Liverpool Private Hospital located at 61-71 Goulburn Street, Liverpool.

The following operational noise and vibration assessments were conducted as part of this noise and vibration impact assessment:

- Noise impact from helicopter flight movement to and from Liverpool Hospital on the proposed development;
- Noise and vibration impact of mechanical plant and equipment serving the proposed development on surrounding noise and vibration sensitive receivers; and
- Noise impacts of additional traffic on surrounding local roads generated by the proposed development.

The following construction noise and vibration assessments were conducted as part of this noise and vibration impact assessment:

- Noise generated during the construction of the proposed development and associated impacts on the surrounding noise sensitive receivers; and
- Vibration generated during the construction of the proposed development and associated impacts on the surrounding vibration sensitive receivers.

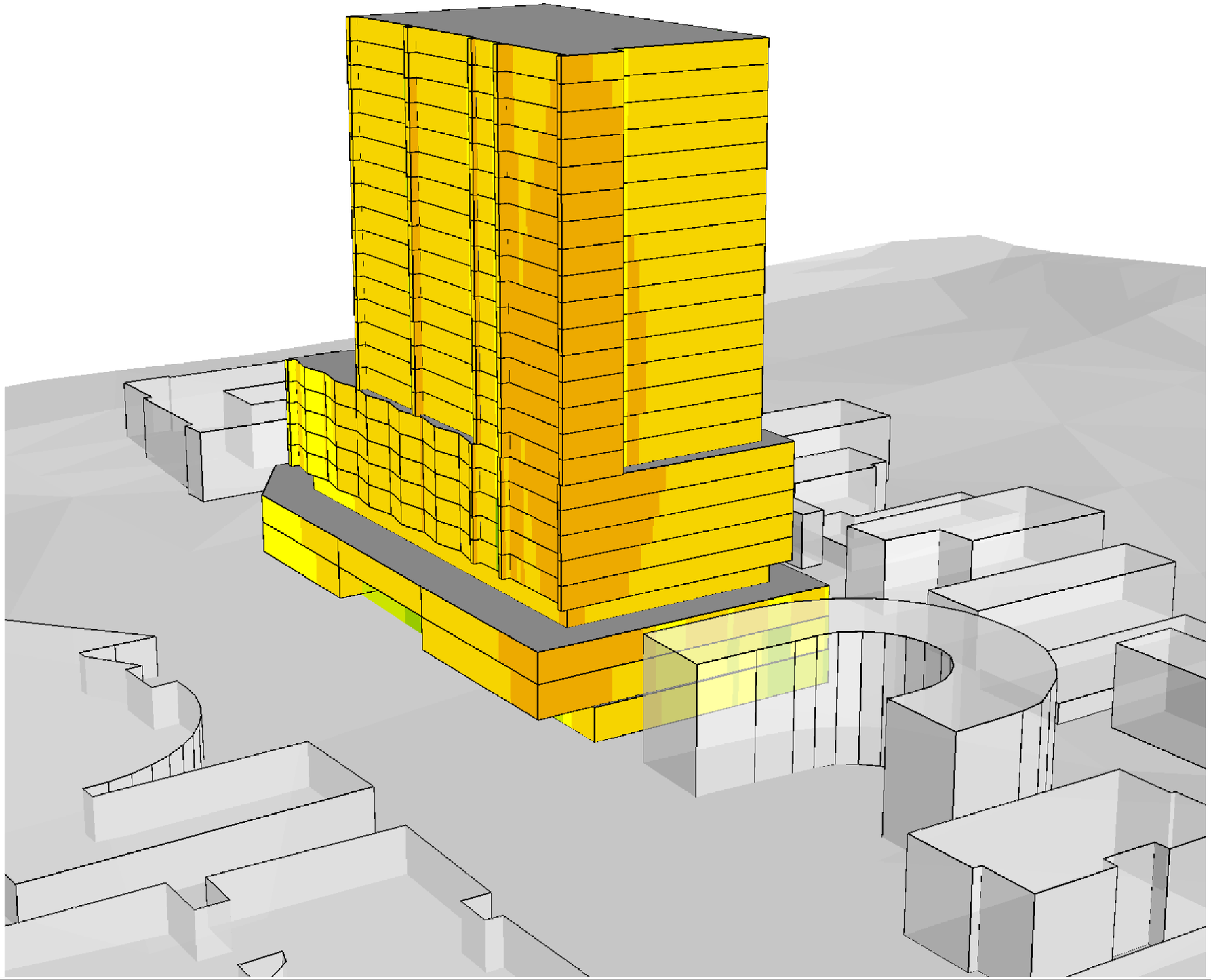
To assess each of the acoustic considerations for the proposed redevelopment, noise and vibration criteria has been established in Section 7 in accordance with the following documents:

- NSW Health Engineering Services Guideline (dated 6 August 2021);
- AS/NZS 2107:2016 “Acoustics - Recommended design sound levels and reverberation times for building interiors”;
- Development Near Rail Corridors and Busy Roads – Interim Guideline;
- NSW Road Noise Policy (RNP), 2011;
- NSW Noise Policy for Industry (NPI) 2017;
- Interim Construction Noise Guideline (ICNG) 2009;
- Assessing vibration: A Technical Guideline 2006;
- British Standard BS5228 – Part 1:1997 “Noise and Vibration Control on Construction and Open Sites.”;
- British Standard BS7358:1993 “Evaluation and Measurement for Vibration in Buildings”;
- German Standard DIN4150 – Part 3: “Structural vibration in buildings – Effects on structures”; and
- ASHRAE Handbook on Noise and Vibration.

Having given regard to the analysis conducted within this report, it is the finding of this noise and vibration impact assessment that the proposed redevelopment is compliant with the relevant noise and vibration criteria controls for this type of development, and it is expected to comply with the applicable regulations with regards to noise and vibration, particularly those listed above.

It is recommended the development application for the proposed redevelopment is not rejected on the basis of noise and vibration, under the implementation of the mitigation measures outlined within the report.

Appendix A **Façade Noise Map**



E-LAB CONSULTING

ISSUE	DATE	STATUS
1	29/09/2021	For Coordination

LEGEND

Facade Noise Level - dB(A) L_{max}

- < 60
- 60 - 64
- 64 - 68
- 68 - 72
- 72 - 76
- 76 - 80
- 80 - 84
- 84 - 88
- 88 - 92
- 92 - 96
- 96 - 100
- ≥ 100

