Prepared for
NSW Department of Education
ABN: 40 300 173 822

AECOM

Glenwood High School

Noise and Vibration Impact Assessment

12-Nov-2021
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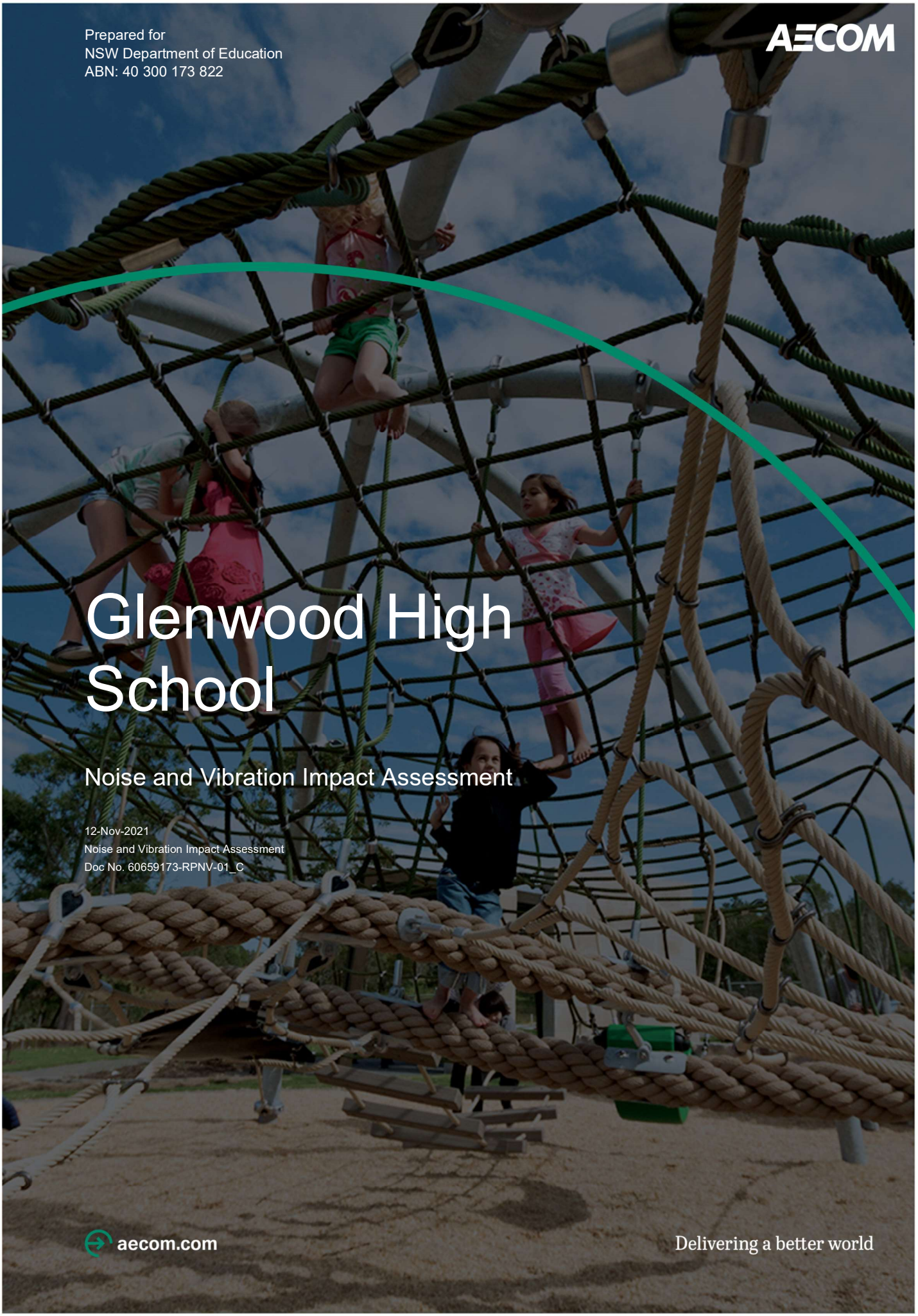

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Glenwood High School

Noise and Vibration Impact Assessment

Client: NSW Department of Education

ABN: 40 300 173 822

Prepared by

AECOM Australia Pty Ltd
Level 21, 420 George Street, Sydney NSW 2000, PO Box Q410, QVB Post Office NSW 1230, Australia
T +61 2 8934 0000 F +61 2 8934 0001 www.aecom.com
ABN 20 093 846 925

