St Augustine's College

Noise and Vibration Impact Assessment

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Client	Sydney Catholic Schools c/- APG – Carter Gaze

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 INTRODUCTION

This Noise and Vibration Impact Assessment has been prepared in support of a Development Application (DA) made to Northern Beaches Council for St Augustine's College, located at 37 Alfred Road, Brookvale. The application seeks the addition of a carpark on Federal Parade, a carpark on Alfred Road, and the increase in school capacity from 1,200 to 1,600 students.

In summary, this noise impact assessment shall address the following key considerations:

- Traffic noise generation from the addition of new carparks and the impact on nearby noise sensitive receivers
- Noise impact to nearby noise sensitive receivers from the operation of the new carpark
- Noise impact to nearby noise sensitive receivers from the increase in students within the school
- Noise and vibration impact to nearby receivers from the construction of proposed carparks

The acoustic, noise and vibration legislation, standards and guidelines applicable to the proposed redevelopment include:

- Warringah Development Control Plan (DCP) 2011
- NSW Road Noise Policy (RNP), 2011
- NSW EPA Noise Policy for Industry (NPI) 2017
- Bureau of Meteorology, Daily rainfall report
- NSW EPA 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" – Part 2: "Guide to Damage Levels from Groundborne Vibration"
- German Standard DIN4150 – Part 3: "Structural vibration in buildings – Effects on structures"

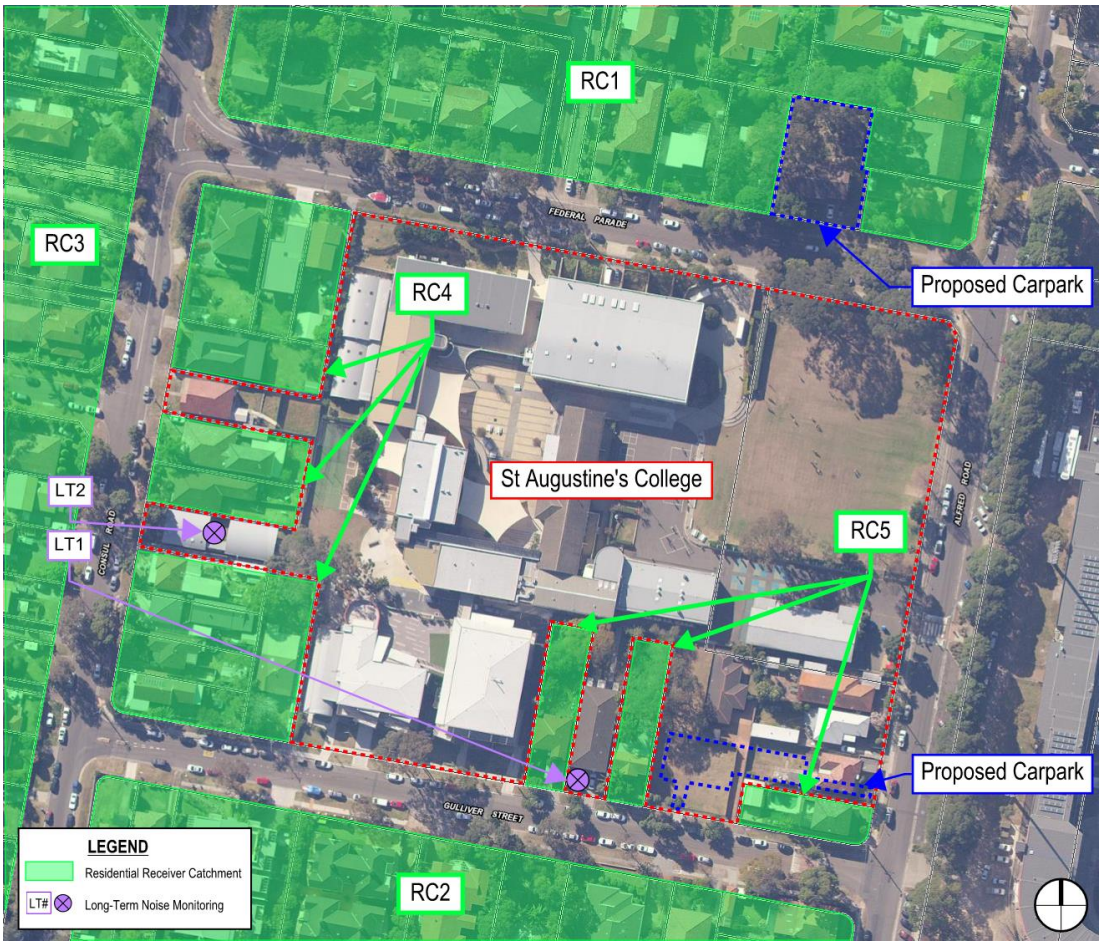
2 PROJECT OVERVIEW

2.1 SITE DESCRIPTION

The location of the school, proposed carpark, long-term noise monitoring positions, and the surrounding noise-sensitive receivers are shown in Figure 1. The noise-sensitive receivers have been delineated into receiver catchments (RCs) as noted in Figure 1, where the permissible land-uses within each of the receiver catchments are outlined below:

- RC1 – Residential receivers, low density residential
- RC2 – Residential receivers, low density residential
- RC3 – Residential receivers, low density residential
- RC4 – Residential receivers, low density residential
- RC5 – Residential receivers, low density residential

Figure 1: Acoustic site plan identifying the surrounding noise-sensitive receivers and noise monitoring locations



2.2 SITE ACOUSTIC CONSIDERATIONS

Upon reviewing the design documentation prepared for the Development Application, the acoustic elements to consider for the proposed redevelopment are:

- Traffic noise generation from the addition of new carparks and the impact on nearby noise sensitive receivers
- Noise impact to nearby noise sensitive receivers from the operation of the new carpark
- Noise impact to nearby noise sensitive receivers from the increase in students within the school

3 NOISE SURVEYS

3.1 IMPLEMENTATION OF PREVIOUS NOISE MONITORING

Previous noise monitoring has been conducted around St Augustine's College, with the results of the noise monitoring outlined in the Acoustic Planning Report prepared by Resonate Acoustics, dated 17/10/2013 (*ref. S13216RP1*), and Complying Development Acoustic Assessment prepared by Acoustic Logic, dated 22/11/2018 (*ref. 20181398.1/2211A/R2/AW)*.