NOTES

PROJECT
61 - 71 GOULBURN STREET, LIVERPOOL

PROJECT NO.
P00074

ARCHITECT
TEAM 2

CLIENT
SACCO BUILDING GROUP

SCALE
NTS

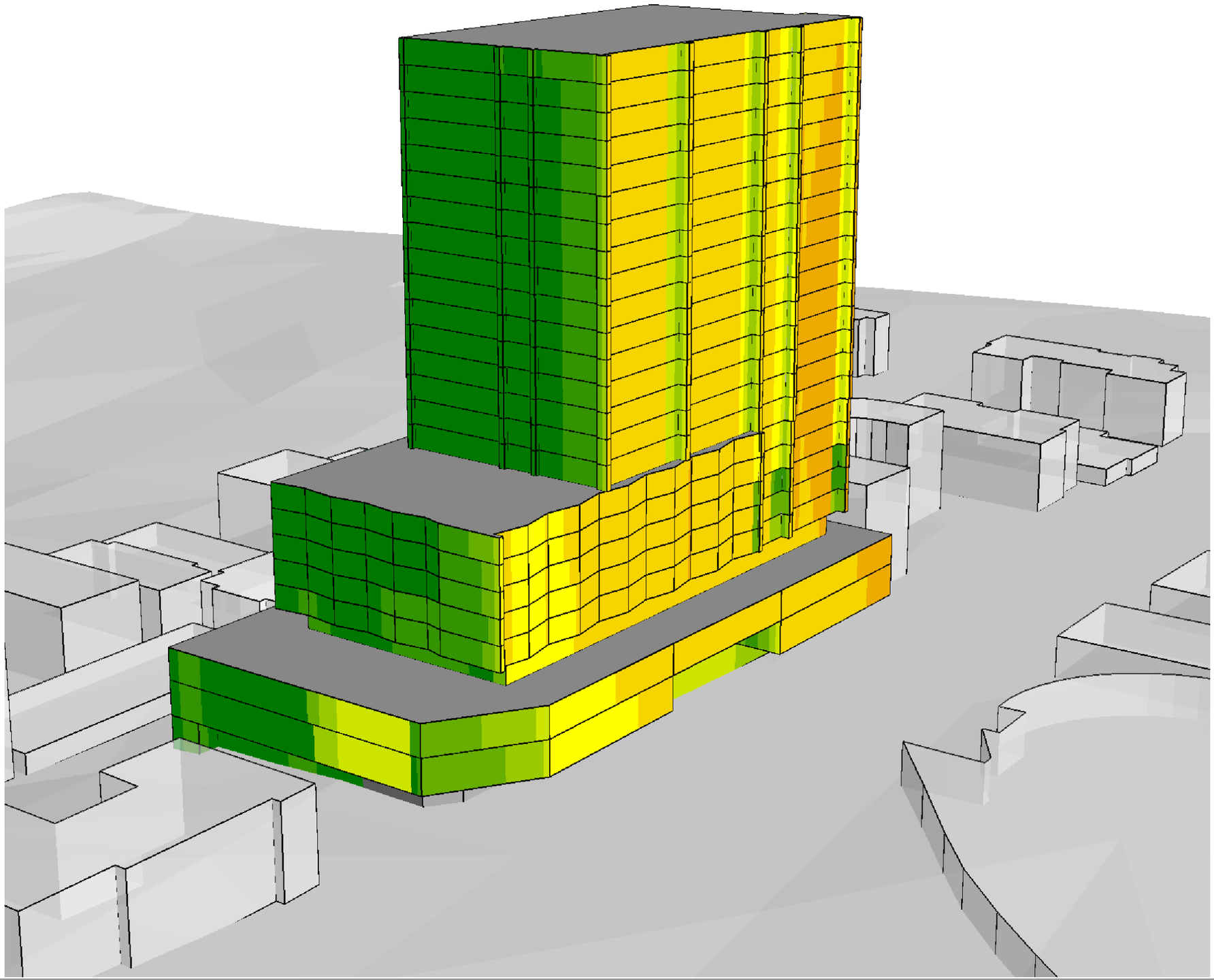
STATUS
FOR COORDINATION

DRAWING
FACADE NOISE LEVEL FROM HELICOPTER FLYBY

SHEET 1

DISCIPLINE
ACOUSTICS

DRAWING NUMBER	REVISION
AC-DWG-100-01-01	001



E-LAB CONSULTING

ISSUE	DATE	STATUS
1	29/09/2021	For Coordination

LEGEND

Facade Noise Level - dB(A) L_{max}

- < 60
- 60 - 64
- 64 - 68
- 68 - 72
- 72 - 76
- 76 - 80
- 80 - 84
- 84 - 88
- 88 - 92
- 92 - 96
- 96 - 100
- ≥ 100

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SACCO BUILDING GROUP

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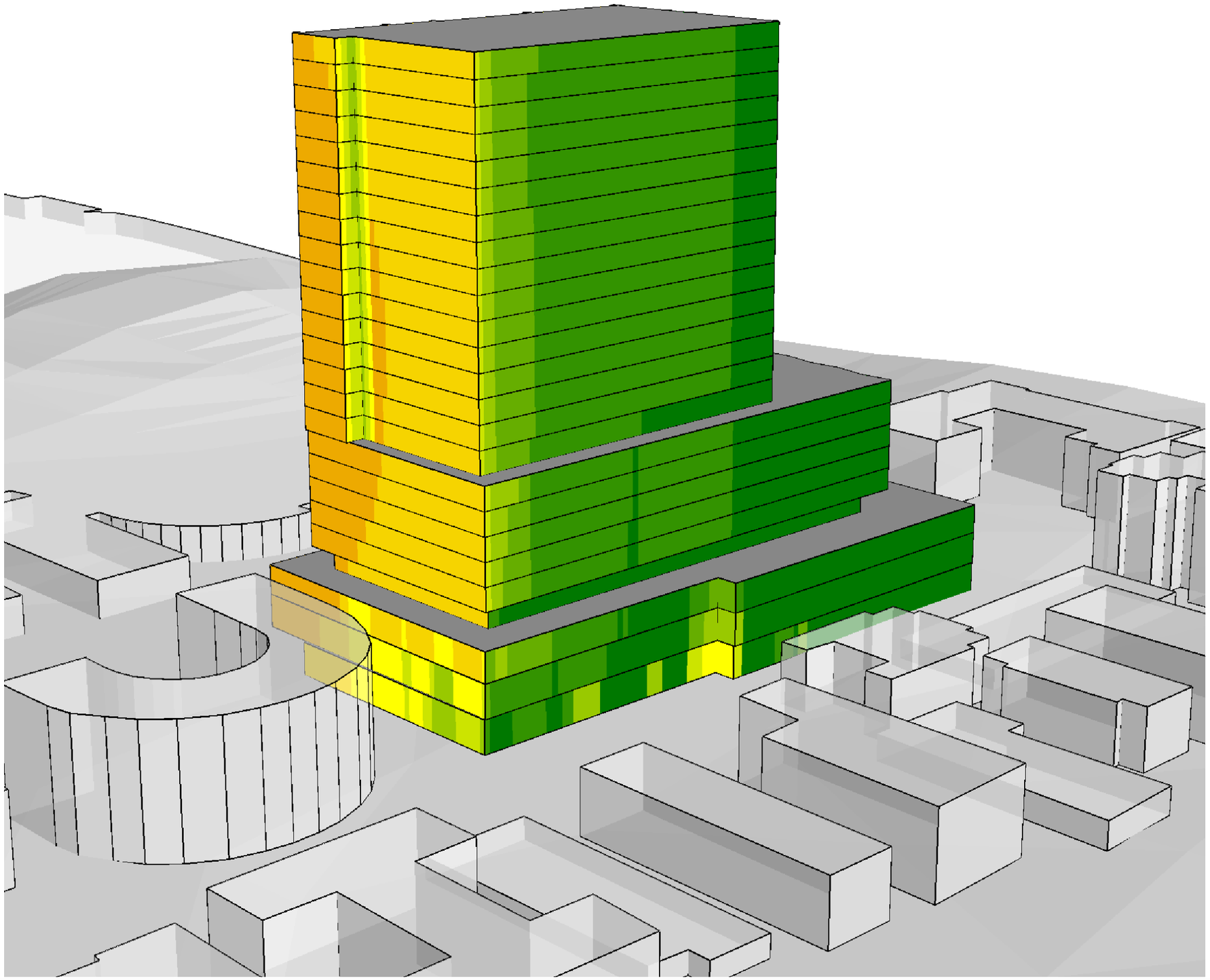
STATUS
FOR COORDINATION