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Table of Contents

1.0 Introduction 1
1.1 Background 1
1.2 The Proposal 2
1.3 Site description 2
1.4 Existing buildings, facilities and access 4
1.5 Details of proposed upgrade 4
1.6 Scope of this report 5
1.7 Standards and guidelines 5
1.8 SEARs requirements 6
2.0 Noise Monitoring 7
2.1 Estimated rating background levels 7
2.1.1 Recommended minimum rating background levels 7
2.1.2 AS1055.2:1997 Estimated background noise levels 7
2.1.3 Other recent ambient background noise measurements 7
2.1.4 Summary of background noise level estimates 8
3.0 Construction Noise and Vibration Criteria 9
3.1 Construction noise management levels 9
3.1.1 Residential receivers 9
3.1.2 Other sensitive land uses and commercial receiver noise management levels 11
3.2 Vibration criteria 11
3.2.1 Structural damage 12
3.2.2 Human comfort 13
4.0 Operation Noise and Vibration Criteria 15
4.1 Noise Policy for Industry – Operational noise trigger levels 15
4.1.1 Intrusiveness noise impacts 15
4.1.2 Protecting noise amenity 15
4.1.3 Project noise trigger levels 16
4.1.4 Sleep disturbance trigger levels 16
4.2 Noise from road traffic generation – Road Noise Policy 17
4.3 Road traffic noise intrusion 18
4.3.1 Development Near Rail Corridors and Busy Roads – Interim Guideline 18
5.0 Construction Noise and Vibration Assessment 19
5.1 Construction noise 19
5.1.1 Construction hours 19
5.1.2 Construction phases and sources 19
5.1.3 Modelling and conditions 20
5.1.4 Results 21
5.2 Construction vibration 21
5.3 Construction traffic 22
6.0 Construction Noise and Vibration Mitigation 23
6.1 Complaints handling procedure 25
7.0 Operational Noise and Vibration Assessment 27
7.1 Assessment receivers 27
7.2 Building services noise emission assessment 29
7.2.1 Equipment selections and noise levels 29
7.2.2 Acoustic treatments 29
7.2.3 Predicted operation noise levels 30
7.2.4 Childcare centre 30
7.3 Out of School Hours Care outdoor area usage noise emission assessment 30
7.3.1 School use of Outdoor areas 31
7.4 Indoor area usage noise emission assessment 31
7.5 School bell and public address operation noise emission 32
7.6 Cumulative emission from school grounds 33

7.7 Road traffic noise intrusion assessment 33
7.8 Traffic generation noise assessment 34
7.9 Operational vibration 34
8.0 Conclusion 35

Appendix A
Glossary of Acoustic Terminology A

Appendix B
Operational Noise Contours B

Appendix C
Construction Noise Contours C

1.0 Introduction

1.1 Background

AECOM Australia Pty Ltd (AECOM) has been engaged by School Infrastructure NSW to provide acoustic consultancy services for the proposed Glenwood High School Upgrade located at the corner of Glenwood Park Drive and Forman Avenue, Glenwood.

This Noise and Vibration Impact Assessment (NVIA) has been prepared on behalf of School Infrastructure NSW and presents the assessment of operational and construction noise and vibration for project. The assessment has been prepared in support of an Environmental Impact Statement (EIS), which has been prepared to assess the environmental impacts associated with the project.

The assessment will accompany an Environmental Impact Statement (EIS) pursuant to Part 4 of the Environmental Planning and Assessment Act 1979 (EP&A Act) in support of a State Significant Development Application (SSD - 23512960).

The development is for upgrading works comprising alterations and additions to Glenwood High School at 85 Forman Avenue, Glenwood. The site is legally described as Lot 5227 DP 868693.

The site is roughly rectangular in shape, with a total area of 60,790 m^2 and street frontages to Forman Avenue to the south and Glenwood Park Drive to the east. Glenwood Reserve adjoins the northern and western boundaries of the school.

The Secretary's Environmental Requirements (SEARS) issued 20 July 2021 states that the EIS must include the following:

10. Noise and Vibration

Provide a noise and vibration impact assessment that:

- *includes a quantitative assessment of the main noise and vibration generating sources during demolition, site preparation, bulk excavation and construction.*
- *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.*
- *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.*
- *outlines measures to minimise and mitigate the potential noise impacts on nearby sensitive receivers.*
- *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.*
- *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.*

Relevant Policies and Guidelines:

- *NSW Noise Policy for Industry 2017 (NSW Environment Protection Authority (EPA).*
- *Interim Construction Noise Guideline (Department of Environment and Climate Change, 2009).*
- *Assessing Vibration: A Technical Guideline 2006 (Department of Environment and Conservation, 2006).*

- *Australian Standard 2363 Acoustics - Measurement of noise from helicopter operations (AS 2363).*

1.2 The Proposal

The proposed development seeks to upgrade Glenwood High School. The upgrade consists of the following alterations and additions:

- Construction of a new three-storey building at the north-eastern portion of the site facing Glenwood Park Drive which will accommodate new learning spaces;
- Construction of one storey performance pavilion;
- Refurbishment of existing Building Block A (ground floor only) to provide one new support unit within the space of an existing general learning space;
- Refurbishment of Building Block D (ground floor only) to provide an additional office space and storeroom;
- Refurbishment of Building Block E to re-purpose it on the ground floor for computer learning spaces, staff and administration spaces as well as upgrades to the library on the first floor;
- Refurbishment of Building Block J to re-purpose it from visual arts and performing arts to learning spaces and workshops for food tech and woods/metal unit;
- Demolition of existing botany room and construction of a new single storey pavilion comprising of interview rooms and end-of trip facilities; and
- The proposed development will also involve ancillary works at the site associated with the proposed upgrades.

1.3 Site description

Glenwood High School is located at 85 Forman Avenue, Glenwood. An existing childcare centre is also located within the site. The site is located in the Blacktown Local Government Area (LGA) in the suburb of Glenwood. It is situated within a well-established residential area approximately 4.7 km north-east of Blacktown Train Station.

The site is bound by residential development and Forman Avenue to the south; Glenwood Reserve to the north and west with residential development beyond; and Glenwood Park Drive to the east, with a drainage channel and residential development beyond. Refer to Figure 1 below.

