Murwillumbah Education Campus (SSD-16848913)

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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1 GLOSSARY AND ABBREVIATIONS

REFERENCE	DESCRIPTION
CMP	Construction Management Plan
DA	Development Application
DPIE	NSW Department of Planning, Industry and Environment
EP&A Act	Environmental Planning and Assessment Act 1979
EPA	NSW Environment Protection Authority
EPA Regulation	Environmental Planning and Assessment Regulation 2000
GFA	Gross floor area
ICNG	Interim Construction Noise Guideline
LGA	Local Government Area
MEC	Murwillumbah Education Campus
NPI	Noise Policy for Industry
POM	Plan of Management
PSI	Preliminary Site Investigation
RMS	Roads and Maritime Services
SEARs	Secretary's Environmental Assessment Requirements
SEPP	State Environmental Planning Policy
SSD	State Significant Development
SSDA	State Significant Development Application
TIA	Traffic Impact Assessment
The proposal	The proposed development which is the subject of the detailed SSDA
The site	The site which is the subject of the detailed SSDA

2 EXECUTIVE SUMMARY

This noise and vibration report has been prepared by E-LAB Consulting to accompany a State Significant Development Application (SSDA) for Murwillumbah Education Campus (MEC).

The Murwillumbah Education Campus development, involves the co-location of Murwillumbah Primary School, Murwillumbah East Primary School, Murwillumbah High School, and Wollumbin High School, to establish a new primary school and a new high school as part of the same education campus.

Murwillumbah High School is located at 86 Riverview St, Murwillumbah and is legally defined as Lot 2 in DP 578679 and Lots 5 and 6 in DP 820602. The school site is located within the Tweed Shire Council Local Government Area (LGA) and the land is owned by the NSW Department of Education (DoE).

This report has been prepared to also address the relevant conditions of the Secretary's Environmental Assessment Requirements (SEARs) issued for SSD-16848913.

This report concludes that the proposed educational campus redevelopment is acceptable and warrants approval subject to the implementation of the mitigation measures outlined in Section 11.

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

3 INTRODUCTION

This report has been prepared in response to the requirements contained within the Secretary's Environmental Assessment Requirements (SEARs), dated 5 May 2021. Table 1 below summarises the SEARs requirements and outlines the appropriate mitigation measures and the corresponding section within this report where the mitigation has been considered.

Table 1 – SEARs requirements and report section reference

ITEM	DESCRIPTION OF REQUIREMENT	SECTION REFERENCE (THIS REPORT)
10	**Noise and Vibration**	
	▪ Includes a quantitative assessment of the main noise and vibration generating sources during demolition, site preparation, bulk excavation and construction.	Refer to Section 10 and Appendix A
	▪ Details the proposed construction hours and provide details of, and justification for, instances where it is expected that works would be carried out outside standard construction hours.	Refer to Section 10
	▪ Includes a quantitative assessment of the main sources of operational noise, including consideration of any public-address system, school bell, mechanical services (e.g. air conditioning plant), use of any school hall for concerts etc. (both during and outside school hours) and any out of hours community use of school facilities.	Refer to Section 9
	▪ Outlines measures to minimise and mitigate the potential noise impacts on nearby sensitive receivers.	Refer to Section 11
	▪ Considers sources of external noise intrusion in proximity to the site (including, road rail and aviation operations) and identifies building performance requirements for the proposed development to achieve appropriate internal amenity standards.	Refer to Section 9.1
	▪ Demonstrates that the assessment has been prepared in accordance with polices and guidelines relevant to the context of the site and the nature of the proposed development.	Refer to Section 6

4 PROJECT SITE

The project site (currently Murwillumbah High School) is located at 86 Riverview Street, Murwillumbah and sits within the Tweed Shire Council's Local Government Area (LGA). The general shape of the site is irregular in shape and has a total area of approximately 11.7ha. The land is owned by the NSW Department of Education (DoE).

The site is bordered on the east, south and west by open rural landscape and is approximately 500 metres from the Tweed River. The school is bound by Riverview Street, High School Lane, Nullum Street and residential structures to the north; grassland/farmland to the west and south; and sports fields to the east. The site comprises of the following allotments and legal description at the date of this report:

- 86 Riverview Street (Lot 6 DP820602);
- 86 Riverview Street (Lot 5 DP820602); and
- 86 Riverview Street (Lot 2 DP820602).

The boundaries of the overall site are presented in red and yellow below.

Figure 1: Aerial image and boundaries of site (source: SIX Maps)

5 PROJECT DESCRIPTION

The Murwillumbah Education Campus development, involves the co-location of Murwillumbah Primary School, Murwillumbah East Primary School, Murwillumbah High School, and Wollumbin High School, to establish a new primary school and a new high school as part of the same education campus.

The project will include the following scope of works within the SSD application:

- Demolition of Building E
- All inground slabs, pathways, hardstands and footings including those to buildings B, C, D, G, H, M, P, S, AW and AZ
- Associated ground works required to facilitate the construction of new buildings and landscaped areas
- Construction of new Buildings 1, 2, 3 and 4:
    - Building 1 – New public school building comprising general learning spaces, administration, canteen, School Support Unit (SSU) and library;
    - Building 2 – Hall building including a public school hall, out of school hours care (OSHC) facilities, high school hall/gymnasium and other spaces for physical education and creative and performing arts (CAPA);
    - Building 3 – New high school building including the following facilities; general and specialist learning spaces, SSU, and library.
    - Building 4 - New high school building including the following facilities; science, support, administration and canteen;
- Refurbish Building A for DoE offices and school community health facilities along with associated access requirements. Building A is a locally listed heritage building and will be retained and refurbished;
- Refurbishment of Building F to provide learning space for agricultural education;
- Retention of existing AY.
- Creation of new public school and high school outdoor learning spaces to support future focused learning outcomes;
- New landscaping and embellishment of outdoor playgrounds;
- Civil and infrastructure works; and
- Kiss n drop and parking off Nullum Street

6 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 the requirements listed in the Secretary's Environmental Assessment Requirements (SEARs);
- 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:

- Road noise intrusion into development from traffic movement on surrounding local roads;
- Noise and vibration impact of mechanical plant and equipment serving the proposed development on surrounding noise and vibration sensitive receivers;
- Noise impact from the proposed educational campus operating PA Systems and Bells.

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:

- Tweed Shire Council, Development Construction Specification C101 – General (v1.4)
- NSW Noise Policy for Industry (NPI) 2017;
- SEPP (Infrastructure) 2007;
- Development Near Rail Corridors and Busy Roads – Interim Guideline;
- 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"; and
- German Standard DIN4150 – Part 3: "Structural vibration in buildings – Effects on structures".