DRAWING
FACADE NOISE LEVEL FROM HELICOPTER FLYBY

SHEET 2

DISCIPLINE
ACOUSTICS

DRAWING NUMBER	REVISION
AC-DWG-100-02-01	001



E-LAB CONSULTING

ISSUE	DATE	STATUS
1	29/09/2021	For Coordination

LEGEND

Facade Noise Level - dB(A) L_{max}

- < 60
- 60 - 64
- 64 - 68
- 68 - 72
- 72 - 76
- 76 - 80
- 80 - 84
- 84 - 88
- 88 - 92
- 92 - 96
- 96 - 100
- ≥ 100

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DRAWING
FACADE NOISE LEVEL FROM HELICOPTER FLYBY

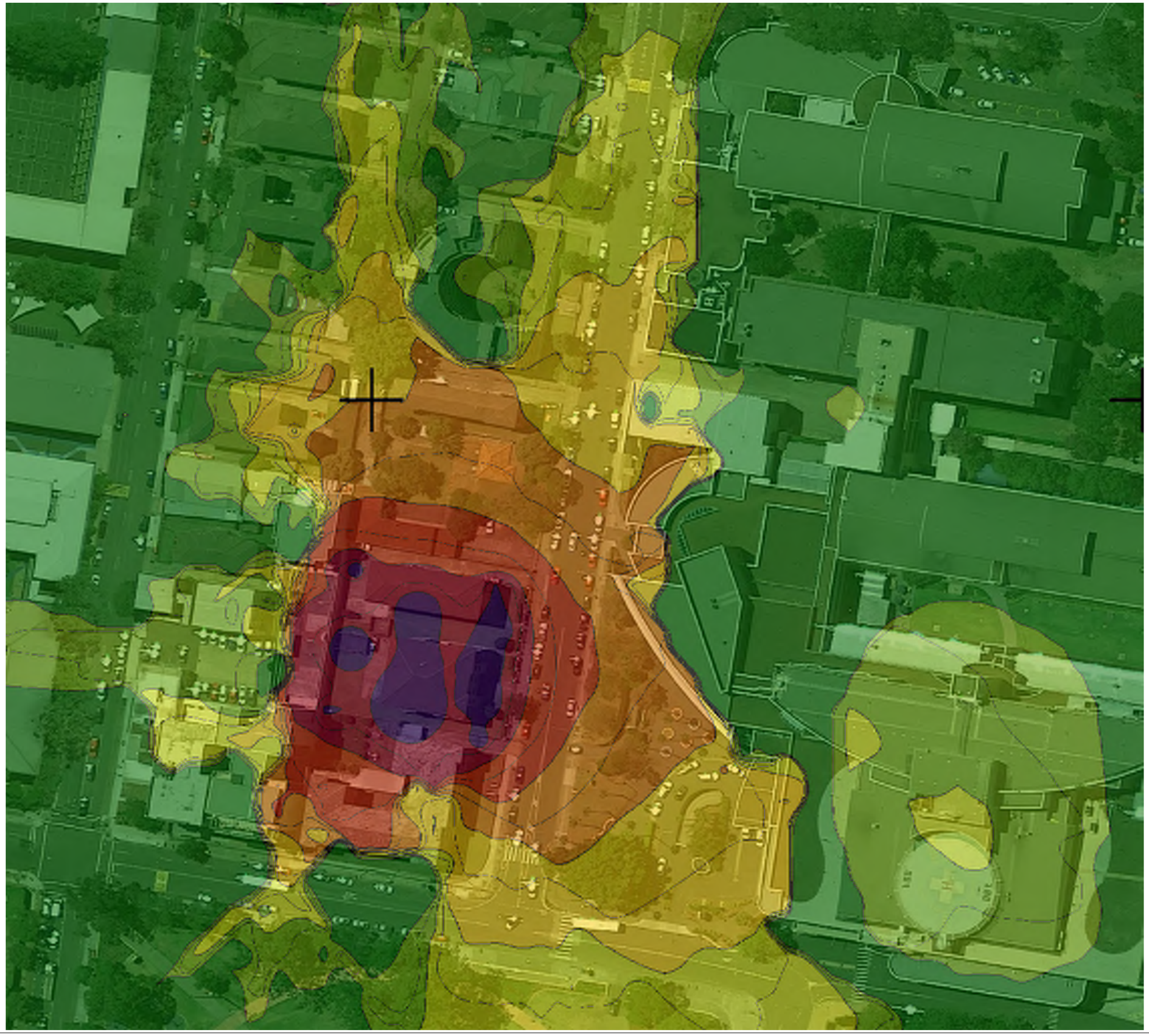
SHEET 3

DISCIPLINE
ACOUSTICS

DRAWING NUMBER
AC-DWG-100-03-01

REVISION
001

Appendix B **Construction Noise Contour Map**



E-LAB CONSULTING

ISSUE	DATE	STATUS
1	29/09/2021	For Coordination

LEGEND

Noise Level - dB(A) $L_{eq,\ 15min}$

- < 49
- 49 - 54
- 54 - 59
- 59 - 64
- 64 - 69
- 69 - 74
- 74 - 79
- ≥ 79

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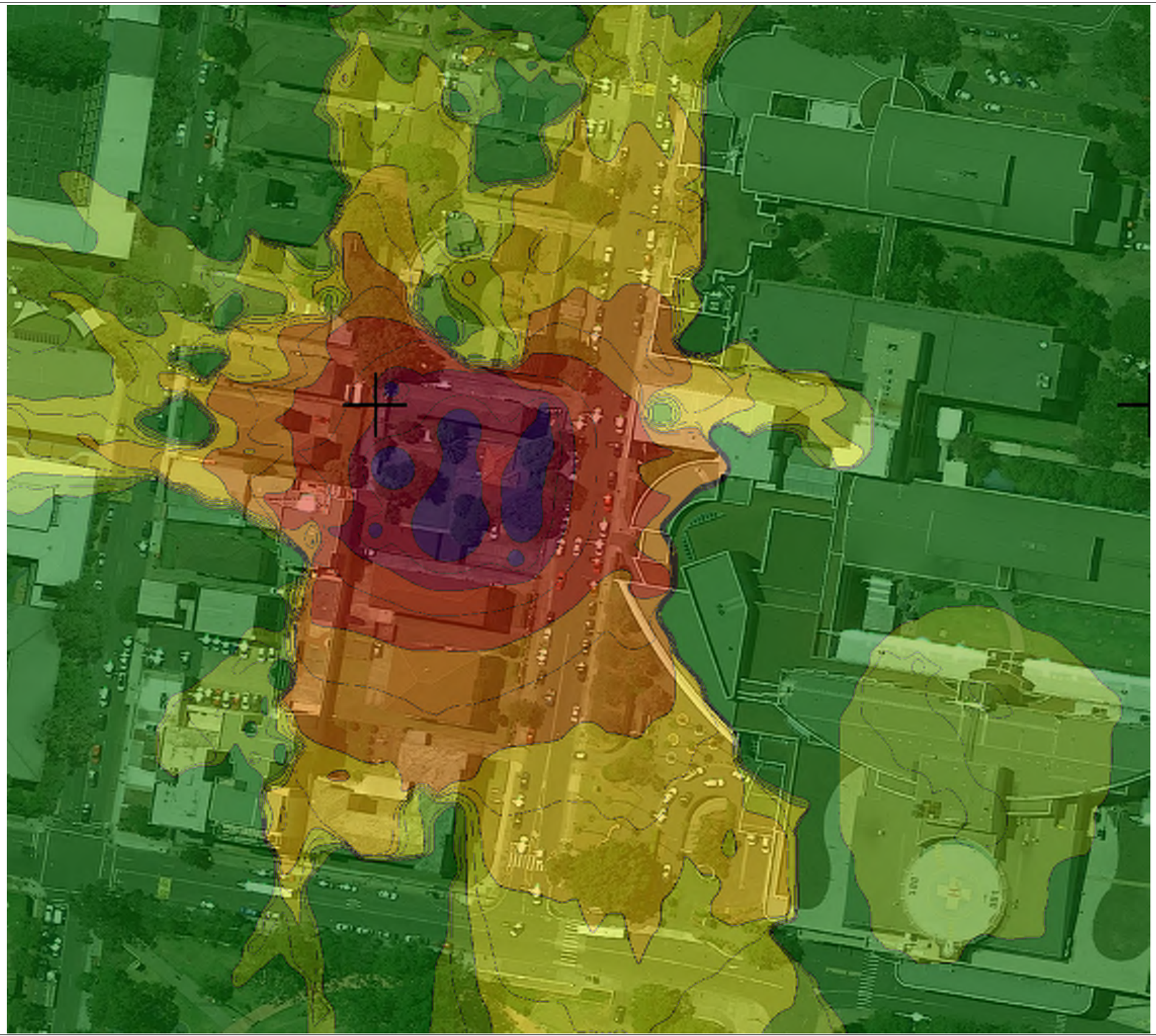
FOR COORDINATION