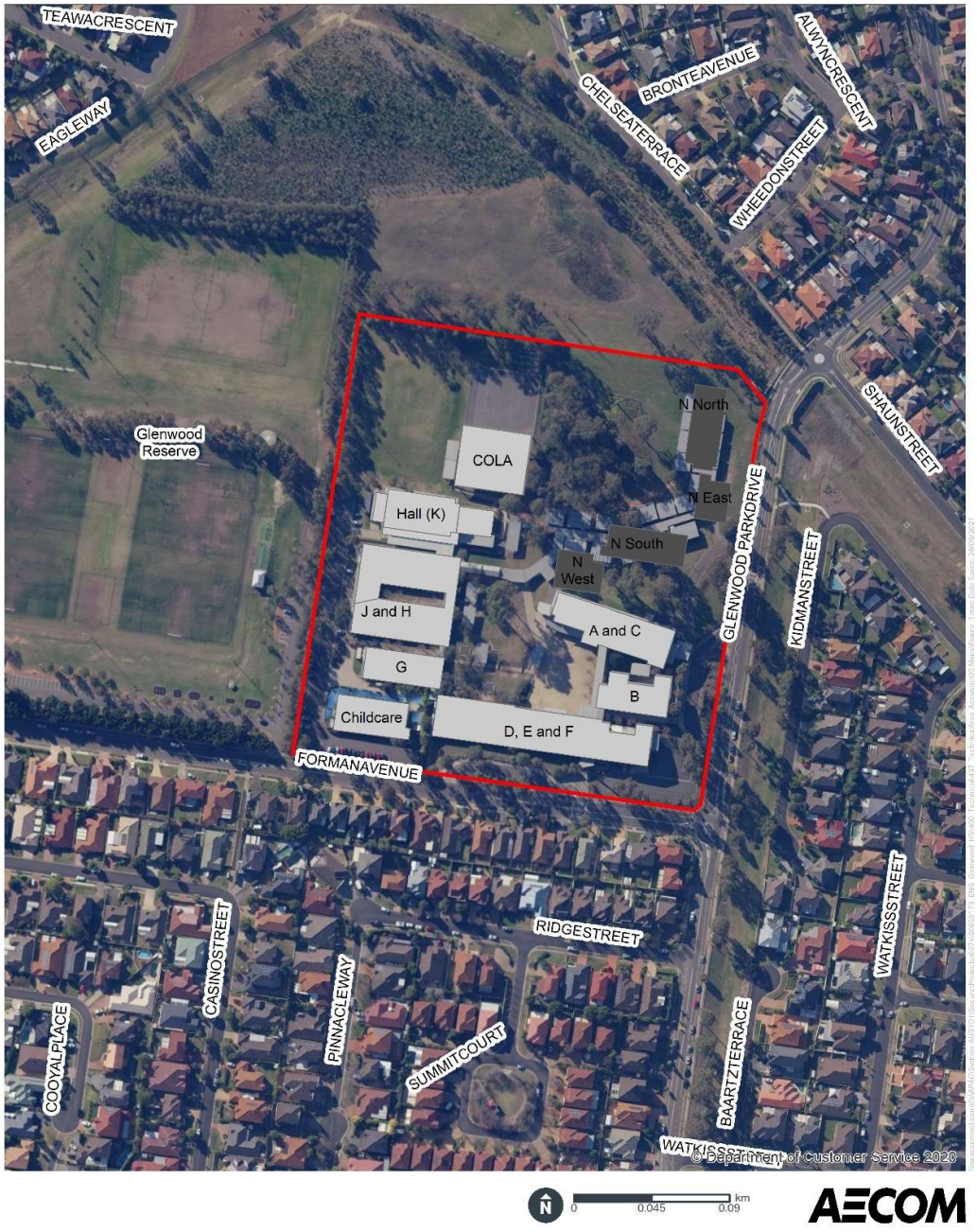


Figure 1 Local context map

1.4 Existing buildings, facilities and access

Glenwood High School is currently a co-educational high school and includes the following existing buildings and facilities:

- Ten existing buildings comprising:
  - Building A and B: double storey classroom building
  - Building C: double storey classroom building with a fitness laboratory on the ground floor
  - Building D: double storey building with administration and staff facilities on the ground floor and classrooms on the first floor
  - Building E: double storey building with classrooms and science laboratories on the ground floor and main library on the first floor
  - Building F: staff building
  - Building G, H and J: single storey classroom buildings (Block J contains school canteen)
  - Building K: single storey gymnasium
  - Building L: existing single storey childcare centre at the southwestern corner of the site.
- 19 single-storey demountable buildings, 17 of which comprise general learning spaces and two which comprise of staff rooms
- At-grade carpark providing for 88 car parking spaces accessed from two separate vehicular access points on Forman Avenue for high school staff
- Three support learning units
- Existing on site bicycle parking racks are provided in the south east corner of the school near the staff parking facility
- Outdoor spaces comprising:
  - Quadrangle space between Buildings C, B and E
  - Playing field at the north-western corner of the site
  - Games court to the east of the playing field
  - Covered outdoor space adjacent to the canteen
  - Grassed open play area in the centre of the site.
- Three pedestrian access points to the school, including:
  - One access point from Glenwood Park Drive
  - Two access points from Forman Avenue.
- Primary drop-off and pick-up area located at Forman Avenue.

1.5 Details of proposed upgrade

The proposed development seeks to upgrade Glenwood High School. The upgrade consists of the following alterations and additions:

- Construction of a new three-storey building at the north-eastern portion of the site facing Glenwood Park Drive which will accommodate new learning spaces
- Construction of one-storey performance pavilion
- Refurbishment of existing Building Block A (ground floor only) to provide one new support unit within the space of an existing general learning space

- Refurbishment of Building Block D (ground floor only) to provide an additional office space and storeroom
- Refurbishment of Building Block E to re-purpose it on the ground floor for computer learning spaces, staff and administration spaces as well as upgrades to the library on the first floor
- Refurbishment of Building Block J to re-purpose it from visual arts and performing arts to learning spaces and workshops for food tech and woods/metal unit
- Demolition of existing botany room and construction of a new single storey pavilion comprising interview rooms and end-of trip facilities
- The proposed development will also involve ancillary works at the site associated with the proposed upgrades.