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 Resonate and Acoustic Logic have been used for this assessment as it is likely to be more reliable.

3.2 LONG-TERM NOISE MONITORING – BACKGROUND NOISE

Long-term noise monitoring was conducted by Resonate Acoustics at the location labelled LT1 in Figure 1, and by Acoustic Logic at the location labelled LT2 in Figure 1. Background noise levels and subsequent Rating Background Noise Level (RBL) have been extracted from these reports, which are 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 1: Unattended noise monitoring results – LT1

LOCATION	MEASURED RATING BACKGROUND NOISE LEVELS - dB(A)		
	DAY	EVENING	NIGHT
LT1	42	38	30[1]
LT2	42	37	30[1]

Note 1: The night time RBL in both reports have been adjusted to be consistent with the NPI's minimum night time RBL, being 30dB(A)

The local ambient noise environment is typical of a suburban residential environment (as classified by the NPI).

4 PROJECT NOISE AND VIBRATION CRITERIA

This section presents the regulatory requirements, and acoustic design criteria for the proposed development.

4.1 EXTERNAL NOISE EMISSIONS

4.1.1 Warringah Development Control Plan 2011

Section D3 of Warringbah DCP 2011 established the following acoustic requirements:

> *"1. Noise from combined operation of all mechanical plant and equipment must not generate Noise levels that exceed the ambient background Noise by more than 5dB(A) when measured in accordance with the NSW Industrial Noise Policy at the receiving boundary of residential and other Noise sensitive land uses."*

It is also noted that the NSW Industrial Noise Policy has been superseded by the NSW EPA Noise Policy for Industry (NPI) 2017. The above requirement is comparable to the NPI's method of determining the Project Intrusiveness Noise Level (see Section 4.1.2 below).

4.1.2 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:

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

Where the RBLs established in accordance with Fact Sheet A are lower than the values presented in Table 2 for each assessment period, the values presented in Table 2 shall be used for that particular assessment period. These result in the minimum intrusiveness noise levels provided in Table 2.

Table 2: 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 3 provides the project intrusiveness noise levels applicable to each of the surrounding residential noise-sensitive receivers.

Table 3: 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 – RC5	Day	42	47
	Evening	37	42
	Night	30	35

Note 1: for the purpose of a conservative assessment, RBLs for the nearby noise receiver catchments have been adopted from Acoustic Logic's report, being the lower out of the 2 reports.

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 4) – 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 4.

Table 4: 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 – RC5	Residential – Suburban[1]	Day	55	50	53
		Evening	45	40	43
		Night	40	35	38

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 5 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 5: 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 – RC5	Residential	Day	47	53	N/A	47
		Evening	42	43	N/A	42
		Night	35	38	40 $L_{Aeq,15min}$ 52 L_{AFmax}	35

4.2 CONSTRUCTION NOISE CRITERIA

The noise criteria outlined within the Interim Construction Noise Guideline (ICNG) 2009 has been adopted for the assessment of noise emissions from the construction of the proposed redevelopment.

4.2.1 Airborne Noise – Residential Receiver Catchments

The airborne noise criteria for surrounding residential receiver catchments (RC1 – RC5) have been extracted from Table 2 in the ICNG has been extracted and is presented in Table 6 below.

Table 6: NSW ICNG construction noise criteria for surrounding residential receiver catchments (RC1 – 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.

4.2.2 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)
- 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.

4.3 CONSTRUCTION VIBRATION CRITERIA

4.3.1 Human Comfort – Continuous and Impulsive Vibration Criteria

Where occupants can detect vibration in buildings, this may potentially impact on their quality of life or working efficiency. The level of vibration that affects the amenity of occupants within a building is lower than that associated with building damage. The NSW DEC have prepared a guideline, *"Assessing vibration: a technical guideline"*, which presents preferred and maximum vibration values for use in assessing human responses to vibration and provides recommendations for measurement and evaluation techniques.

Acceptable values of human exposure to continuous and impulsive vibration are dependent on the time of day and the activity taking place in the occupied space. Guidance on preferred values for continuous and impulsive vibration acceleration is provided in Table 7.

Table 7: 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

4.3.2 Human Comfort – Intermittent Vibration Criteria

Intermittent vibration is vibration which is perceived in separately identifiable repeated bursts. Its onset can be sudden, or there might be a gradual onset and termination bounding a more sustained event. The vibration dose value (VDV) defines a relationship that yields a consistent assessment of intermittent vibration and correlates well with subjective human response.

Acceptable values of vibration dose have been extracted from Table 2.4 of the guideline and are presented in Table 8.

Table 8: 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

4.3.3 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 9 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 9: 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)

4.3.4 Structural Damage

Structural damage criteria are established within DIN4150-Part 3 “Structural vibration in buildings – Effects on structures”. Table 10 indicates the vibration limits presented in DIN4150-Part 3, where upon exceeding these thresholds lies the risk in inducing structural damage.

Table 10: Guideline value of vibration velocity, vi, for evaluating the effects of short-term vibration – DIN4150-3

LINE	TYPE OF STRUCTURE	VIBRATION VELOCITY, VI, IN MM/S			
		FOUNDATION			PLANE OF FLOOR OF UPPERMOST FULL STOREY
		AT A FREQUENCY OF			
		LESS THAN 10HZ	10 TO 50HZ	50 TO 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					

5 NOISE AND VIBRATION IMPACT ASSESSMENT

5.1 CARPARK NOISE IMPACT ASSESSMENT

An assessment of the noise generated by activities from the carparks have been conducted to determine the impacts on the surrounding noise-sensitive receivers.