DRAWING
EARLY WORKS - DEMOLITION & DISMANTLE (WITHOUT MITIGATION)

SCENARIO 1

DISCIPLINE
ACOUSTICS

DRAWING NUMBER	REVISION
AC-DWG-200-01-01	001



E-LAB CONSULTING

ISSUE	DATE	STATUS
1	29/09/2021	For Coordination

LEGEND

Noise Level - dB(A) $L_{Aeq,\ 15min}$

- < 49
- 49 - 54
- 54 - 59
- 59 - 64
- 64 - 69
- 69 - 74
- 74 - 79
- ≥ 79

NOTES

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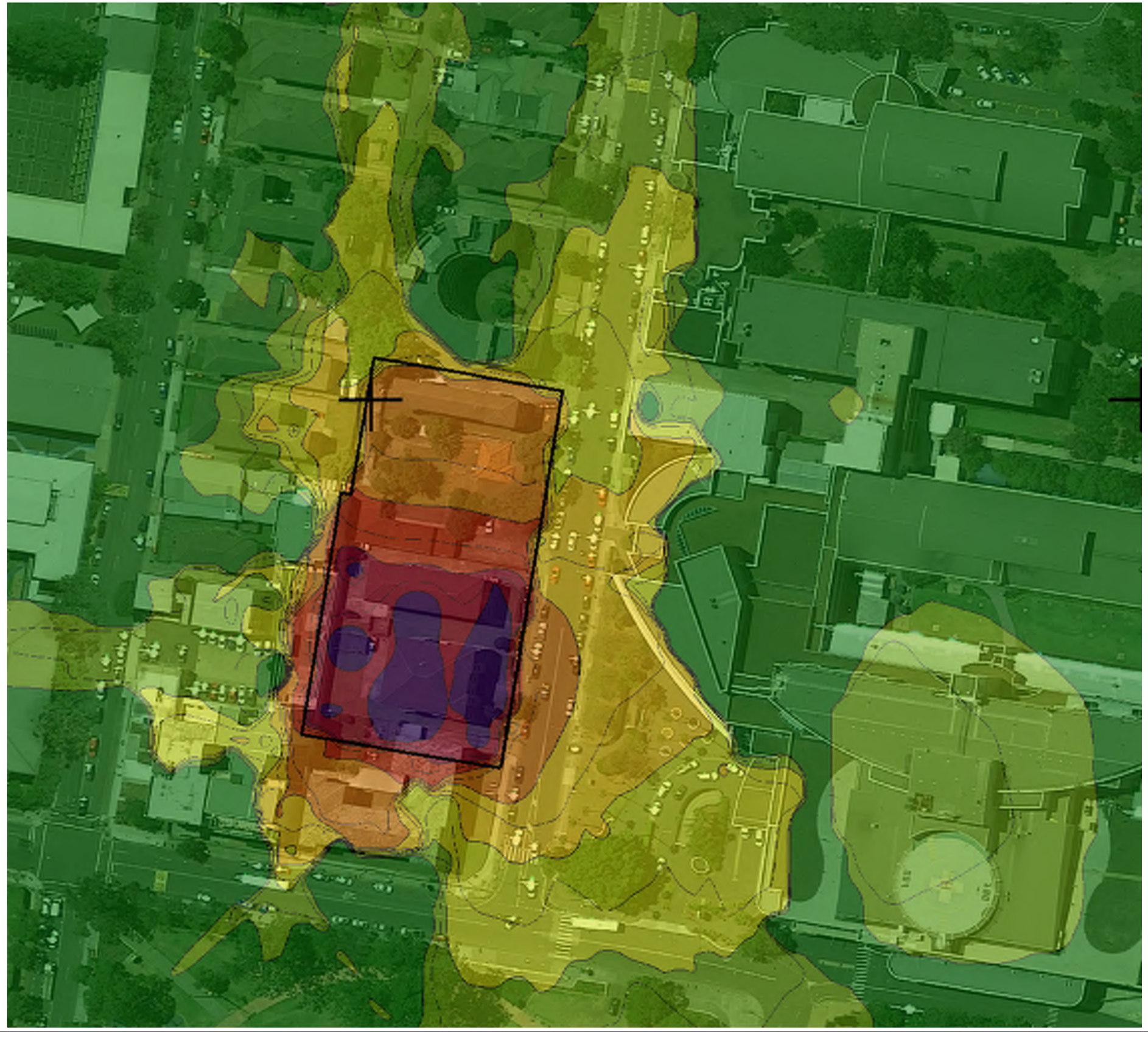
EARLY WORKS - DEMOLITION & DISMANTLE (WITHOUT MITIGATION)