1.6 Scope of this report

This Noise and Vibration Impact Assessment (NVIA) is intended to provide a reference for the policies, guidelines and standards that apply to the treatment and management of operational and construction noise and vibration associated with a large building project.

The Noise and Vibration Impact Assessment also sets out the applicable criteria, standard noise and vibration mitigation measures and monitoring, reporting and complaint management requirements.

The scope of the assessment includes:

- Operational noise and vibration
  - Major noise emitting plant
  - Traffic noise generation
  - Design of building envelope to attenuate traffic noise intrusion
  - Noise emission from indoor spaces, such as the school hall
  - Noise emission from outdoor spaces, such as outdoor play and sport
  - Recommendations for noise control measure to be incorporated into the architectural and services design strategies.
- Construction noise and vibration
  - Noise predictions for construction scenarios
  - Noise impact assessment
  - Recommendations for construction noise control measures to be incorporated into a construction noise management strategy.

The operational and construction noise and vibration impact assessment is presented in this report along with noise and vibration mitigation treatments and strategies.

1.7 Standards and guidelines

The operational noise management levels and vibration criteria have been established using:

- *Noise Policy for Industry* (NPfI), Environmental Planning Authority (EPA), 2017
- *State Environmental Planning Policy (SEPP) (Infrastructure*), 2007
- *Development Near Rail Corridors and Busy Roads – interim guideline*, Department of Planning, 2008
- *Assessing Vibration: A Technical Guideline* (AVATG), Department of Environment and Conservation (DEC), 2006

- *NSW Road Noise Policy* (RNP), Department of Environment, Climate Change and Water (DECCW), 2011
- *Australian Standard AS 2021:2015 Acoustics – Aircraft noise intrusion – Building siting and construction.*

Construction noise management levels and vibration criteria have been established using:

- *Interim Construction Noise Guideline* (ICNG), Department of Environment and Climate Change (DECC), 2009
- *Assessing Vibration: A Technical Guideline* (AVATG), Department of Environment and Conservation (DEC), 2006.
- *NSW Road Noise Policy* (RNP), Department of Environment, Climate Change and Water (DECCW), 2011.

1.8 SEARs requirements

Table 1 presents a guide to where the noise and vibration SEARs requirements have been addressed in this report.

Table 1 SEARs requirements

SEARs Requirements		Relevant Section of the Report
12 Noise and Vibration		
Construction Noise	Includes a quantitative assessment of the main noise and vibration generating sources during demolition, site preparation, bulk excavation and construction	Section 3.0 Section 5.0 Appendix C
	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	Section 3.0
Operational Noise	Includes a quantitative assessment of the main sources of operational noise, including consideration of any public address system, school bell, mechanical services (eg 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	Section 4.0 Section 7.0 Appendix B
	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	Section 4.0 Section 4.0
Construction and Operational Noise	Outline measures to minimise and mitigate the potential noise impacts on nearby sensitive receivers	Section 6.0 Section 7.7
	Demonstrates that the assessment has been prepared in accordance with policies and guidelines relevant to the context of the site and the nature of the proposed development	This document

2.0 Noise Monitoring

Due to the COVID-19 lockdown occurring in Sydney at present, the amount of road traffic, school activities and pedestrian traffic which would normally contribute to the local noise environment are currently absent to a large extent. As a result, it was not considered reasonable to conduct noise monitoring in order to establish ambient noise levels, as they would not be considered indicative of 'normal' activity in the area.

As a result, we have considered the following methods in order to establish reasonable background noise levels for the purpose of determining construction and operational noise criteria:

- Recommended minimum background noise levels presented in the EPA's Noise Policy for Industry (see Section 2.1.1)
- Estimated average background noise levels as presented in AS1055.2-1997 *Acoustics – Description and measurement of environmental noise Part 2: Application to specific situations* (see Section 2.1.2)
- Noise and vibration impact assessments completed for any other developments in the vicinity of the schools which may include recent ambient background noise measurements (see Section 2.1.3)

2.1 Estimated rating background levels

2.1.1 Recommended minimum rating background levels

The EPA's Noise Policy for Industry's (NPfI) presents minimum rating background levels (RBL) for residential receivers. The relevant RBLs are presented below in Table 2.

Table 2 Recommended minimum rating background levels

Time of day	Minimum assumed rating background noise level, dB(A)
Day 0700-1800	35
Evening 1800 – 2200	30
Night 2200 – 0700	30

2.1.2 AS1055.2:1997 Estimated background noise levels

Appendix A of Australian Standard 1055.2-1997 *Acoustics – 'Description and measurement of environmental noise – Part 2: Application to specific situations'* provides estimated Rating Background Level (RBL) values for different areas in Australia. In lieu of noise logging, conservative estimates have been used to establish rating background levels (RBL) for the nearby residential receivers.

As the receivers are all low-density suburban, they are concluded to lie within Noise Area Category R1: "*Areas with negligible transportation"*. The relevant RBLs are presented below in Table 3.

Table 3 Rating background levels

Noise Area Category	Description of Neighbourhood	Average rating background A-weighted sound pressure level, L_{A90} dB(A)		
		Day 0700 - 1800	Evening 1800 - 2200	Night 2200 - 0700
Area R1	Areas with negligible transportation	40	35	30

2.1.3 Other recent ambient background noise measurements

AECOM conducted a review of other nearby recent Development Applications where noise monitoring was conducted. Table 4 below presents noise monitoring conducted by Day Design for a proposed childcare centre located at 174 Glenwood Park Drive, Glenwood, report reference 6912-2.1R dated 3 September 2020.