7 SITE NOISE INVESTIGATIONS

7.1 IMPLEMENTATION OF PREVIOUS NOISE MONITORING

Previous noise monitoring has been conducted around the project site, with the results of the noise monitoring outlined in the acoustic report prepared by Acoustiworks, dated 13 November 2020 (*ref. 1020184 L01A Murwillumbah Education Campus - Preliminary review.doc*).

Given the nature of restrictions and lockdowns during the COVID-19 pandemic, additional measurements and monitoring was not conducted by E-LAB. Further, lockdowns have resulted ever-changing traffic volumes and unpredictable background noise environments, and as such, the noise monitoring conducted by Acoustiworks have been used for this assessment as it is likely to be more reliable.

7.2 LOCATIONS

The site location, measurement positions (conducted by Acoustiworks) 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 Acoustiworks

7.3 LONG-TERM (UNATTENDED) NOISE SURVEYS

7.3.1 Background Noise

Long-term noise monitoring was conducted by Acoustiworks (locations presented in Figure 2). Background noise levels and subsequent Rating Background Noise Level (RBL) have been established in accordance with the Noise Policy for Industry 2017.

The description of time of day is outlined within the Noise Policy for Industry and described as follows:

- Day – the period from 7am to 6pm Monday to Saturday or 8am to 6pm on Sundays and public holidays
- Evening – the period from 6pm to 10pm
- Night – the remaining periods

Table 2: Unattended noise monitoring results (conducted by Acoustiworks)

LOCATION	MEASURED RATING BACKGROUND NOISE LEVELS - dB(A) WEEKDAY			MEASURED RATING BACKGROUND NOISE LEVELS - dB(A) WEEKEND		
	DAY	EVENING	NIGHT	DAY	EVENING	NIGHT
LT1	42	32	30	41	36	31
LT2	45	34	31	45	42	34
LT3	41	36	30	41	38	36

8 PROJECT NOISE AND VIBRATION CRITERIA

8.1 RELEVANT NOISE AND VIBRATION ASSESSMENT DOCUMENTS

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

- NSW Noise Policy for Industry (NPI) 2017;
- SEPP (Infrastructure) 2007;
- Development Near Rail Corridors and Busy Roads – Interim Guideline;
- 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"; and
- German Standard DIN4150 – Part 3: "Structural vibration in buildings – Effects on structures".

8.2 OPERATIONAL NOISE CRITERIA

8.2.1 Internal Noise Levels

SEPP (Infrastructure) 2007 & Development Near Rail Corridors and Busy Roads – Interim Guideline

SEPP (Infrastructure) 2007 and DoP's Development Near Rail Corridors and Busy Roads – Interim Guideline provides internal noise level requirements for educational establishments, in the event that the development is likely to be adversely affected by road noise (Clause 102 of SEPP (Infrastructure) 2007).

Table 3 provides a summary of the internal noise limits for both windows closed and open established in Clause 3.6 "What Noise and Vibration Criteria Should Be Applied" of the DoP Interim Guideline.

Table 3: Summary of DoP's Interim Guideline criteria spaces adjacent to busy roads

TYPE OF HABITABLE SPACE	APPLICABLE TIME PERIOD	ASSESSMENT NOISE METRIC	WINDOWS / DOORS CLOSED CRITERIA, dB(A)	WINDOWS / DOORS OPEN CRITERIA, dB(A)
Educational Spaces & Facilities	When in use	$L_{Aeq,T}$	40	50

It should be noted that Clause 102 of SEPP (Infrastructure) 2007 states that the clause applies to developments *"that is on land in or adjacent to the road corridor for a freeway, a tollway or a transitway or any other road with an annual average daily traffic volume of more than 20,000 vehicles (based on the traffic volume data published on the website of TfNSW) and that the consent authority considers is likely to be adversely affected by road noise or vibration"*.

The roads surrounding the proposed development, being Riverview Street, High School Lane and Nullum Street, are not considered as a freeway, a tollway or a transitway, nor do they contain an AADT volume of more than 20,000 vehicles.

8.2.2 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	Day	42	47
	Evening	32	37
	Night	30	35
RC2	Day	45	50
	Evening	34	39
	Night	31	36
RC3	Day	41	46
	Evening	36	41
	Night	30	35

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	Commercial	When in use	65	60	63

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	Residential	Day	47	53	N/A	47
		Evening	37	43	N/A	37
		Night	35	38	40 $L_{Aeq,15min}$ 52 L_{AFmax}	35
RC2		Day	50	53	N/A	50
		Evening	39	43	N/A	39
		Night	36	38	40 $L_{Aeq,15min}$ 52 L_{AFmax}	36
RC3		Day	46	53	N/A	46
		Evening	41	43	N/A	41
		Night	35	38	40 $L_{Aeq,15min}$ 52 L_{AFmax}	35
RC4	Commercial	When in use	N/A	63	N/A	63

8.3 CONSTRUCTION NOISE CRITERIA

8.3.1 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 8 below.

Table 8: 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 – Commercial Receiver Catchments

The airborne noise criteria for surrounding commercial receiver catchments (RC4) have been extracted from Table 3 in the ICNG and is presented in Table 9 below.

Table 9: NSW ICNG construction noise criteria for surrounding commercial receiver catchments (RC4)

LAND USE	MANAGEMENT LEVEL (APPLIES WHEN PROPERTIES ARE BEING USED) $L_{Aeq,15min}$
Offices, Retail Outlets	70 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.

8.4 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.

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

Table 10: 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					
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

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 11: 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
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

8.4.2 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 12 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 12: 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)

8.4.3 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 13 indicates the vibration limits presented in DIN4150-Part 3 to ensure structural damage doesn't occur.

Table 13: 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					

8.4.4 Project Construction Vibration Limits

Table 14 indicates the vibration criteria for the surrounding sensitive receivers to the development.

Table 14: 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	20 - 40	14 – 28	0.40 – 0.80	20

9 OPERATIONAL NOISE AND VIBRATION ASSESSMENT

9.1 ROAD NOISE ASSESSMENT

A review has been conducted for road noise intrusion on the proposed development. As discussed in Section 8.2.1, the development is bounded by Riverview Street, High School Lane and Nullum Street, all of which aren't considered a freeway, a tollway or a transitway, nor do they contain an AADT volume of more than 20,000 vehicles, therefore Clause 102 of SEPP (Infrastructure) 2007 isn't applicable, by definition.

Nonetheless, for the purpose of this assessment, it can be reasonably expected that internal noise levels for the development from road noise intrusion, will satisfy SEPP's and DoP's internal noise level criteria using standard façade elements without the need for additional acoustic treatment or mitigation.