As part of the application, there are 2 new carparks envisaged:

- One is to be located at 60 Federal Parade which will yield 24 car parking spaces. The driveway will remain on Federal Parade but will be slightly relocated and widened. See Figure 1 for an aerial overview of the site and Figure 2 for the carpark concept plan.
- Another is to be located on the corner of Alfred Road and Gulliver Street which will yield 30 car parking spaces. Currently, there is a playground belonging to the school where majority of the proposed car spaces are. The carpark is to have one-way traffic flow with entrance on Alfred Road and exit on Gulliver Street. See Figure 1 for an aerial overview of the site and Figure 3 for the carpark concept plan.

Figure 2: Federal Pde carpark concept plan, dated 22/09/21 (issue P6)

Figure 3: Alfred Rd carpark concept plan, dated 22/09/21 (issue P6)

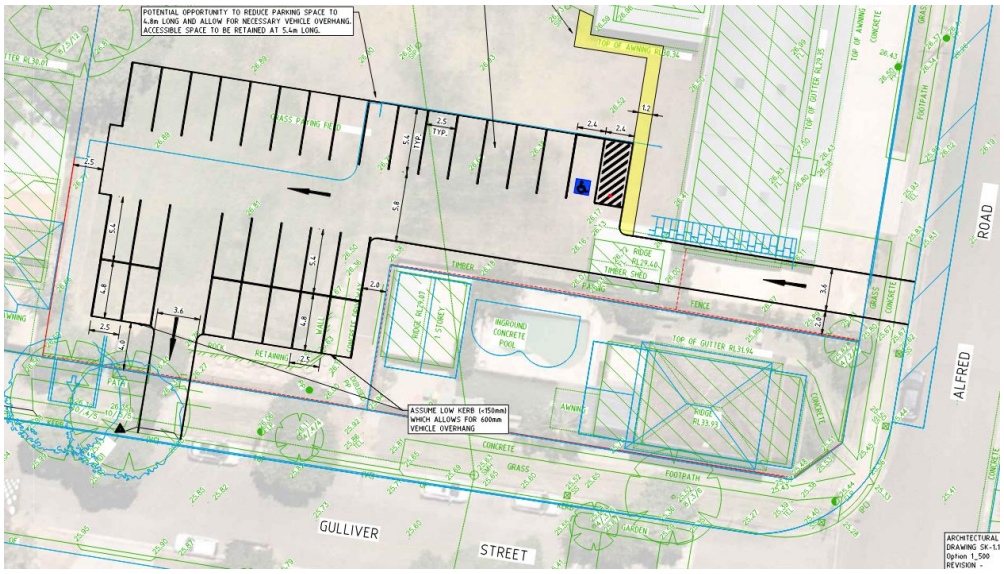


Table 11 outlines the sound power level (SWL) and typical duration (minutes) associated with standard carpark activities.

Table 11: Typical sound power levels and durations of carpark activities

ACTIVITIES	TYPICAL DURATION OF ACTIVITY WITHIN A 15 MINUTE PERIOD (SINGLE CAR)	SOUND POWER LEVEL $L_{Aeq,period}$ – dB(A)
Car Engine Start	2 seconds	82
Car Manoeuvring @ 10km/hr	20 seconds	85
Car Door Close	1 second	84

Adjustments have been made to the above for the expected $L_{Aeq,15min}$ sound power levels.

Table 12: Duration correction of carpark sound power levels

ACTIVITIES	DURATION CORRECTION dB(A)	CORRECTED SOUND POWER LEVEL $L_{Aeq,15min}$ – dB(A)
Car Engine Start	-26.5	55.5
Car Manoeuvring @ 10km/hr	-16.5	68.5
Car Door Close	-29.5	54.5

The noise generated by the activities during a 15-minute period have been predicted to the facades of the nearest surrounding noise-sensitive receivers and are summarised below in Table 13.

The following assumptions have been made for the noise modelling and assessment:

- Carparks will only be used by school staff and students, on normal occasions (allocated spaces), and overflow of student / parent vehicles during after-hours events;
- Carparks will only be used during the day (7am to 6pm) for normal school days, with evening usage (6m to 10pm) only for after-hours events;
- Peak carpark usage is predicted to be between 7am to 8am when staff/students arrive and 3pm to 4pm when staff/students leave;
- Carpark capacity (24 cars for Federal Parade and 30 cars for Alfred Road) is linearly filled or emptied in a span of 1 hour; and
- Installation of mitigation measures proposed in Section 6.1.

The noise emissions contour maps for the proposed car parks are provided in Appendix A. The results of the noise modelling are provided in Table 13.

Table 13: Predicted noise levels at most affected façade of receiver catchments from carpark operations

RECEIVER CATCHMENT	PREDICTED NOISE LEVEL (WITH MITIGATION) $L_{Aeq,15min}$ – dB(A)	NOISE CRITERIA DAYTIME $L_{Aeq,15min}$ – dB(A)	COMPLIES (YES/NO)
RC1	< 39	49[1]	Yes
RC2	< 39		
RC3	< 30		
RC4	< 30		
RC5	< 42		

Note 1: For standard operation of the carparks, it is expected that there'll be a 1 hour usage in the morning (when staff/teachers arrive) and 1 hour in the afternoon (when staff/teachers leave), generating a total usage of 2 hours. As such, a 2dB correction has been applied to the daytime criterion as per the NPI's modifying factor corrections (specifically Table C3).

Based on the results of the assessment of the noise generated by activities within the carparks, the predicted noise levels at the surrounding noise-sensitive receivers are expected to comply with the project noise trigger levels established in Section 4.1 during expected hours of operation.

Further, receivers around the Alfred Road / Gulliver Street carpark are expected to be less affected by noise given the intrusive nature of playground activities compared to car park activities.

5.2 SCHOOL OPERATION NOISE IMPACT ASSESSMENT

As part of the application, the school's capacity is proposed to increase from 1,200 to 1,600 students. To assess the extent of noise impact to surrounding receivers, noise emissions from within the school for both the currently allowed school capacity (1,200) and proposed new capacity (1,600) will be predicted and compared.