Table 4 Rating background levels – 174 Glenwood Park Drive, Glenwood

Time of day	Rating background noise level, dB(A)
Early Morning 0630-0700	41
Day 0700-1800	38
Evening Shoulder 1800 – 1630	45

2.1.4 Summary of background noise level estimates

From review of these three methods, it is deemed that the recommended minimum rating background levels identified in the NPfI may be too conservative for the surrounding noise environment for the site during the daytime. These minimum RBLs would be more typical of a rural environment. Based on the measurements presented in Table 4 and NPfI minimum background noise levels the RBLs as presented in Table 5 have been conservatively assumed.

Table 5 Assumed rating background levels

Time of day	Minimum assumed rating background noise level, dB(A)
Day 0700-1800	38
Evening 1800 – 2200	30
Night 2200 – 0700	30

3.0 Construction Noise and Vibration Criteria

Construction of the proposed development has the potential to temporarily contribute to the existing external noise environment. Noise is expected to be generated by construction works as well as construction traffic movements. This section presents construction noise and vibration management levels in order to address the following acoustical issues:

- Construction noise and vibration impacts

3.1 Construction noise management levels

The ICNG is a NSW Government document that identifies ways to manage impacts of construction noise on residences and other noise sensitive land uses. It is the principal guideline for the assessment and management of construction noise in NSW and is used to establish construction noise management levels (NML).

As the proposed works are expected to continue for a period of more than three weeks and are within relatively close proximity to noise sensitive receivers, a quantitative assessment, based on 'reasonable' worst case construction scenarios, has been carried out for these works. Noise levels resulting from construction activities are predicted at nearby noise sensitive receivers using environmental noise modelling software and compared to the noise management levels, derived in accordance with the ICNG. As discussed in Section 2.0, long term unattended noise monitoring was not conducted due to COVID-19 restrictions.

Where an exceedance of the NMLs is predicted, the ICNG advises that receivers can be considered 'noise affected' and the proponent should apply all feasible and reasonable work practices to minimise the noise impact. The proponent should also inform all potentially impacted residents of the nature of the works to be carried out, the expected noise level and duration, as well as provide contact details to facilitate feedback from affected residents during construction.

The ICNG also states that during recommended standard construction hours where construction noise levels reach 75 dB(A) at residences, residential receivers can be considered as 'highly noise affected' and the proponent may be required to consider restricting hours of very noisy works (such as rock breaking or road cutting) to provide respite periods. In this assessment, receivers are considered as 'highly noise affected' where noise levels are 75 dB(A) or above, regardless of the time of day. Respite periods could be a negotiated outcome with highly noise affected receivers, taking into account times identified by the community when they are less sensitive to noise, or considering whether the community is prepared to accept a longer period of construction in exchange for restrictions on construction times. The ICNG defines what is considered to be feasible and reasonable as follows:

Feasible

> *A work practice or abatement measure is feasible if it is capable of being put into practice or of being engineered and is practical to build given project constraints such as safety and maintenance requirements.*

Reasonable

> *Selecting reasonable measures from those that are feasible involves making a judgment to determine whether the overall noise benefits outweigh the overall adverse social, economic and environmental effects, including the cost of the measure.*

The construction noise management levels (NMLs) for the residential and other sensitive land uses in proximity to the site are detailed below.

3.1.1 Residential receivers

Guidance for setting construction noise management levels for residential receivers are summarised in Table 6.

Table 6 Construction noise management levels – residential receivers

Time of day	NML, $L_{Aeq,15min}$, dB(A)[1]	How to apply
Recommended standard hours[2]: Monday to Friday 7 am to 6 pm Saturday 8 am to 1 pm No work on Sundays or public holidays	Noise affected RBL + 10 dB	The noise affected level represents the point above which there may be some community reaction to noise. • Where the predicted or measured $L_{Aeq\ (15\ min)}$ 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 residents 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, taking into account: 1. 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 2. 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 + 5 dB	• A strong justification would typically be required for works outside the recommended standard hours. • The proponent should apply all feasible and reasonable work practices to meet the noise affected level. • Where all feasible and reasonable practices have been applied and noise is more than 5 dB(A) above the noise affected level, the proponent should negotiate with the community. • For guidance on negotiating agreements see section 7.2.2 (ICNG).

Notes:

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 30 m of the residence. Noise levels may be higher at upper floors of the noise affected residence.*
2. *As noted, standard construction hours are Monday to Friday 7 am to 6 pm and Saturday 8 am to 1 pm*

The above guidance has been utilised to define NMLs applicable to residences adjacent to the development. The project specific NMLs are summarised in Table 7.

Table 7 Construction noise management levels – Residential receivers

Receiver type	Recommended standard hours RBL	Recommended standard hours noise management levels L_{Aeq} dB(A)	Highly noise affected level L_{Aeq} dB(A)
Residential	38	48	75

3.1.2 Other sensitive land uses and commercial receiver noise management levels

Noise management levels for non-residential receivers located adjacent to the site have been determined using the recommended levels in the ICNG for other sensitive land uses and commercial buildings. The NMLs are presented in Table 8.

Table 8 Noise at sensitive land uses (other than residences) and commercial buildings

Land use	External noise levels, $L_{Aeq,15min}$ (Applies when properties are in use)
Educational institutions	65 dB(A)[1]
Active recreation areas	65 dB(A)

Notes:

1. *Assumes an external to internal noise level reduction through a closed window of 20 dB(A)*

3.2 Vibration criteria

Vibration, at levels high enough, has the potential to cause damage to structures and disrupt human comfort. Vibration and its associated effects are usually classified as continuous, impulsive or intermittent as follows:

- continuous vibration continues uninterrupted for a defined period and includes sources such as machinery and continuous construction activities
- impulsive vibration is a rapid build up to a peak followed by a damped decay. It may consist of several cycles at around the same amplitude, with durations of typically less than two seconds and no more than three occurrences in an assessment period. This may include occasional dropping of heavy equipment or loading activities
- intermittent vibration occurs where there are interrupted periods of continuous vibration, repeated periods of impulsive vibration or continuous vibration that varies significantly in magnitude. This may include intermittent construction activity, impact pile driving, jack hammers.