9.2 MECHANICAL SERVICES ASSESSMENT

This assessment has considered the noise emissions from major mechanical plant items proposed to serve the development. These noise sources have been used to predict the worst-case scenario noise impact of the proposed use of the site to the nearby sensitive receivers. The assessment has been conducted to achieve noise levels as per the NSW NPI and have been assessed at the most affected external point at the surrounding receivers.

While exact equipment may change during the detailed design stage, the sound power levels provided in Table 15 have been assigned to each significant plant and equipment item, based on preliminary selections for the development.

For our assessment, we have assumed the mechanical plant and equipment located within development will include the following:

- 9-off VRV AC units along north façade of Building 1
- 3-off VRV AC units on roof of Building 2
- 6-off VRV AC units along south façade of Building 4
- 3-off VRV AC units along north façade of Building 3
- 3-off VRV AC units along west façade of Building 3
- 2-off VRV AC units along south façade of Building 3
- Dust extraction unit (DEU) along the south-western corner of Building 3
- 2-off VRV AC units along east façade of Building A (existing)
- 1 kitchen exhaust fan (KEF) and 1 kitchen supply fan (KSF) on roof of Building 4

Table 15: Sound power levels of major mechanical equipment and plant

PLANT AND EQUIPMENT	SOUND POWER LEVEL RE 10^{-12} W, dB – OCTAVE BAND CENTRE FREQUENCY								
	63 Hz	125 Hz	250 Hz	500 Hz	1 kHz	2 kHz	4 kHz	8 kHz	dB(A)
VRV Unit	80	79	76	73	68	64	57	53	74
DEU	77	77	78	76	76	73	70	61	80
KEF	82	87	84	88	89	85	80	73	94
KSF	78	81	76	72	70	70	68	63	84

The noise generated by the mechanical plant and equipment within the development has been assessed to what can be reasonably considered the most-affected point at surrounding noise-sensitive receivers, with consideration of the following assumptions:

- Mechanical plant only operates during the day (7am to 6pm)
- Mechanical plant operates at 100% capacity during the entire operation period

Table 16 provides a summary of the results of the noise impact assessment of the mechanical plant and equipment.

Table 16: Predicted noise levels at surrounding receiver catchments from mechanical equipment and plant

RECEIVER CATCHMENT	PREDICTED NOISE LEVEL $L_{Aeq,15min}$ – dB(A)	NOISE CRITERIA (DAY) $L_{Aeq,15min}$ – dB(A)	COMPLIES (YES/NO)
RC1	< 45	47	Yes
RC2	< 35	50	Yes
RC3	< 35	46	Yes
RC4	< 40	63	Yes

Based on the results of the assessment of the noise generated by the mechanical plant and equipment, the predicted noise levels at the surrounding noise-sensitive receivers are expected to comply with the project noise trigger levels established in Section 8.2.2 upon implementation of the mitigation measures outlined in Section 11.1.

9.3 PA SYSTEM AND SCHOOL BELL ASSESSMENT

An assessment of the noise generated by the PA system and the school bell noise emissions throughout the school grounds has been conducted to assess the potential impact and disturbance to nearby receivers. It should be noted this assessment has only been conducted for the external PA systems and school bells and not any that may be located within internal hallways and classrooms.

The following assumptions have been made for this assessment.

- PA systems / bells are located within the school areas (refer to Figure 3 for assumed locations used for the assessment);
- There is a PA system / bell for each individual building;
- The worst-case scenario of each school bell and/or PA system operating at a maximum of 90dB(A) sound power level, running simultaneously;
- For the above worst-case scenario, PA systems / bells run simultaneously for a duration of 10 seconds in any 15-minute period; and
- PA Systems and Bells are only used during school hours (NPI Daytime criteria).

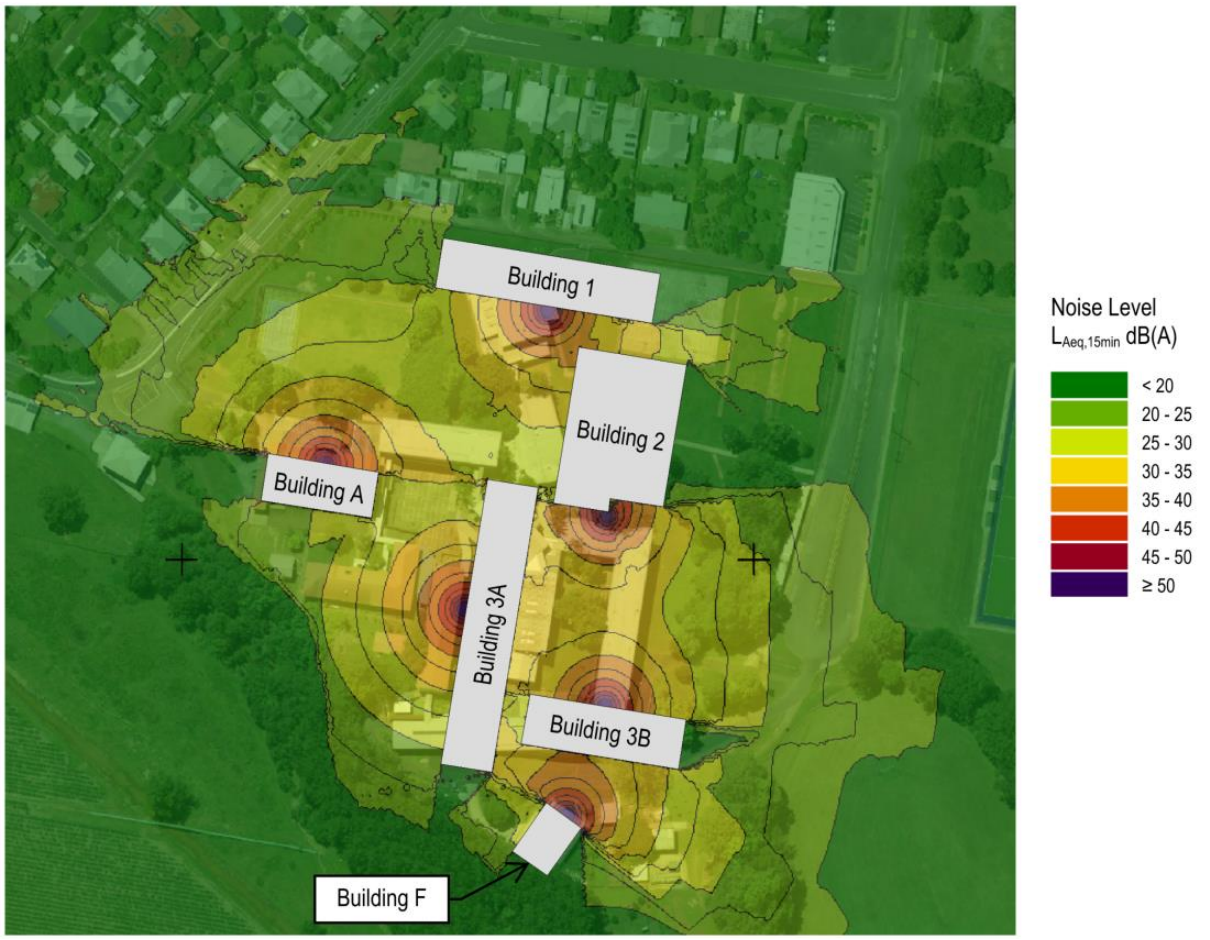
Figure 3: Locations of bells and PA systems used for noise assessment