It is acknowledged in the field of acoustics that a noise difference of up to 2dB is generally indiscernible to an average person. This principle is discussed in Section 3.4 of the NSW Road Noise Policy, which states:

> *"In assessing feasible and reasonable mitigation measures, an increase of up to 2dB represents a minor impact that is considered barely perceptible to the average person"*

Further, the same approach is established in the NSW EPA Noise Policy for Industry, where Section 4.2 of the document provides the following tables.

Table 14 – Significance of residual noise impacts (Table 4.1 from NPI)

IF THE PREDICTED NOISE LEVEL MINUS THE PROJECT TRIGGER LEVEL IS:	AND THE TOTAL CUMULATIVE INDUSTRIAL NOISE LEVEL IS:	THEN THE SIGNIFICANCE OF RESIDUAL NOISE LEVEL IS:
≤ 2 dB(A)	Not Applicable	Negligible

Table 15 – Examples of receiver-based treatments to mitigate residual noise impacts (Table 4.2 from NPI)

SIGNIFICANCE OF RESIDUAL NOISE LEVEL	EXAMPLE OF POTENTIAL TREATMENT
Negligible	The exceedances would not be discernible by the average listener and therefore would not warrant receiver-based treatments or controls.

As shown above, the NSW NPI similarly suggests that a noise level exceedance of up to 2 dB is of negligible significance. Based on this principle, an increase of up to 2dB at surrounding receivers from the increase in school student capacity would be acceptable.

Detailed noise emission modelling was conducted for 1,200 and 1,600 students to determine predicted noise levels at surrounding noise sensitive receivers for both scenarios. As part of these models, it is assumed that students are evenly distributed throughout all school outdoor play areas and sports fields. Typical sound power levels for groups of students were then allocated into these areas and overall noise emission contours for the daytime period (7am to 6pm) were generated.

The noise emissions contour maps for the operation of the school with both 1,200 and 1,600 students on the premises provided in Appendix B. The results of the noise modelling are provided in Table 16.

Table 16: Predicted noise levels at most affected façade of receiver catchment from existing school capacity

RECEIVER CATCHMENT	PREDICTED NOISE LEVEL (1,200 STUDENTS) $L_{Aeq,daytime}$ – dB(A)	PREDICTED NOISE LEVEL (1,600 STUDENTS) $L_{Aeq,daytime}$ – dB(A)	PREDICTED INCREASE IN NOISE LEVEL $L_{Aeq,daytime}$ – dB(A)	ACCEPTABLE? (YES/NO)
RC1	49-50	51	1-2	Yes
RC2	45-46	47	1-2	
RC3	37-38	39	1-2	
RC4	49-50	51	1-2	
RC5	53-54	55	1-2	

Based on the noise emission modelling of both student capacities, it is observed that predicted noise levels at surrounding receiver catchments increases by 1-2dB(A) as a result of an additional 400 students. As noted above, a difference of up to 2 dB(A) will not be discernible by the average listener and is considered acceptable.

6 NOISE MITIGATION MEASURES

6.1 CARPARK NOISE MITIGATION

To ensure compliance with noise emission criteria outlined in Section 4.1, the following recommendations are to be implemented and followed:

- Standard carpark hours of operation are to only be after 7am and before 6pm, with operation of the car parks from 6pm to 10pm only permitted for special events (infrequently);
- Carpark boundaries adjacent to residential receivers to have an acoustic barrier as shown in Figure 4 and Figure 5; and
- Acoustic barrier shall be minimum 1.8m in height and all gaps are to be minimised.
- Acoustic barrier shall be made of a material and constructed to have a minimum surface density of 16kg/m^2