The relevant standards and guidelines for the assessment of construction vibration are summarised in Table 9.

Table 9 Standards/guidelines used for assessing construction vibration

Item	Standard/guideline
Structural damage	Heritage structures – German Standard DIN 4150 – Part 3 – Structural Vibration in Buildings – Effects on Structures (DIN 4150) Non-heritage structures – Evaluation and Measurement for Vibration in Buildings Part 2, (British Standard (BS) 7385:Part 2-1993) (BS 7385)
Human comfort (tactile vibration)	Assessing Vibration: A Technical Guideline (AVATG)[1]

Notes:

1. *This document is based upon the guidelines contained in British Standard 6472:1992, "Evaluation of human exposure to vibration in buildings (1-80 Hz)". This British Standard was superseded in 2008 with BS 6472-1:2008 "Guide to evaluation of human exposure to vibration in buildings – Part 1: Vibration sources other than blasting" and the 1992 version of the Standard was withdrawn. However, the Environment Protection Authority still requires vibration to be assessed in accordance with the 1992 version of the Standard at this point in time.*

3.2.1 Structural damage

At present, no Australian Standards exist for the assessment of building damage caused by vibration.

DIN 4150 and BS 7385-2 provide recommended maximum levels of vibration that reduce the likelihood of building damage caused by vibration and are presented in Table 10 and Table 11. DIN 4150 states that buildings exposed to higher levels of vibration than recommended limits would not necessarily result in damage. Structural damage criteria for heritage items have been taken from DIN 4150, whilst criteria for commercial/residential items have been taken from BS 7385.

Table 10 Structural damage safe limits (DIN 4150) for building vibration (Vibration peak particle velocity)

Group	Type of structure	At foundation – Less than 10 Hz	At foundation – 10 Hz to 50 Hz	At foundation – 50 Hz to 100 Hz[1]	Vibration at the horizontal plane of the highest floor for all frequencies
1	Buildings used for commercial purposes, industrial buildings and buildings of similar design	20 mm/s	20 to 40 mm/s	40 to 50 mm/s	40 mm/s
2	Dwellings and buildings of similar design and/or use	5 mm/s	5 to 15 mm/s	15 to 20 mm/s	15 mm/s
3	Structures that because of their particular sensitivity to vibration, do not correspond to those listed in Lines 1 or 2 and have intrinsic value (e.g. buildings that are under a preservation order/heritage listed)	3 mm/s	3 to 8 mm/s	8 to 10 mm/s	8 mm/s

Notes:

1. At frequencies above 100 Hz, the values given in this column may be used as minimum values

Table 11 BS 7385-2: Transient vibration guide values for cosmetic damage

Group	Type of building	Peak component particle velocity in frequency range of predominant pulse	
		4 Hz to 15 Hz	15 Hz and above
1	Reinforced or framed structures Industrial and heavy commercial buildings	50 mm/s at 4 Hz and above	
2	Unreinforced or light framed structures Residential or light commercial type buildings	15 mm/s at 4 Hz increasing to 20 mm/s at 15 Hz	20 mm/s at 15 Hz increasing to 50 mm/s at 40 Hz and above

3.2.2 Human comfort

The assessment of intermittent vibration outlined in the NSW EPA guideline As*sessing Vibration: A Technical Guideline* (AVTG) is based on Vibration Dose Values (VDVs). The VDV accumulates the vibration energy received over the daytime and night-time periods.

Maximum and preferred VDVs for intermittent vibration arising from construction activities are listed in Table 12. The VDV criteria are based on the likelihood that a person would comment adversely on the level of vibration over the entire assessment period.

Table 12 Preferred and maximum vibration dose values for intermittent vibration (m/s1.75)

Location	Daytime (7am – 10pm)		Night-time (10pm – 7am)	
	Preferred	Maximum	Preferred	Maximum
Critical areas[1]	0.1	0.2	0.1	0.2
Residences	0.2	0.4	0.13	0.26
Offices, schools, educational institutions and places of worship	0.4	0.8	0.4	0.8
Workshops[2]	0.8	1.6	0.8	1.6

Notes:

1. *Examples include hospital operating theatres and precision laboratories where sensitive operations are occurring. Places where sensitive equipment is stored or delicate tasks are undertaken require more stringent criteria than the residential criteria specified above*
2. *Examples include automotive repair shops, manufacturing or recycling facilities. This includes places where manufacturing, recycling or repair activities are undertaken but do not require sensitive or delicate tasks.*

4.0 Operation Noise and Vibration Criteria

4.1 Noise Policy for Industry – Operational noise trigger levels

Under the NSW Protection of the Environment (Operations) Act 1997, the Environment Protection Authority (EPA) document Noise Policy for Industry (NPfI) provides guidance in relation to acceptable noise trigger levels for industrial noise emissions.

The NPfI provides noise levels for assessing the potential impact of noise from industry and includes a framework for considering feasible and reasonable noise mitigation measures. The NPfI applies to all noise emission from permanent operations fixed facilities for the project. The assessment procedure for industrial noise sources has two components that must be considered:

- Controlling intrusiveness noise impacts in the short term for residences
- Maintaining noise level amenity for residences and other land uses.