The noise generated by the PA Systems and School Bells during a 15-minute period have been predicted to the facades of the nearest surrounding noise-sensitive receivers. Using the assessment methods outlined above, the predicted noise levels at the nearest noise-affected premises are summarised below in Table 17 and results presented in Figure 4.

Table 17: Predicted noise levels at surrounding receiver catchments from bells and PA systems

RECEIVER CATCHMENT	PREDICTED NOISE LEVEL $L_{Aeq,15min}$ – dB(A)	NOISE CRITERIA (DAY) $L_{Aeq,15min}$ – dB(A)	COMPLIES (YES/NO)
RC1	< 30	47	Yes
RC2	< 30	50	Yes
RC3	< 30	46	Yes
RC4	< 30	63	Yes

Figure 4: Coverage of Bells and PA systems used for assessment



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);
- Bulk excavation with piling;
- Civil works after piling (excavation, retention and foundation); and
- Structural works (construction, façade, finishes and services).

Refer to Section 5 for a detailed description of the works within the SSD application.

The construction works are expected to occur during the hours nominated within Tweed Shire Council, Development Construction Specification C101 – General (v1.4), which are as follows:

- Monday to Friday: 7:00am to 6:00pm;
- Saturday: 7:00am 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 18. The equipment noise levels have been extracted from AS2436:2010 “Guide to Noise and Vibration Control on Construction, Demolition and Maintenance Sites”.

Table 18: 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
Bulk Excavation (with Piling)	1 month	Impact Hammer Piling Rig	1	134	20	3	127
		Excavator 30 tonne	1	110	40	6	106
		Bobcat	1	107	70	10.6	105
Civil / Ground Works (without Piling)	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	6	102	50	7.5	99
		Concrete pump	1	109	50	7.5	106

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) $L_{Aeq,15min}$
		Generator	1	104	20	3	97
		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 11.2 are implemented; and
- Neutral weather conditions;

10.4 PREDICTED NOISE LEVELS

The predicted noise levels have been presented in Table 19 to Table 28 and have been assessed to the construction noise criteria established in Section 8.3. The noise contour maps produced by the three-dimensional noise propagation modelling are provided in Appendix A.

Table 19: Predicted noise levels – Early Works – Demolition & Dismantle (weekday)

RECEIVER CATCHMENT	PREDICTED NOISE LEVEL RANGE dB(A) $L_{Aeq,15min}$	NOISE MANAGEMENT LEVEL dB(A) $L_{Aeq,15min}$ (7AM – 6PM)	NOISE MANAGEMENT LEVEL EXCEEDANCE dB	EXCEEDS HIGHLY NOISE AFFECTED LEVEL (YES/NO)
RC1	56 – 66	52	4 – 14	No
RC2	51 – 61	55	0 – 6	No
RC3	46 – 51	51	0	No
RC4	56 – 61	70	0	N/A

Table 20: Predicted noise levels – Early Works – Demolition & Dismantle (weekend)

RECEIVER CATCHMENT	PREDICTED NOISE LEVEL RANGE 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)
		7AM – 8AM	8AM – 1PM	7AM – 8AM	8AM – 1PM	
RC1	56 – 66	46	51	10 – 20	5 – 15	No
RC2	51 – 61	50	55	1 – 11	0 – 6	No
RC3	46 – 51	46	51	0 – 5	0	No
RC4	56 – 61	70		0		N/A

Table 21: Predicted noise levels – Bulk Excavation (with Piling) – Scenario 1 (weekday)

RECEIVER CATCHMENT	PREDICTED NOISE LEVEL RANGE dB(A) $L_{Aeq,15min}$	NOISE MANAGEMENT LEVEL dB(A) $L_{Aeq,15min}$ (7AM – 6PM)	NOISE MANAGEMENT LEVEL EXCEEDANCE dB	EXCEEDS HIGHLY NOISE AFFECTED LEVEL (YES/NO)
RC1	65 – 90	52	13 – 38	Yes
RC2	55 – 70	55	0 – 15	No
RC3	50 – 55	51	0 – 4	No
RC4	65 – 70	70	0	N/A

Table 22: Predicted noise levels – Bulk Excavation (with Piling) – Scenario 1 (weekend)

RECEIVER CATCHMENT	PREDICTED NOISE LEVEL RANGE 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)
		7AM – 8AM	8AM – 1PM	7AM – 8AM	8AM – 1PM	
RC1	65 – 90	46	51	19 – 44	14 – 39	Yes
RC2	55 – 70	50	55	5 – 20	0 – 15	No
RC3	50 – 55	46	51	0 – 9	0 – 4	No
RC4	65 – 70	70		0		N/A

Table 23: Predicted noise levels – Bulk Excavation (with Piling) – Scenario 2 (weekday)

RECEIVER CATCHMENT	PREDICTED NOISE LEVEL RANGE dB(A) $L_{Aeq,15min}$	NOISE MANAGEMENT LEVEL dB(A) $L_{Aeq,15min}$ (7AM – 6PM)	NOISE MANAGEMENT LEVEL EXCEEDANCE dB	EXCEEDS HIGHLY NOISE AFFECTED LEVEL (YES/NO)
RC1	60 – 70	52	8 – 18	No
RC2	55 – 65	55	0 – 10	No
RC3	50 – 55	51	0 – 4	No
RC4	60 – 65	70	0	N/A

Table 24: Predicted noise levels – Bulk Excavation (with Piling) – Scenario 2 (weekend)

RECEIVER CATCHMENT	PREDICTED NOISE LEVEL RANGE 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)
		7AM – 8AM	8AM – 1PM	7AM – 8AM	8AM – 1PM	
RC1	60 – 70	46	51	14 – 24	9 – 19	No
RC2	55 – 65	50	55	5 – 15	0 – 10	No
RC3	50 – 55	46	51	0 – 9	0 – 4	No
RC4	60 – 65	70		0		N/A

Table 25: Predicted noise levels – Civil / Ground Works (without Piling) (weekday)