Figure 4: Federal Parade carpark fencing

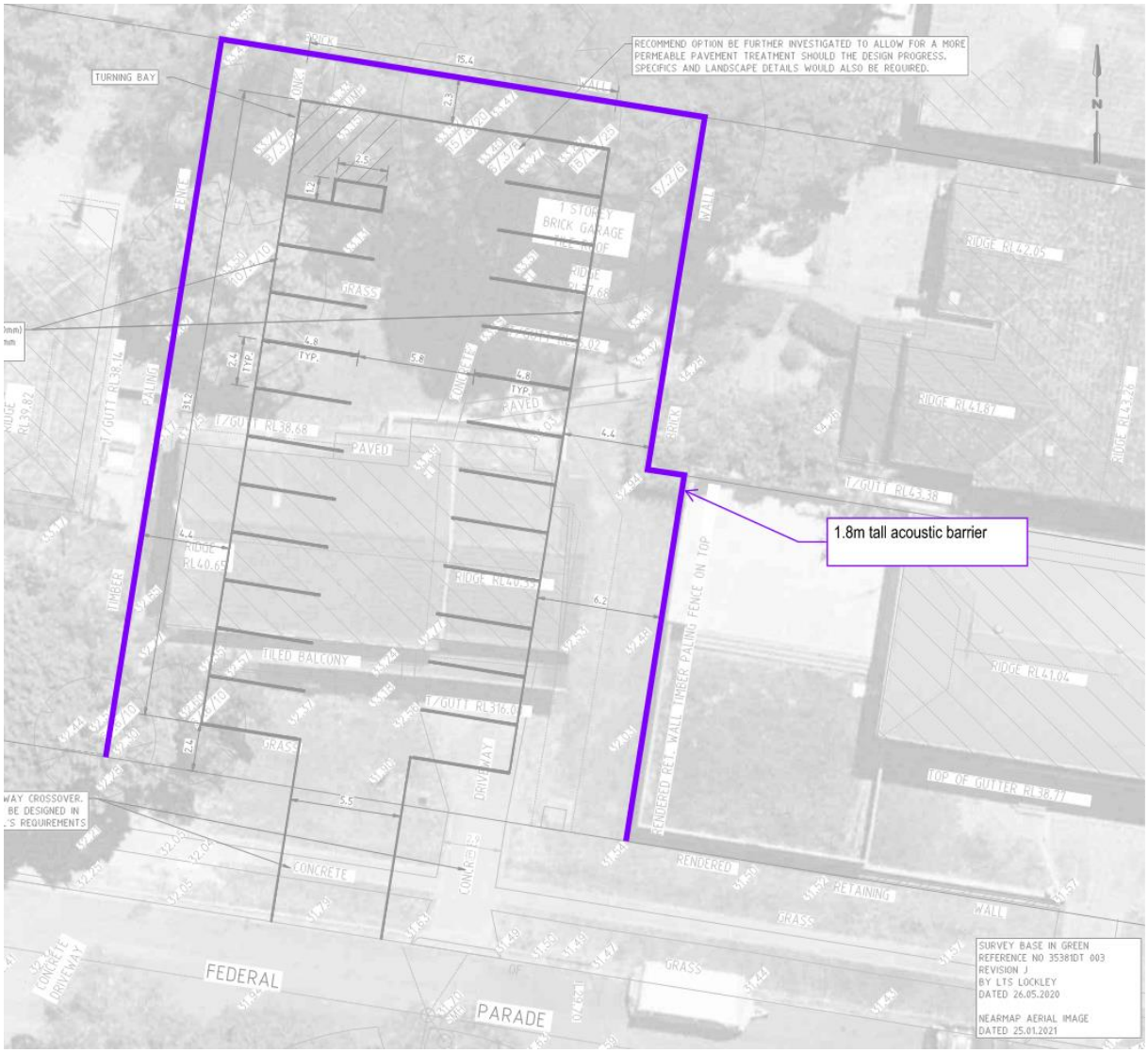


Figure 5: Alfred Road carpark fencing

7 CONSTRUCTION NOISE EMISSIONS

7.1 PROJECT SPECIFIC RECOMMENDATIONS

Project specific recommendations and required mitigation methods have been listed below. For general noise and vibration mitigation and management measures, refer to Section 7.2 of this report.

7.1.1 Noise

The use of a standard A-class hoarding of the following materials and construction will suffice to mitigate the impact of the highest predicted noise levels, installed to the extent illustrated in Figure 6 and Figure 7:

- The A-class hoarding should be impervious of gaps and cracks which would compromise its performance
- it should be comprised of acoustically suitable materials such as 17 mm plywood
- be minimum 2.1m in height

The barrier shall reduce the noise levels experienced at the surrounding residential receivers to the proposed carparks. Locating site amenities towards the site boundaries further increases the shielding of construction noise.

Figure 6: Hoarding required around Federal Parade carpark

Figure 7: Hoarding required around Alfred Road carpark

7.2 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.

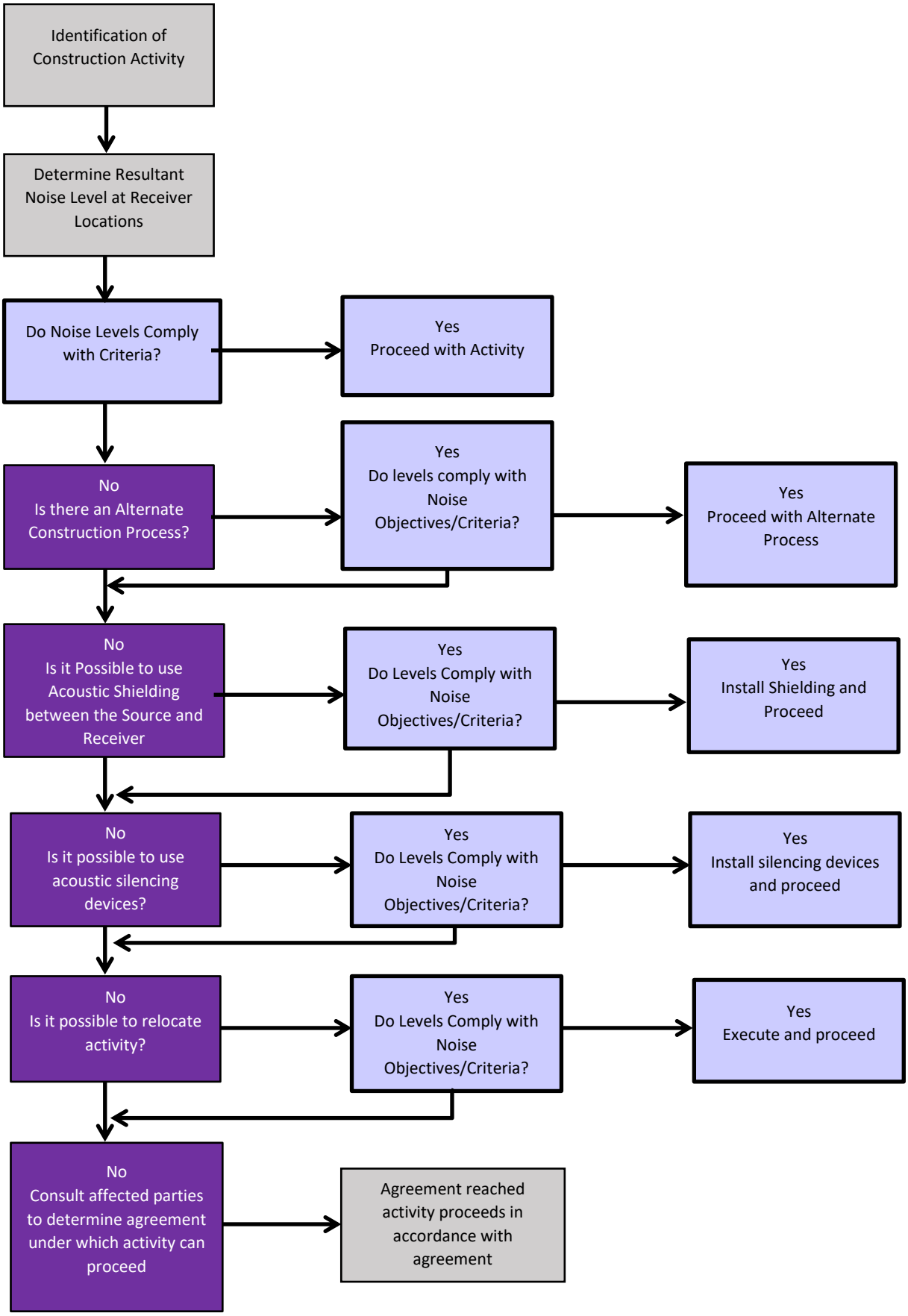
7.2.1 Noise

Figure 8 demonstrates the preferred order of actions taken to mitigate excessive construction noise emissions. If a process that generates significant noise levels cannot be avoided, the amount of noise reaching the receiver should be minimized. Two ways of achieving this are to either increase the distance between the noise source and the receiver or to introduce noise reduction measures such as screens. Practices that will reduce noise from the site include:

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

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

Figure 8: Noise mitigation management flow chart



7.2.2 Screening

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

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

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

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

General remarks:

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

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

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

7.2.3 Cranes

For the construction of the carparks, any cranage are expected to be limited to mobile cranes where the engines are typically enclosed in an acoustically treated housing.