4.1.1 Intrusiveness noise impacts

The NPfI states that the intrusiveness of an industrial noise source may generally be considered acceptable if the level of noise from the source (L_{Aeq} level), measured over a 15 minute period, does not exceed the background noise level measured by more than 5 dB. The Rating Background Levels (RBLs) and resultant project intrusiveness noise levels are presented in Table 13.

Table 13 NPfI recommended $L_{Aeq,15\ minute}$ intrusiveness noise levels from industrial noise sources

Location	Period[4]	RBL (L_{A90}), dB(A)	Intrusiveness noise level (RBL + 5), ($L_{Aeq\ 15\ minutes}$), dB(A)
Residential Receivers	Day	38	43
	Evening	30	35
	Night	30	35

Notes:

1. *Day is defined as 7am to 6pm Monday to Saturday and 8am to 6pm Sundays and Public Holidays.*

   Evening is defined as 6pm to 10pm Monday to Sunday and Public Holidays.

   Night is defined as 10pm to 7am Monday to Saturday and 10pm to 8am Sundays and Public Holidays.

As per the NPfI, intrusiveness noise levels are only applied to residential receivers. For other receivers, only the amenity levels apply.

4.1.2 Protecting noise amenity

To limit continuing increases in noise levels, the maximum ambient noise level resulting from all industrial noise sources in an area should not normally exceed the recommended amenity noise levels specified in Table 2.2 of the NPfI. As per the definitions of receiver types within the NPfI, residences are classified as being in a suburban area.

Table 14 NPfI recommended L_{Aeq} amenity noise levels from industrial sources

Type of receiver	Noise amenity area	Time of day	Recommended noise level ($L_{Aeq, period}$), dB(A)
Residential	Suburban	Day	55
		Evening	45
		Night	40
School Classroom – Internal	All	Noisiest 1-hour period when in use	35[1]
Passive recreation area	All	When in use	50
Active recreation area	All	When in use	55

Notes:

1. *In the case where existing schools are affected by noise from existing industrial noise sources, the acceptable L_{Aeq} noise level may be increased to 40 dB L_{Aeq1hr}.*

The amenity level applicable to the project is equal to the recommended level minus 5 dB(A). This takes into account the cumulative impacts from other industrial noise sources in the area.

As per the NPfI, the project amenity level is converted to a 15 minute period by adding 3 dB.

4.1.3 Project noise trigger levels

Table 15 presents the applicable project noise trigger levels.

Table 15 NPfI project noise trigger levels

Type of receiver	Time of day	Intrusiveness noise level (RBL+5) ($L_{Aeq, 15 minutes}$), dB(A)	Project amenity level ($L_{Aeq, 15 minutes}$), dB(A)	Project noise trigger level ($L_{Aeq 15 minutes}$), dB(A)
Residential Receivers	Day	43	53	43
	Evening	35	43	35
	Night	35	38	35
School Classroom – Internal	Noisiest 1-hour period when in use	-	38[1]	38[1]
Passive recreation area	When in use	-	48	48
Active recreation area	When in Use	-	53	53

Notes:

1. *Amenity noise level has been adjusted due to existing industrial noise levels at the project site in accordance with Section 2.4 of the Noise Policy for Industry.*

Adjustments to the level of noise predicted at the assessment location may be applied in accordance with Fact Sheet C of the NPfI to account for the subjective effects of specific noise characteristics including tonality, low frequency content, intermittency, impulsiveness and duration.

4.1.4 Sleep disturbance trigger levels

The NPfI requires the potential for sleep disturbance to be assessed by considering maximum noise level events during the night-time period.

Where night-time noise levels from the proposed development at a residential location exceed the following screening levels, a detailed maximum noise level event assessment should be undertaken:

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

The detailed assessment should cover the maximum noise level, the extent to which the maximum noise level exceeds the RBL and the number of times this happens during the night-time period.

Based on the measured background noise levels during the night, the sleep disturbance trigger levels for the noise sensitive residential receivers are presented in Table 16.

Table 16 Night-time sleep disturbance trigger levels

Type of receiver	Measured night period RBL ($L_{Aeq,\ 15\ minute}$), dB(A)	Sleep disturbance screening trigger levels	
		$L_{Aeq,\ 15\ minutes,\ dB(A)}$	$L_{AFmax,\ dB(A)}$
Residential	30	40	52

4.2 Noise from road traffic generation – Road Noise Policy

Land use developments with the potential to create additional traffic on surrounding roads should be assessed using the EPA's Road Noise Policy (RNP). The external noise criteria are applied at 1 metre from the affected external building façade.

Table 17 Road traffic noise assessment criteria for existing residences affected by additional traffic

Period	Parameter	Criterion
Glenwood Park Drive (Collector road)[1]		
Day (7am – 10pm)	$L_{Aeq\ (15hr)}$	60 dB(A)
Night (10pm – 7am)	$L_{Aeq\ (19hr)}$	55 dB(A)
Forman Avenue (Local road)[1]		
Day (7am – 10pm)	$L_{Aeq\ (1hr)}$	55 dB(A)
Night (10pm – 7am)	$L_{Aeq\ (1hr)}$	50 dB(A)

Notes:

1. *Road categories assigned in line with the Road Noise Policy*

In cases where existing traffic noise levels are above the noise assessment criteria, the primary objective is to reduce these through feasible and reasonable measures to meet the assessment criteria. In assessing feasible and reasonable mitigation measures, an increase of up to 2 dB represents a minor impact that is considered barely perceptible to the average person.