RECEIVER CATCHMENT	PREDICTED NOISE LEVEL RANGE dB(A) $L_{Aeq,15min}$	NOISE MANAGEMENT LEVEL dB(A) $L_{Aeq,15min}$ (7AM – 6PM)	NOISE MANAGEMENT LEVEL EXCEEDANCE dB	EXCEEDS HIGHLY NOISE AFFECTED LEVEL (YES/NO)
RC1	56 – 66	52	4 – 14	No
RC2	46 – 56	55	0 – 1	No
RC3	< 46	51	0	No
RC4	56 – 66	70	0	N/A

Table 26: Predicted noise levels – Civil / Ground Works (without Piling) (weekend)

RECEIVER CATCHMENT	PREDICTED NOISE LEVEL RANGE 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)
		7AM – 8AM	8AM – 1PM	7AM – 8AM	8AM – 1PM	
RC1	56 – 66	46	51	10 – 20	5 – 15	No
RC2	46 – 56	50	55	0 – 6	0 – 1	No
RC3	< 46	46	51	0	0	No
RC4	56 – 66	70		0		N/A

Table 27: Predicted noise levels – Structural Works & Façade and Finishes (weekday)

RECEIVER CATCHMENT	PREDICTED NOISE LEVEL RANGE dB(A) $L_{Aeq,15min}$	NOISE MANAGEMENT LEVEL dB(A) $L_{Aeq,15min}$ (7AM – 6PM)	NOISE MANAGEMENT LEVEL EXCEEDANCE dB	EXCEEDS HIGHLY NOISE AFFECTED LEVEL (YES/NO)
RC1	51 – 61	52	0 – 9	No
RC2	46 – 56	55	0 – 1	No
RC3	46 – 51	51	0	No
RC4	51 – 61	70	0	N/A

Table 28: Predicted noise levels – Structural Works & Façade and Finishes (weekend)

RECEIVER CATCHMENT	PREDICTED NOISE LEVEL RANGE 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)
		7AM – 8AM	8AM – 1PM	7AM – 8AM	8AM – 1PM	
RC1	51 – 61	46	51	5 – 15	0 – 10	No
RC2	46 – 56	50	55	0 – 6	0 – 1	No
RC3	46 – 51	46	51	0 – 5	0	No
RC4	51 – 61	70		0		N/A

11 MITIGATION MEASURES

11.1 MECHANICAL SERVICES

11.1.1 VRV Units

- VRV Units along north façade of Building 1 shall be installed below ground (trenched), whereby the top of the VRV unit (discharge) is no higher than 1m from ground level
- Perimeter of trench to be installed with a 1.8m high non-perforated solid screen (e.g. lapped and capped timber fence) to create an open-top enclosure

11.1.2 General Measures

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 8.2.2. 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 CONSTRUCTION NOISE AND VIBRATION

11.2.1 Noise

It is proposed that impact hammer piling will occur during the initial stages of excavation, and this is predicted to produce the highest noise levels at the surrounding most affected sensitive receivers, during the construction of the development.

The most affected receiver catchment is predicted to be RC1 and will be when piling occurs at Building 1, due to its close proximity to the northern project site boundary.

Given this prediction, the following is recommended during highly noisy activities, such as impact hammer piling:

- Noise monitoring at the most-affected noise-sensitive receivers in accordance with the monitoring program proposed in Section 11.2.4; and
- In addition to noise monitoring, at least a one hour respite period, for example between 12:00pm – 1:00pm (or other period to coincide with construction workers lunch time(s)), should be offered per day during the most intensive periods of piling, hammering and rock breaking. Limiting these activities outside of sensitive hours (e.g. no piling, hammering and breaking between 7:00am – 8:00am) shall also be considered. Frequent and proactive communication with the surrounding residents is also encouraged. More details regarding communication with the community can be found in Section 11.2.3.

11.2.2 Vibration

The highest vibration inducing activities are predicted to be impact hammer piling and rock hammering / breaking. Wagstaff Piling have provided vibration monitoring results for an activity of similar nature to the proposed piling method, whereby a distance of 10 to 15 metres from the piling rig produced a Peak Vector Sum of approximately 1 to 2 mm/s.

The most-affected receivers are predicted to be RC1, which is approximately 14m to Building 1 (nearest point to point). Although the provided results indicate a lower magnitude than the DIN 4150 criteria (structural damage)

for dwellings, it is still recommended that vibration monitoring be conducted at the most-affected receivers in accordance with the monitoring program proposed in Section 11.2.3, as the working and ground conditions will be different than that of the provided results.

Prior to the use of piling or rock hammering / breaking on the northern boundary, attended vibration measurements should be conducted to determine if there is an exceedance of the vibration limits set out in Section 8.4.

Upon any exceedances in vibration levels, reasonable and feasible measures should be considered to lessen the impact, such as alternative methods or equipment for excavation / piling to achieve the vibration levels required.

To further diminish the vibration impact, the one hour respite period, for example between 12:00pm – 1:00pm (or other period to coincide with construction workers lunch time(s)), recommended for noise mitigation shall also apply for vibration mitigation.

11.2.3 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.