7.2.4 Reversing and warning alarms

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

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

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

- Spotters or observers.

The above methods should be combined, where appropriate.

7.3 COMPLAINT HANDLING PROCEDURES AND COMMUNITY LIAISON

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

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

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

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

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

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

7.4 NOISE & VIBRATION MONITORING STRATEGY

7.4.1 General Methodology

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

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

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

Noise and vibration monitoring can take two forms:

- Short-term monitoring
- Long-term monitoring

Both of these approaches are elaborated below.

7.4.2 Short-term Monitoring

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

7.4.3 Long-term Monitoring

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

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

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

7.4.4 Noise & Vibration Monitoring Program

A monitoring program for the construction works is proposed in Table 17. The monitoring program is to be carried out during the likely noisiest periods during each construction phase as agreed with the Acoustic engineer and Contractor.

Table 17: Noise and vibration monitoring program

CONSTRUCTION ACTIVITY	MONITORING LOCATION	MONITORING RECOMMENDED
During highly noise intrusive activities (jackhammering, rock breaking, rock sawing)	RC1 and RC5	Noise

8 CONCLUSION

This Noise and Vibration Impact Assessment has been prepared in support of a Development Application (DA) made to Northern Beaches Council for St Augustine's College, located at 37 Alfred Road, Brookvale.

The assessment has considered the following key acoustic elements:

- Traffic noise generation from the addition of new carparks and the impact on nearby noise sensitive receivers
- Noise impact to nearby noise sensitive receivers from the operation of the new carpark
- Noise impact to nearby noise sensitive receivers from the increase in students within the school
- Noise and vibration impact to nearby receivers from the construction of proposed carparks

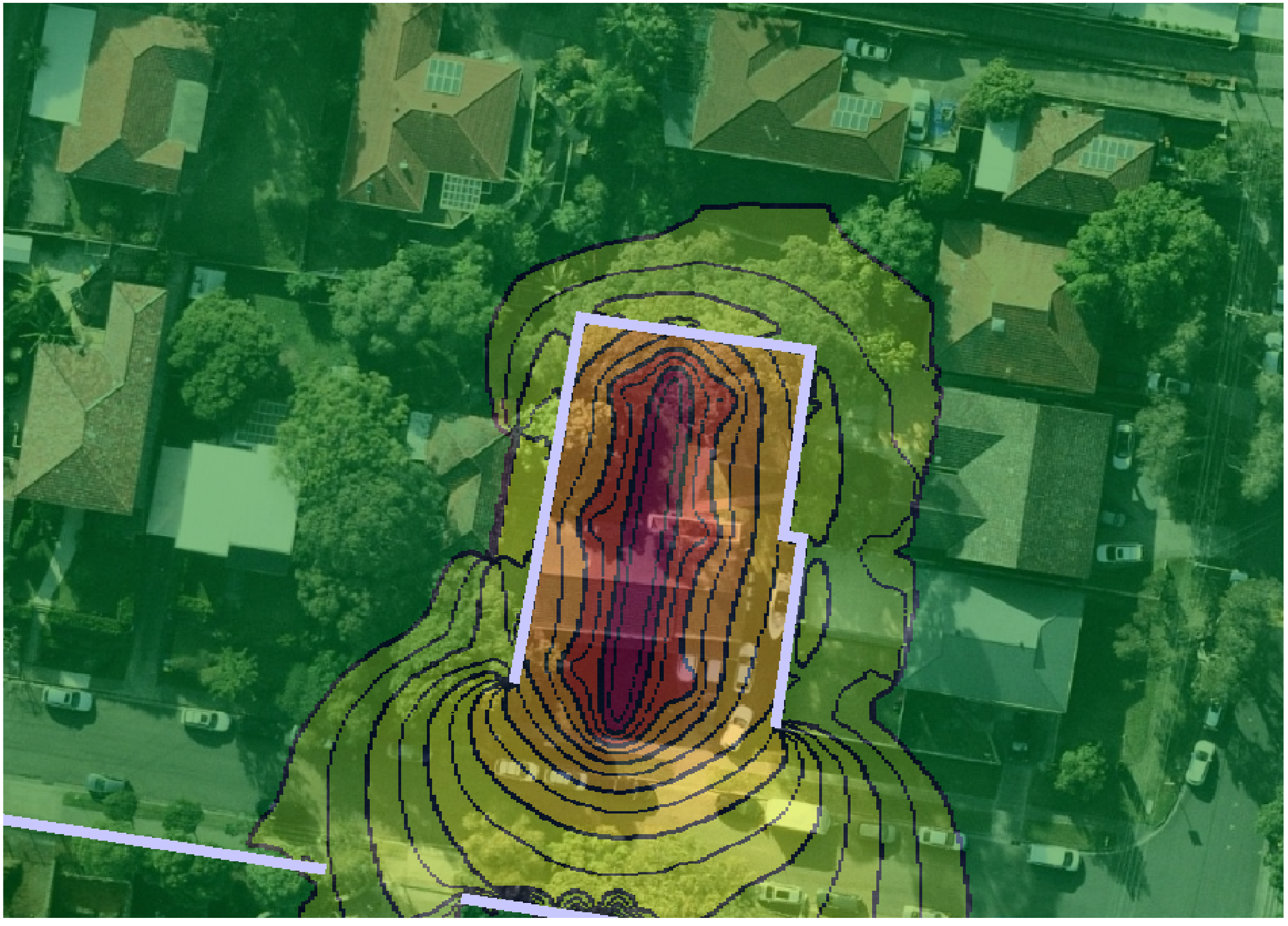
To assess each of the acoustic considerations for the proposed redevelopment, noise and vibration criteria has been established in Section 4 in accordance with the following documents:

- Warringah Development Control Plan (DCP) 2011
- NSW Road Noise Policy (RNP), 2011
- NSW EPA Noise Policy for Industry (NPI) 2017
- Bureau of Meteorology, Daily rainfall report
- NSW EPA 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" – Part 2: "Guide to Damage Levels from Groundborne Vibration"
- 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 SoundPLAN Models for Carpark Operations



E-LAB CONSULTING

ISSUE	DATE	STATUS
1	17/08/2021	DA Issue
2	29/10/2021	Updated for DA

LEGEND

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

- < 30
- 30 - 33
- 33 - 36
- 36 - 39
- 39 - 42
- 42 - 45
- 45 - 48
- 48 - 51
- 51 - 54
- ≥ 54

NOTES

PROJECT
ST AUGUSTINE'S COLLEGE

PROJECT NO.
P00054

PROJECT MANAGER
APG

CLIENT
ST AUGUSTINE'S COLLEGE

SCALE
NTS

STATUS
FOR COORDINATION

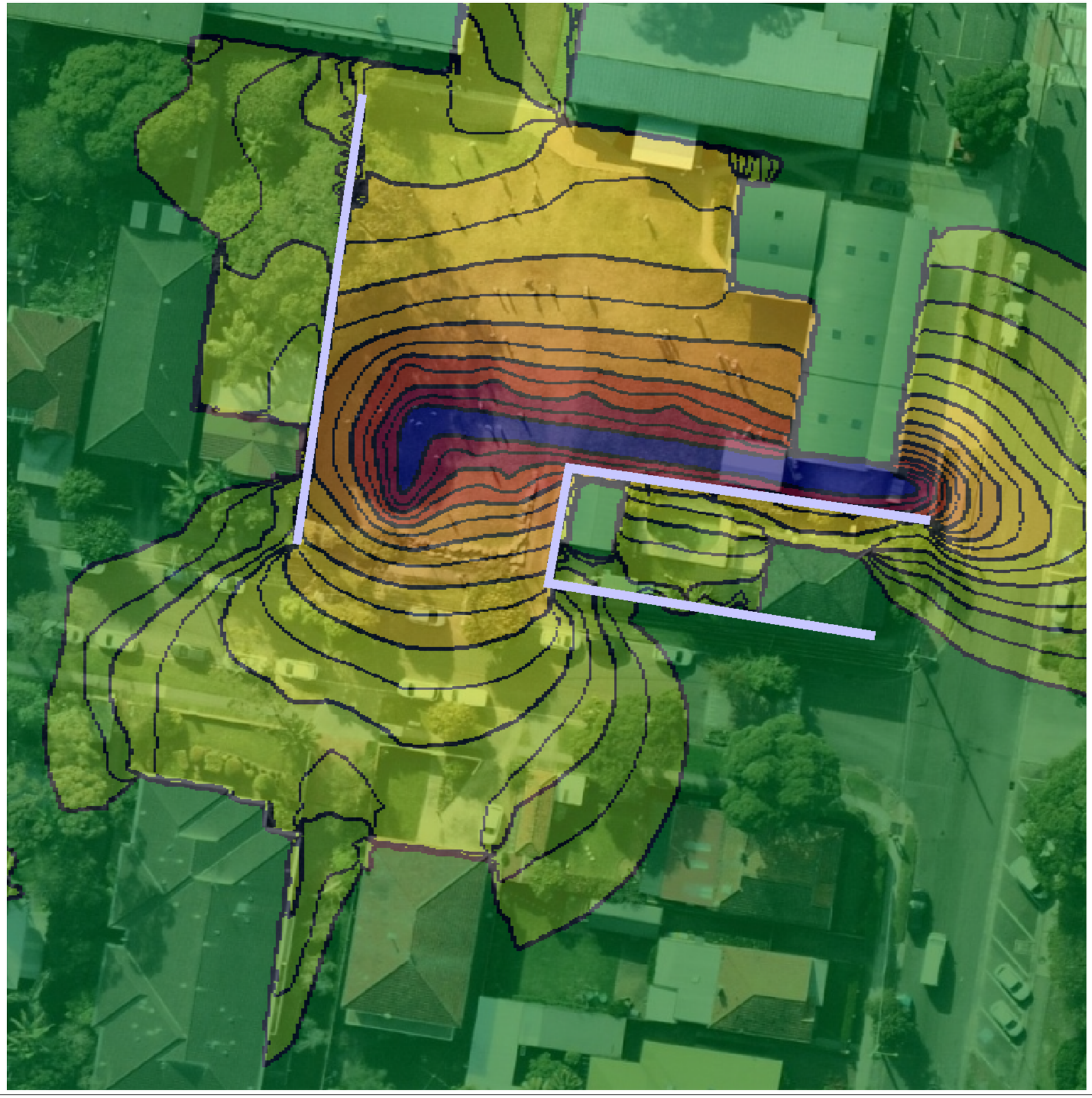
DRAWING
NOISE EMISSIONS CONTOUR MAP
(7AM - 6PM)

FEDERAL PARADE CARPARK

DISCIPLINE
ACOUSTICS

DRAWING NUMBER
AC-DWG-600-03-00

REVISION
002



E-LAB CONSULTING

ISSUE	DATE	STATUS
1	17/08/2021	DA Issue
2	29/10/2021	Updated for DA

LEGEND

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

- < 30
- 30 - 33
- 33 - 36
- 36 - 39
- 39 - 42
- 42 - 45
- 45 - 48
- 48 - 51
- 51 - 54
- ≥ 54

NOTES

PROJECT
ST AUGUSTINE'S COLLEGE

PROJECT NO.
P00054

PROJECT MANAGER
APG

CLIENT
ST AUGUSTINE'S COLLEGE

SCALE
NTS

STATUS
FOR COORDINATION

DRAWING
NOISE EMISSIONS CONTOUR MAP
(7AM - 6PM)