SCENARIO 2

DISCIPLINE
ACOUSTICS

DRAWING NUMBER
AC-DWG-200-02-01

REVISION
001



E-LAB CONSULTING

ISSUE	DATE	STATUS
1	29/09/2021	For Coordination

LEGEND

Noise Level - dB(A) $L_{eq,\ 15min}$

- < 49
- 49 - 54
- 54 - 59
- 59 - 64
- 64 - 69
- 69 - 74
- 74 - 79
- ≥ 79

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ACOUSTICS

DRAWING NUMBER	REVISION
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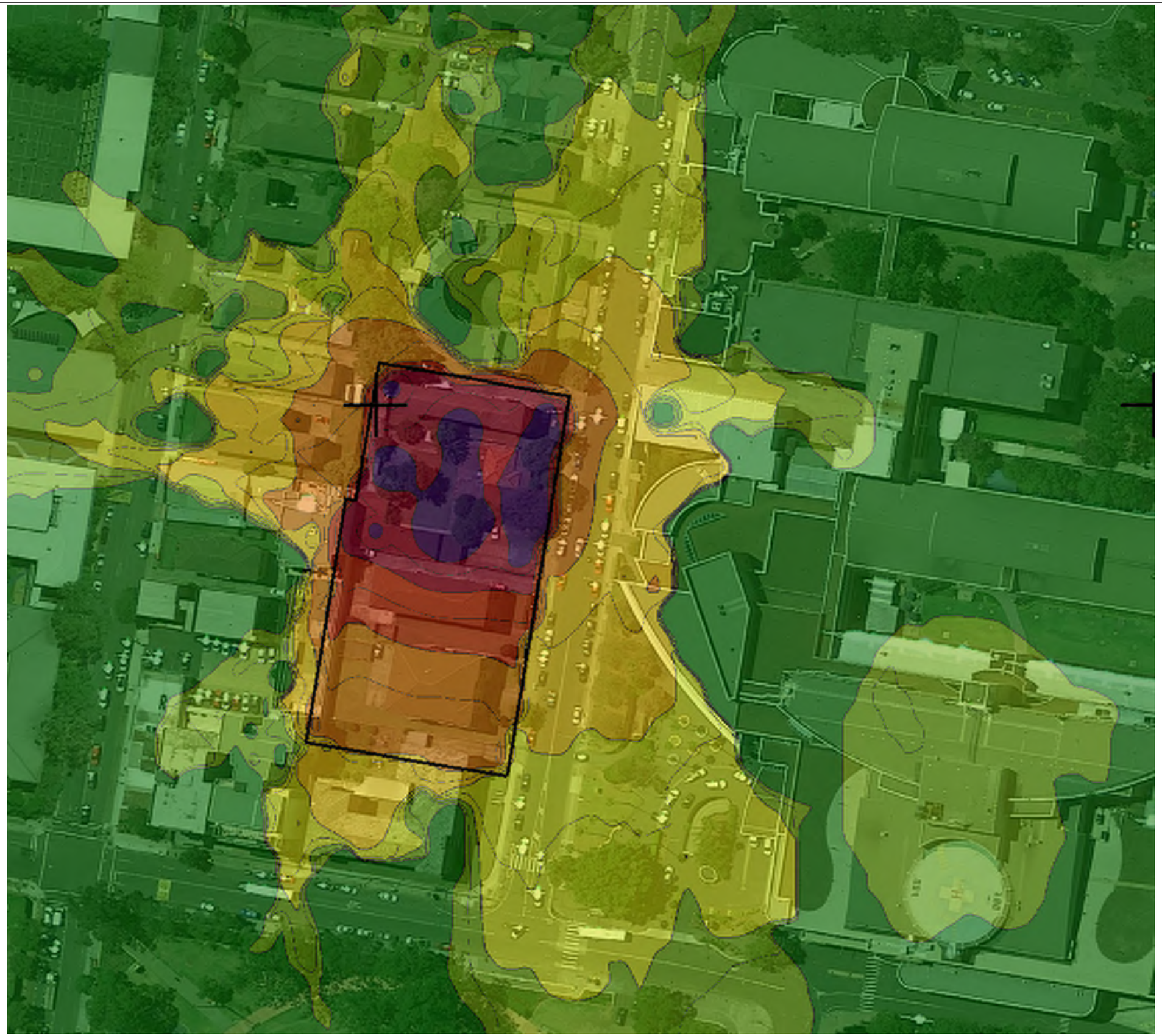

E-LAB CONSULTING

ISSUE	DATE	STATUS
1	29/09/2021	For Coordination

LEGEND

Noise Level - dB(A) $L_{eq,\ 15min}$

- < 49
- 49 - 54
- 54 - 59
- 59 - 64
- 64 - 69
- 69 - 74
- 74 - 79
- ≥ 79

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SCENARIO 2

DISCIPLINE
ACOUSTICS

DRAWING NUMBER	REVISION
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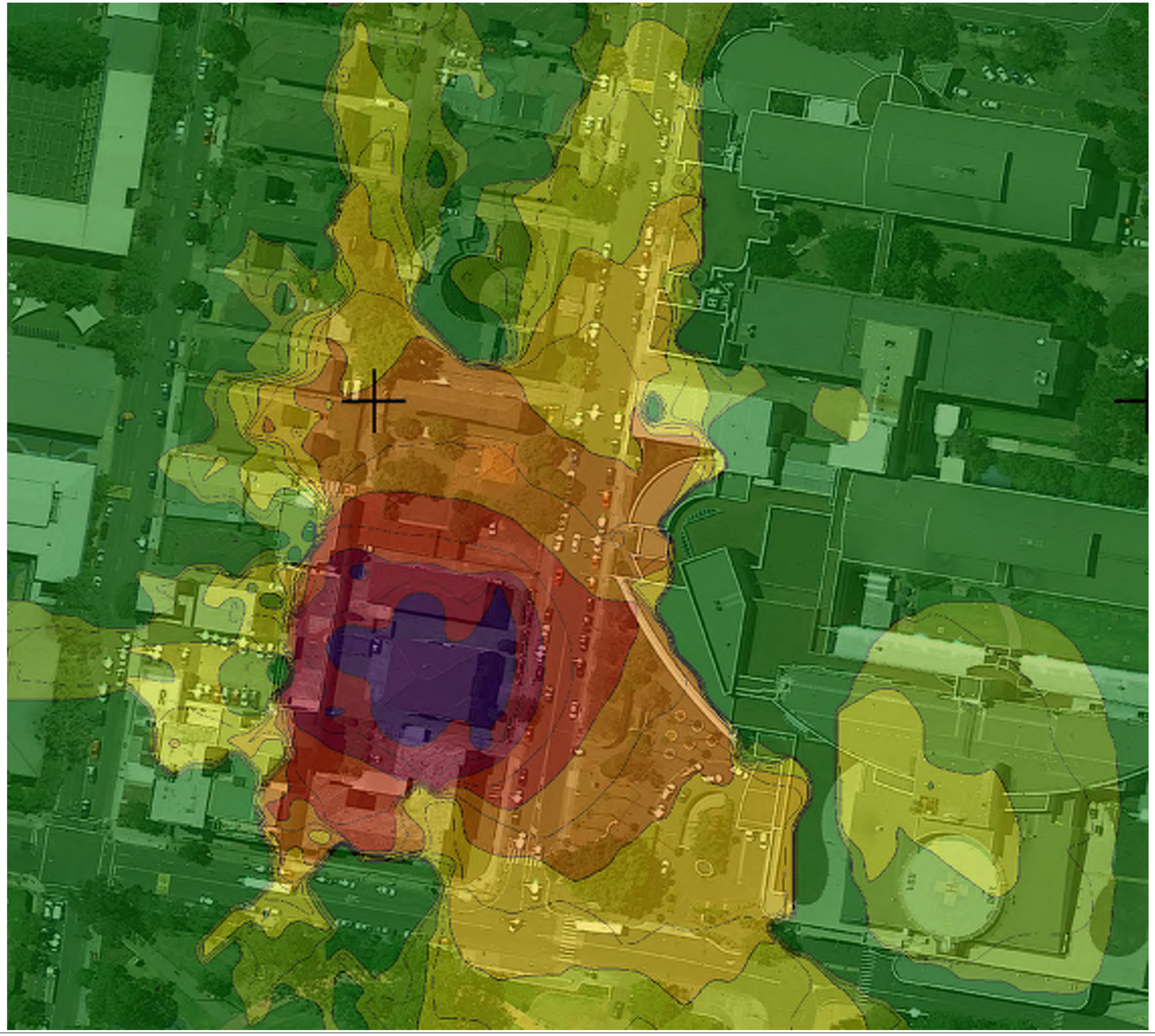