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

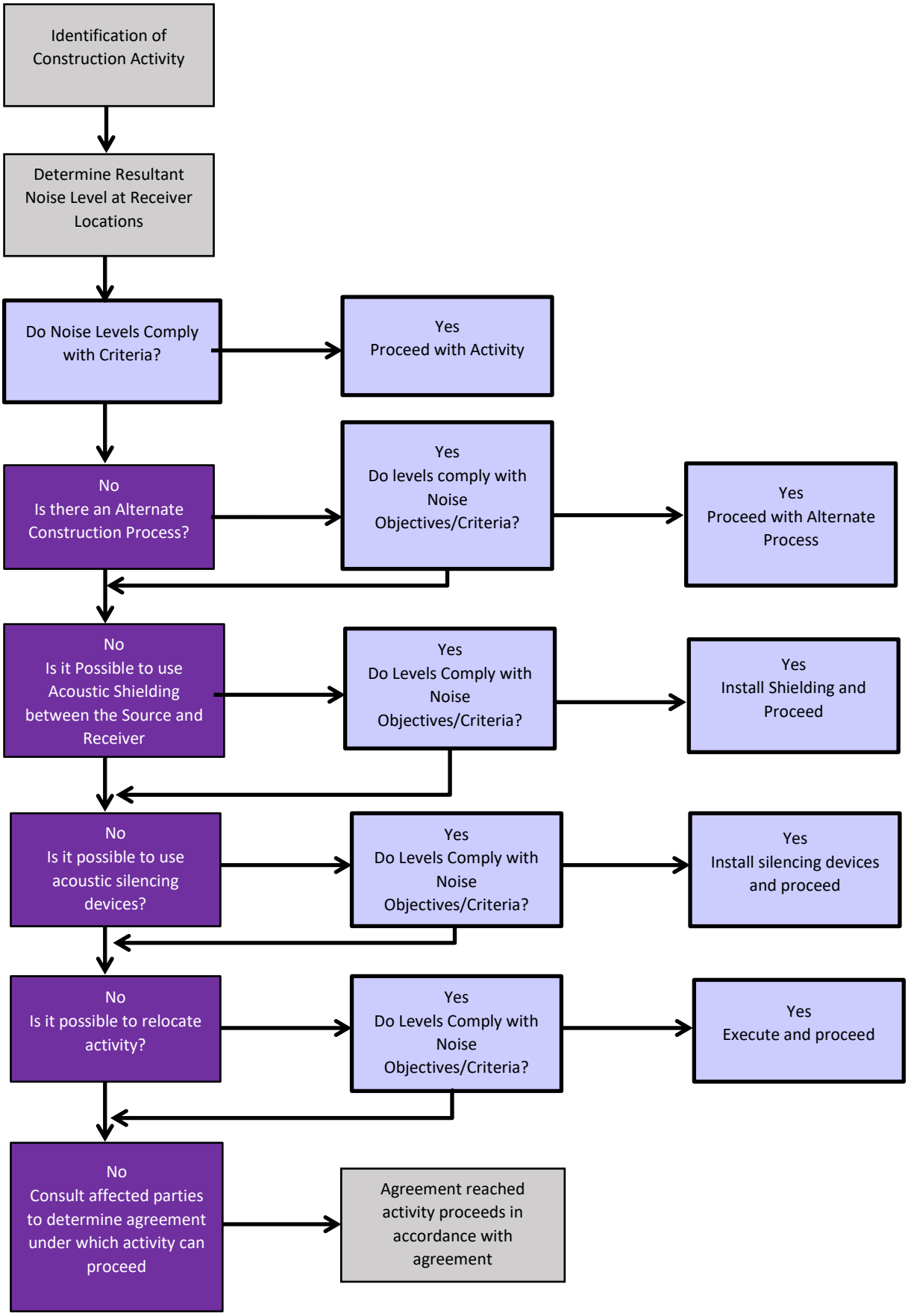
Community complaints often involve the intrusive noise of alarms commonly used to provide a safe system of work for vehicles operating on a site. Beeper reversing alarm noise is generally tonal and may cause annoyance at significant distances from the work site.

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 5: Noise mitigation management flow chart



11.2.4 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.

Noise and Vibration Monitoring Program

The proposed noise and vibration monitoring program during the construction works is outlined in Table 29.

Table 29: Proposed noise and vibration monitoring locations details

RECEIVER LOCATION	PROPOSED MONITORING TYPE AND PHASE
RC1	Noise – Bulk Excavation (with Piling)
	Vibration – Bulk Excavation (with Piling)
RC2	Noise – Bulk Excavation (with Piling)
	Vibration – Bulk Excavation (with Piling)
RC3	Noise – Bulk Excavation (with Piling)
	Vibration – Bulk Excavation (with Piling)

12 CONCLUSION

This noise and vibration report has been prepared by E-LAB Consulting to accompany a State Significant Development Application (SSDA) for Murwillumbah Education Campus (MEC) located at 86 Riverview Street, Murwillumbah.

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

- Road noise intrusion into development from traffic movement on surrounding local roads;
- Noise and vibration impact of mechanical plant and equipment serving the proposed development on surrounding noise and vibration sensitive receivers;
- Noise impact from the proposed educational campus operating PA Systems and Bells.

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.

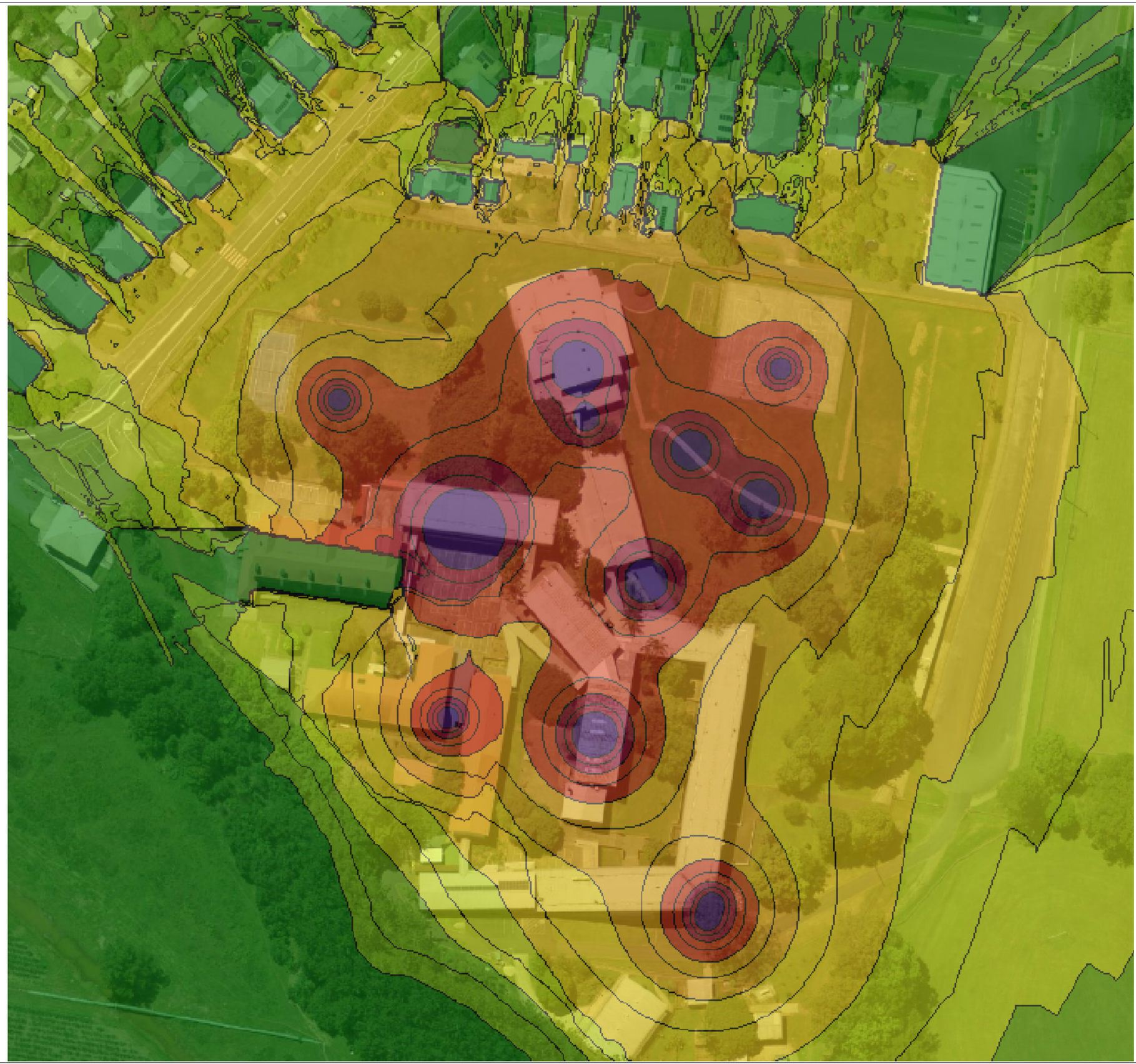
To assess each of the acoustic considerations for the proposed redevelopment, noise and vibration criteria has been established in Section 8 in accordance with the following documents:

- Tweed Shire Council, Development Construction Specification C101 – General (v1.4)
- NSW Noise Policy for Industry (NPI) 2017;
- SEPP (Infrastructure) 2007;
- Development Near Rail Corridors and Busy Roads – Interim Guideline;
- 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”; and
- German Standard DIN4150 – Part 3: “Structural vibration in buildings – Effects on structures”.

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 Construction Noise Emissions Modelling



E-LAB CONSULTING

ISSUE	DATE	STATUS
1	19/10/2021	Issue for SSDA
2	15/03/2022	For Coordination

LEGEND

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

- < 46
- 46 - 51
- 51 - 56
- 56 - 61
- 61 - 66
- 66 - 71
- 71 - 76
- ≥ 76

NOTES

PROJECT
MURWILLUMBAH EDUCATION CAMPUS (MEC)

PROJECT NO.
P00106

ARCHITECT
ARCHITECTUS

CLIENT
BUILT

SCALE
NTS

STATUS
FOR COORDINATION

DRAWING
NOISE EMISSIONS CONTOUR MAP

EARLY WORKS - DEMOLITION & DISMANTLE

DISCIPLINE
ACOUSTICS AND VIBRATION

DRAWING NUMBER	REVISION
AC-DWG-100-01-02	002

E-LAB CONSULTING

ISSUE	DATE	STATUS
1	19/10/2021	Issue for SSDA
2	15/03/2022	For Coordination

LEGEND

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

- < 55
- 55 - 60
- 60 - 65
- 65 - 70
- 70 - 75
- 75 - 80
- 80 - 85
- ≥ 85

NOTES

PROJECT
MURWILLUMBAH EDUCATION CAMPUS (MEC)

PROJECT NO.
P00106

ARCHITECT
ARCHITECTUS

CLIENT
BUILT

SCALE
NTS

STATUS
FOR COORDINATION

DRAWING
NOISE EMISSIONS CONTOUR MAP

BULK EXCAVATION (WITH PILING)
SCENARIO 1

DISCIPLINE
ACOUSTICS AND VIBRATION

DRAWING NUMBER	REVISION
AC-DWG-100-02-02	002

E-LAB CONSULTING

ISSUE	DATE	STATUS
1	19/10/2021	Issue for SSDA
2	15/03/2022	For Coordination

LEGEND

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

- < 55
- 55 - 60
- 60 - 65
- 65 - 70
- 70 - 75
- 75 - 80
- 80 - 85
- ≥ 85

NOTES

PROJECT
MURWILLUMBAH EDUCATION CAMPUS (MEC)