ALFRED ROAD CARPARK

DISCIPLINE
ACOUSTICS

DRAWING NUMBER
AC-DWG-600-04-00

REVISION
002

Appendix B SoundPLAN Models for School Operations

E-LAB CONSULTING

ISSUE	DATE	STATUS
1	17/08/2021	DA Issue
2	29/10/2021	Updated for DA
3	01/12/2021	Final DA Issue

LEGEND

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

- < 38
- 38 - 42
- 42 - 46
- 46 - 50
- 50 - 54
- 54 - 58
- ≥ 58

NOTES

PROJECT
ST AUGUSTINE'S COLLEGE

PROJECT NO.
P00054

PROJECT MANAGER
APG

CLIENT
ST AUGUSTINE'S COLLEGE

SCALE
NTS

STATUS
FINAL DA ISSUE

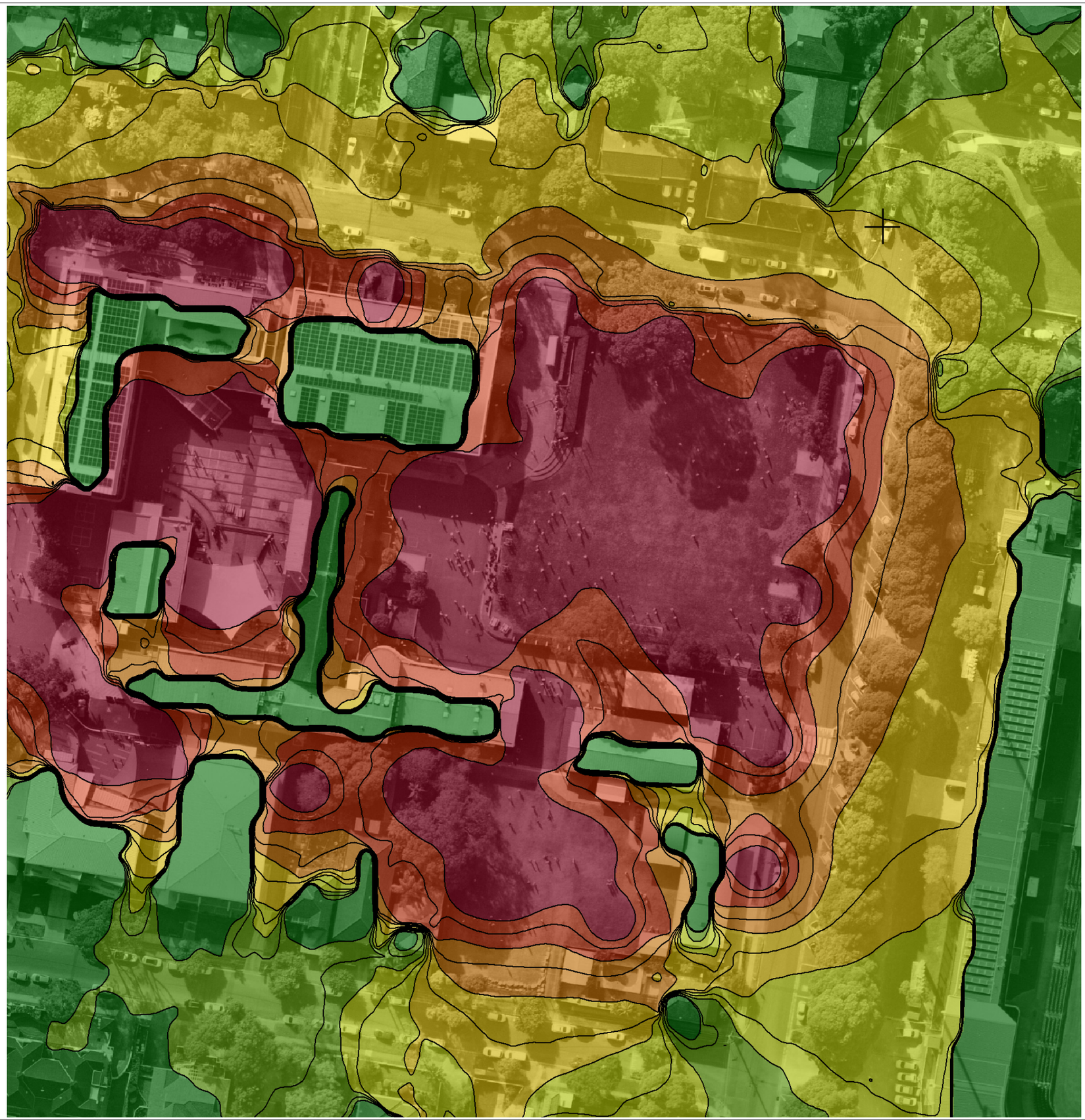
DRAWING
NOISE EMISSIONS CONTOUR MAP
(7AM - 6PM)

OPERATION OF SCHOOL - 1200 CHILDREN

DISCIPLINE
ACOUSTICS

DRAWING NUMBER
AC-DWG-600-01-03

REVISION
003



E-LAB CONSULTING

ISSUE	DATE	STATUS
1	17/08/2021	DA Issue
2	29/10/2021	Updated for DA
3	01/12/2021	Final DA Issue

LEGEND

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

- < 38
- 38 - 42
- 42 - 46
- 46 - 50
- 50 - 54
- 54 - 58
- ≥ 58

NOTES

PROJECT
ST AUGUSTINE'S COLLEGE

PROJECT NO.
P00054

PROJECT MANAGER
APG

CLIENT
ST AUGUSTINE'S COLLEGE

SCALE
NTS

STATUS
FINAL DA ISSUE

DRAWING
NOISE EMISSIONS CONTOUR MAP
(7AM - 6PM)

OPERATION OF SCHOOL - 1600 CHILDREN

DISCIPLINE
ACOUSTICS

DRAWING NUMBER
AC-DWG-600-02-03

REVISION
003

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