E-LAB CONSULTING

ISSUE	DATE	STATUS
1	29/09/2021	For Coordination

LEGEND

Noise Level - dB(A) $L_{eq,\ 15min}$

	< 49
	49 - 54
	54 - 59
	59 - 64
	64 - 69
	69 - 74
	74 - 79
	≥ 79

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SCENARIO 1

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ACOUSTICS

DRAWING NUMBER	REVISION
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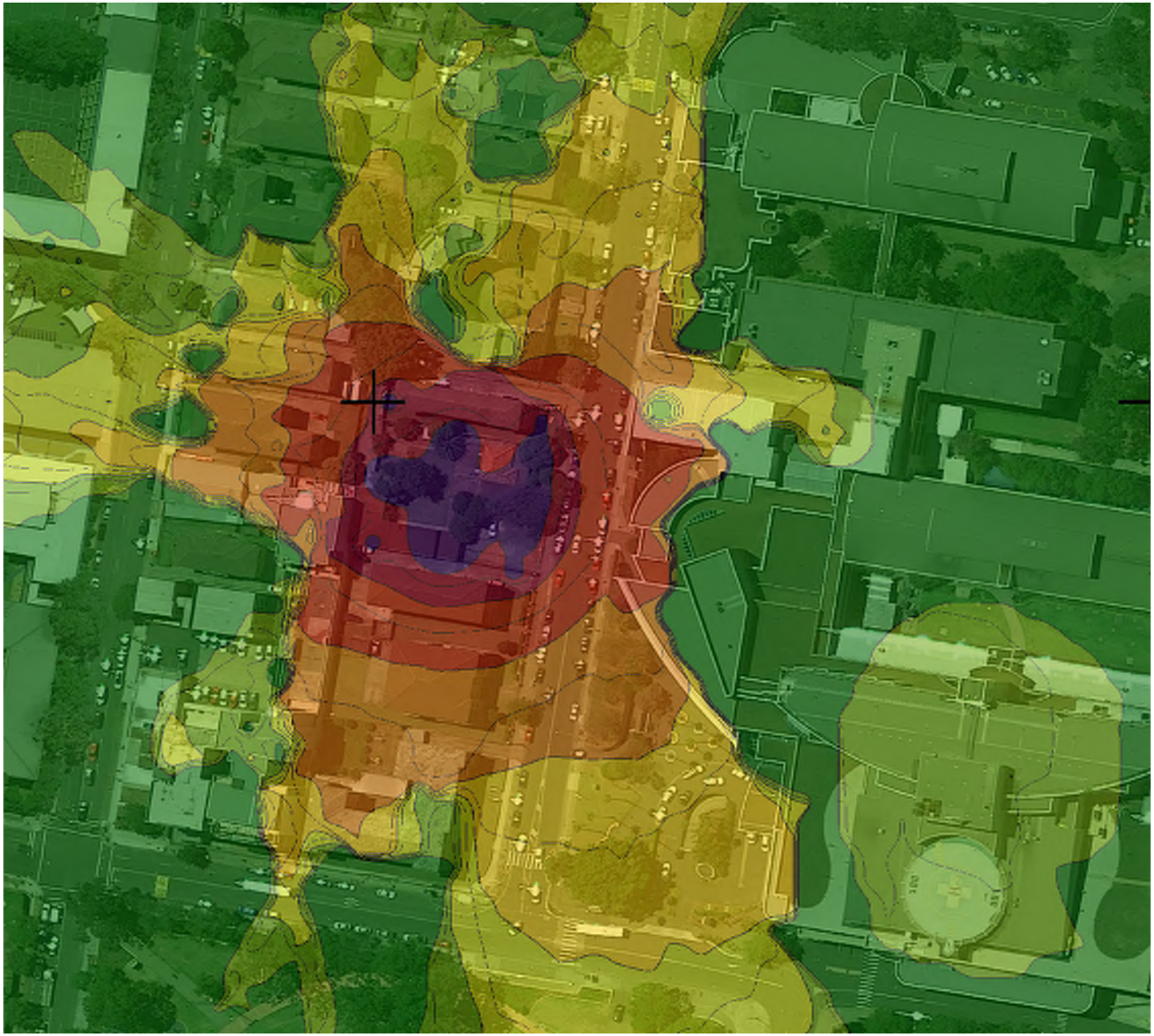

E-LAB CONSULTING

ISSUE	DATE	STATUS
1	29/09/2021	For Coordination

LEGEND

Noise Level - dB(A) $L_{Aeq,\ 15min}$

- < 49
- 49 - 54
- 54 - 59
- 59 - 64
- 64 - 69
- 69 - 74
- 74 - 79
- ≥ 79

NOTES

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ACOUSTICS

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REVISION
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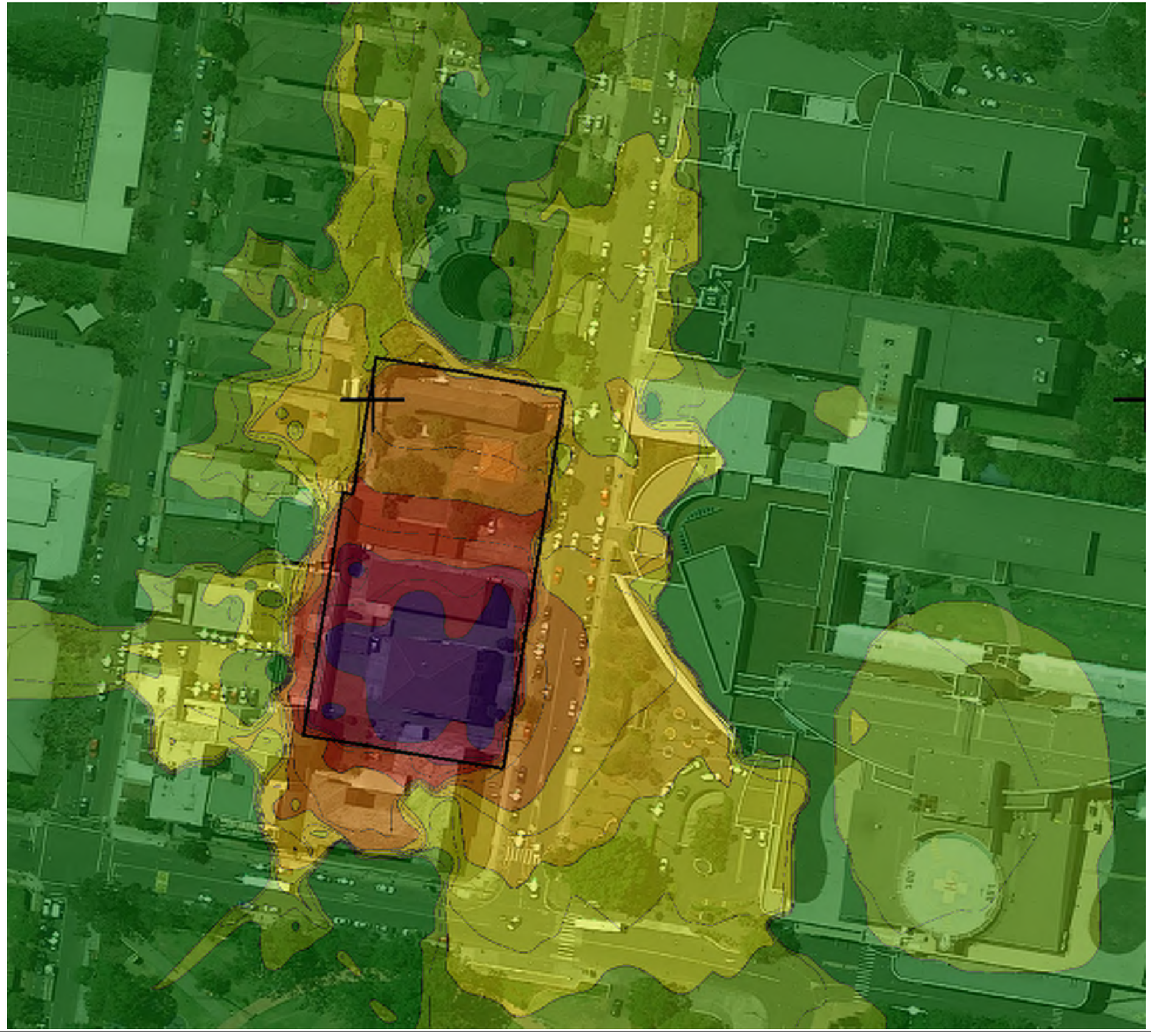