PROJECT NO.
P00106

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BUILT

SCALE
NTS

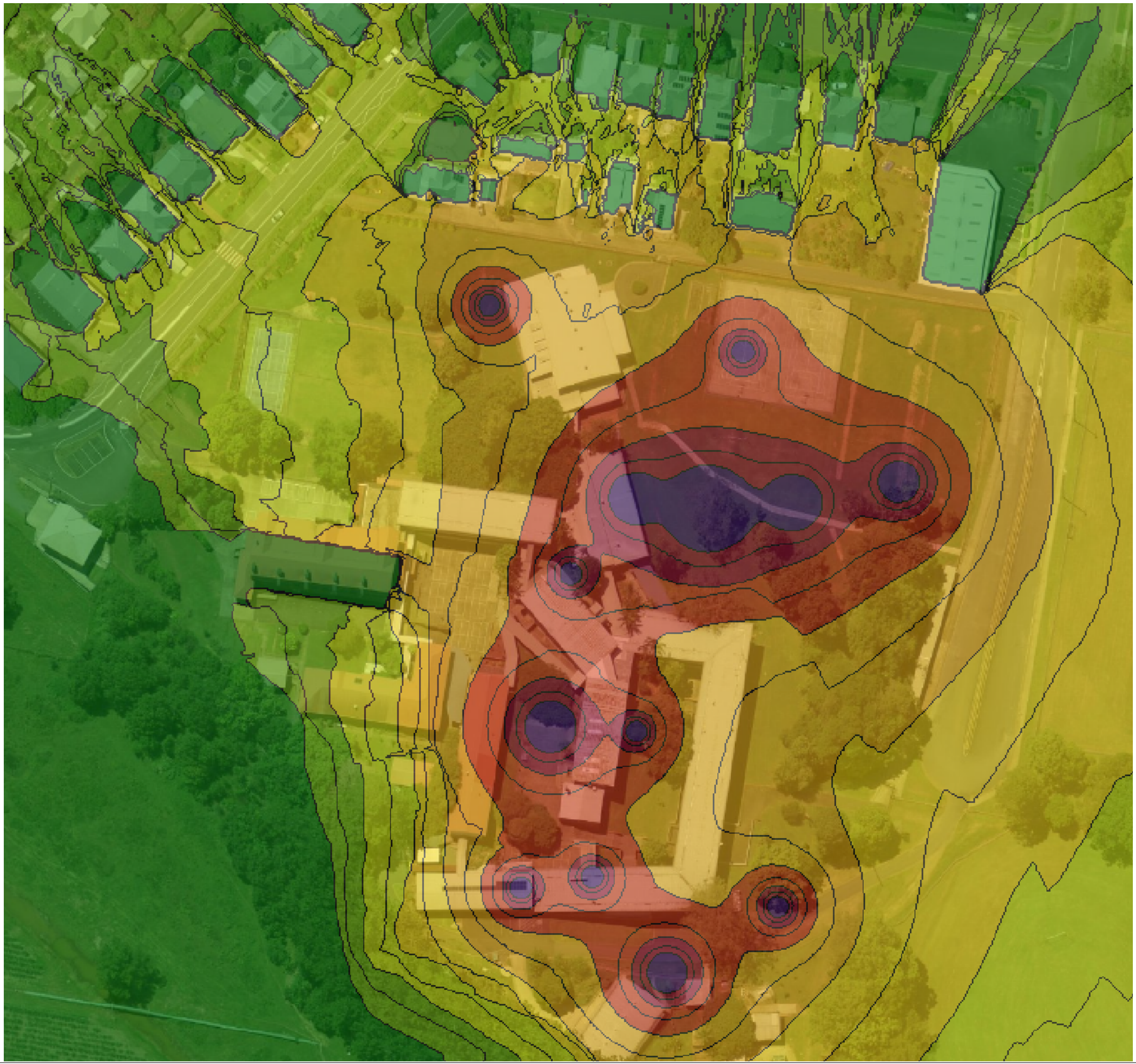
STATUS
FOR COORDINATION

DRAWING
NOISE EMISSIONS CONTOUR MAP

BULK EXCAVATION (WITH PILING)
SCENARIO 2

DISCIPLINE
ACOUSTICS AND VIBRATION

DRAWING NUMBER	REVISION
AC-DWG-100-03-02	002



E-LAB CONSULTING

ISSUE	DATE	STATUS
1	19/10/2021	Issue for SSDA
2	15/03/2022	For Coordination

LEGEND

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

- < 46
- 46 - 51
- 51 - 56
- 56 - 61
- 61 - 66
- 66 - 71
- 71 - 76
- ≥ 76

NOTES

PROJECT
MURWILLUMBAH EDUCATION CAMPUS (MEC)

PROJECT NO.
P00106

ARCHITECT
ARCHITECTUS

CLIENT
BUILT

SCALE
NTS

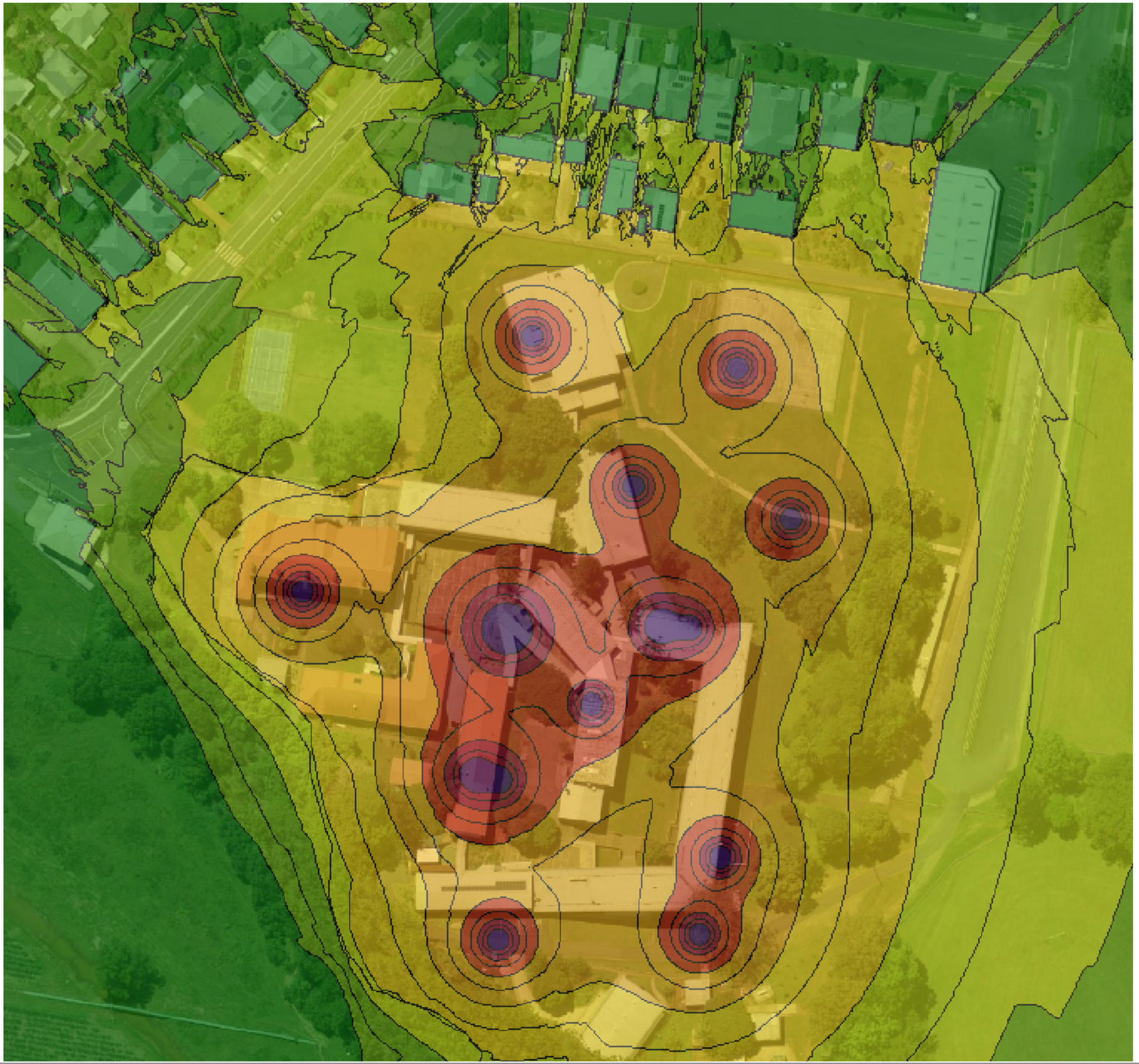
STATUS
FOR COORDINATION

DRAWING
NOISE EMISSIONS CONTOUR MAP

CIVIL / GROUND WORKS (WITHOUT PILING)

DISCIPLINE
ACOUSTICS AND VIBRATION

DRAWING NUMBER	REVISION
AC-DWG-100-04-02	002



E-LAB CONSULTING

ISSUE	DATE	STATUS
1	19/10/2021	Issue for SSDA
2	15/03/2022	For Coordination

LEGEND

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

- < 46
- 46 - 51
- 51 - 56
- 56 - 61
- 61 - 66
- 66 - 71
- 71 - 76
- ≥ 76

NOTES

PROJECT
MURWILLUMBAH EDUCATION CAMPUS (MEC)

PROJECT NO.
P00106

ARCHITECT
ARCHITECTUS

CLIENT
BUILT

SCALE
NTS

STATUS
FOR COORDINATION

DRAWING
NOISE EMISSIONS CONTOUR MAP

STRUCTURAL WORKS &
FACADE AND FINISHES

DISCIPLINE
ACOUSTICS AND VIBRATION

DRAWING NUMBER
AC-DWG-100-05-02

REVISION
002

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