E-LAB CONSULTING

ISSUE	DATE	STATUS
1	29/09/2021	For Coordination

LEGEND

Noise Level - dB(A) $L_{eq,\ 15min}$

- < 49
- 49 - 54
- 54 - 59
- 59 - 64
- 64 - 69
- 69 - 74
- 74 - 79
- ≥ 79

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ACOUSTICS

DRAWING NUMBER	REVISION
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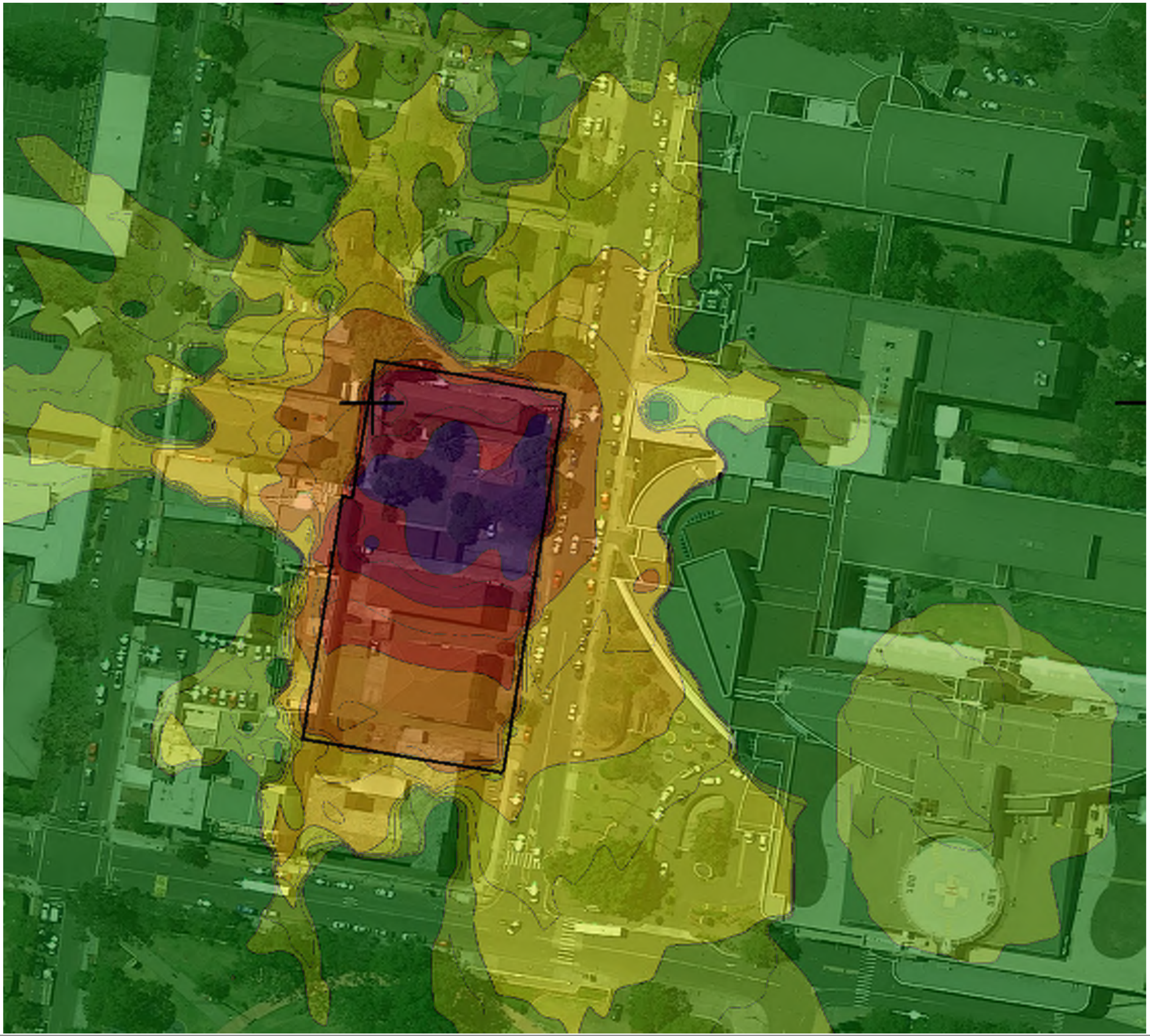

E-LAB CONSULTING

ISSUE	DATE	STATUS
1	29/09/2021	For Coordination

LEGEND

Noise Level - dB(A) $L_{Aeq,\ 15min}$

- < 49
- 49 - 54
- 54 - 59
- 59 - 64
- 64 - 69
- 69 - 74
- 74 - 79
- ≥ 79

NOTES

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AC-DWG-200-08-01

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001

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ISSUE	DATE	STATUS
1	29/09/2021	For Coordination

LEGEND

Noise Level - dB(A) $L_{eq,\ 15min}$

- < 49
- 49 - 54
- 54 - 59
- 59 - 64
- 64 - 69
- 69 - 74
- 74 - 79
- ≥ 79

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STRUCTURAL WORKS & FACADE AND FINISHES (WITHOUT MITIGATION)

SCENARIO 1

DISCIPLINE
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AC-DWG-200-09-01

REVISION
001

E-LAB CONSULTING

ISSUE	DATE	STATUS
1	29/09/2021	For Coordination

LEGEND

Noise Level - dB(A) $L_{Aeq,\ 40min}$

- < 49
- 49 - 54
- 54 - 59
- 59 - 64
- 64 - 69
- 69 - 74
- 74 - 79
- ≥ 79

NOTES

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SCENARIO 2

DISCIPLINE
ACOUSTICS

DRAWING NUMBER
AC-DWG-200-10-01

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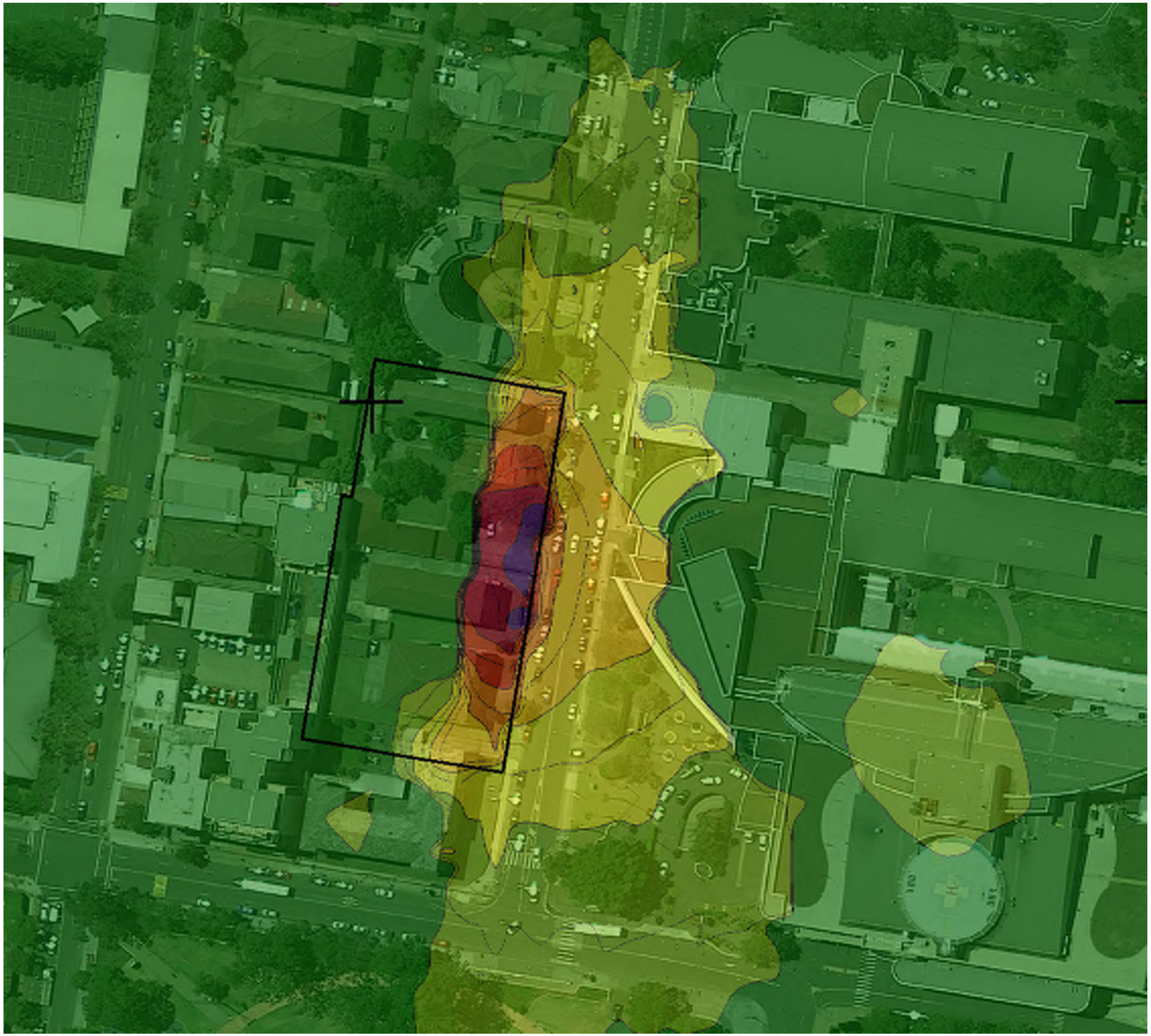

E-LAB CONSULTING

ISSUE	DATE	STATUS
1	29/09/2021	For Coordination

LEGEND

Noise Level - dB(A) $L_{eq,\ 15min}$

- < 49
- 49 - 54
- 54 - 59
- 59 - 64
- 64 - 69
- 69 - 74
- 74 - 79
- ≥ 79

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SCENARIO 1

DISCIPLINE
ACOUSTICS

DRAWING NUMBER
AC-DWG-200-11-01

REVISION
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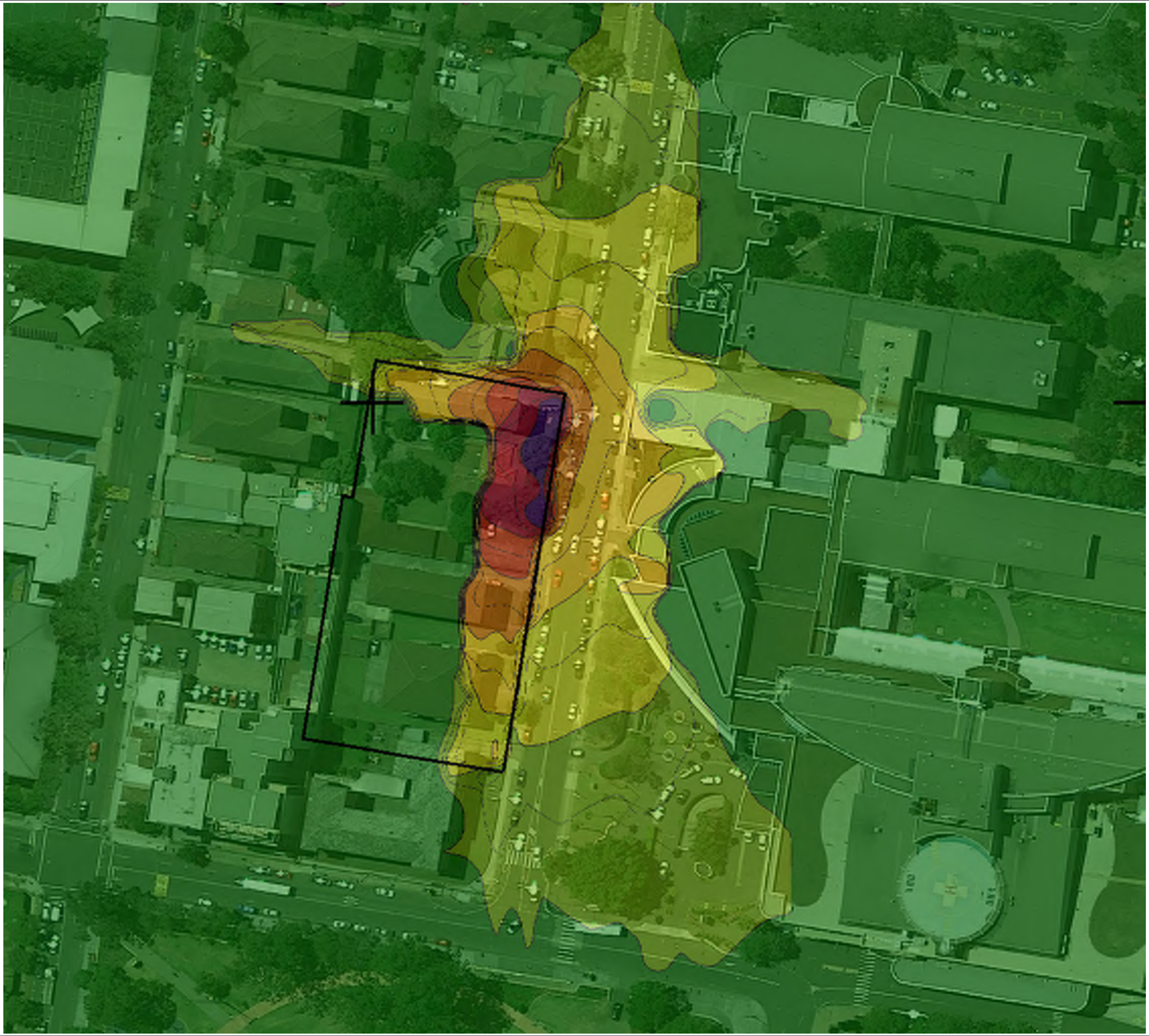

E-LAB CONSULTING

ISSUE	DATE	STATUS
1	29/09/2021	For Coordination

LEGEND

Noise Level - dB(A) $L_{eq,\ 15min}$

- < 49
- 49 - 54
- 54 - 59
- 59 - 64
- 64 - 69
- 69 - 74
- 74 - 79
- ≥ 79

NOTES

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DRAWING
STRUCTURAL WORKS & FACADE AND FINISHES (WITH MITIGATION)

SCENARIO 2

DISCIPLINE
ACOUSTICS

DRAWING NUMBER	REVISION
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