To assess noise impacts from additional traffic generated by the project, an initial screening test is undertaken to determine if existing road traffic noise levels would increase by more than 2 dB(A). Where the predicted noise increase is 2 dB(A) or less, then no further assessment is required. However, where the predicted noise level increase is greater than 2 dB(A), and the predicted road traffic noise level exceeds the road category specific criterion then noise mitigation should be considered for those receivers affected. The RNP does not require assessment of noise impact to commercial or industrial receivers.

4.3 Road traffic noise intrusion

4.3.1 Development Near Rail Corridors and Busy Roads – Interim Guideline

The NSW Department of Planning document Development Near Rail Corridors and Busy Roads – Interim Guideline, presents noise criteria for sensitive receivers. Criteria relevant to the development are outlined in Table 18.

Table 18 Traffic noise intrusion – Development Near Rail Corridors and Busy Roads – Interim Guideline

Type of occupancy	Noise criteria, dB(A)
Educational Institutions	40

5.0 Construction Noise and Vibration Assessment

5.1 Construction noise

This construction noise and vibration assessment is based on typical construction scenarios for this type of development.

5.1.1 Construction hours

Construction activities at the GHS site are proposed to be limited to the recommended standard hours Monday to Friday and slightly extend hours on Saturdays as follows:

- Monday to Friday: 7 am to 6 pm
- Saturday: 8 am to 1 pm
- Sunday and Public Holidays: No works

It should be noted that the proposed extended hours on Saturdays are outside of the standards hours as defined in the ICNG.

5.1.2 Construction phases and sources

The equipment and associated sound powers for the proposed GHS development works are shown in Table 19. The assessment has been based on a worst-case scenario of all equipment operating concurrently.

Table 19 Construction phases and equipment

Phase	Equipment/activity	Percentage time on	'A' Weighted SWL dB(A)
Site Preparation and Excavation	Smooth Drum Roller	100	105
	Plate Compactor	100	108
	Front End Loader	100	108
	Posi-Track Loader	100	104
	5 Tonne Excavator	100	94
	10 Tonne Excavator	100	94
	Rigid Truck	100	98
	Articulated Truck	100	98
	Overall	**-**	**113**
Building Construction	Posi Track Loader	100	104
	50 Tonne Mobile Crane	100	104
	Concrete Boom and Pump	100	106
	Concrete Agitator Delivery Truck	100	105
	Hand tools	100	94
	Rigid Truck	100	98
	Articulated Truck	100	98
	300 Tonne All-Terrains Crane	100	106
	Overall	-	**113**
Demountable Removal	Articulated Truck	100	98
	Rigid Truck	100	98
	50 Tonne Mobile Crane	100	104
	Hand tools	100	94
	Overall	**-**	**106**

Construction is scheduled to be undertaken during recommended standard hours only. As such the impacts of construction activities on sleep disturbance do not need to be assessed. Sound power levels were obtained from published datasets in Australian Standard AS 2436:2010 *Guide to noise and vibration control on construction, demolition and maintenance sites*, British Standard BS5228: Part 1 2009 *Code of Practice for Noise and Vibration Control on Construction and Open Sites Part 1: Noise* and AECOM's database.

5.1.3 Modelling and conditions

Modelling of the proposed construction scenario has been performed using SoundPLAN 8.0. Standard weather conditions were applied. The following parameters were used in the modelling:

- Standard meteorological conditions – Pasquill-Gillford stability category D with source to receiver wind speed up to 0.5 m/s at 10 metres above ground level.

It can be expected that there may be differences between predicted and measured noise levels due to variations in instantaneous operating conditions, plant in operation during the measurement and also the location of the plant equipment. The acoustic shielding calculated in the model due to localized fixed building structures would also vary as the construction equipment moves around the site.

5.1.4 Results

Construction noise contours are presented in Appendix C. The construction NMLs are predicted to be exceeded at number receivers. The predicted noise level at the worst affected residential receiver in each adjacent street are presented in Table 20.

Table 20 Construction noise NML exceedances

Location		NML, dB(A)	Maximum predicted construction noise level, dB(A)	Maximum predicted exceedance, dB
Site Preparation and Excavation				
Residential properties	To the north – Wheedon Strret, Chelsea Terrce, Shaun Street, Glenwood Park Drive	48	74	26
	To the East – Kidman Street	48	72	24
	To the South – Forman Avenue	48	65	17
Onsite receivers	Buildings A - K	65	95	30
	Child care Centre	65	62	-
Building Construction				
Residential properties	To the north – Wheedon Strret, Chelsea Terrce, Shaun Street, Glenwood Park Drive	48	71	23
	To the East – Kidman Street	48	70	22
	To the South – Forman Avenue	48	61	13
Onsite receivers	Buildings A - K	65	95	30
	Child care Centre	65	56	-
Demountable Removal				
Residential properties	To the north – Wheedon Strret, Chelsea Terrce, Shaun Street, Glenwood Park Drive	48	63	15
	To the East – Kidman Street	48	62	14
	To the South – Forman Avenue	48	53	5
Onsite receivers	Buildings A - K	65	71	6
	Child care Centre	65	53	-

Residences located further to the west, past Glenwood Reserve are located in excess of 250 metres from the proposed works and are therefore likely to experience lower construction noise impacts.

It should be noted that the most affected residences are located to the north in Wheendon Street with worst case construction scenarios. No residential receivers are anticipated to be highly noise affected (i.e. exceed an $L_{Aeq,15min}$ of 75 dB(A)). School buildings within the site are predicted to be highly noise affected. Reasonable and feasible construction mitigation measures are provided in Section 6.0.

5.2 Construction vibration

Vibration-intensive works may include the use of the following items of equipment:

- Plate compactor

The minimum working distances of these items of equipment to nearby receivers are shown in Table 21 which is based on recommendations of the TfNSW *Construction Noise and Vibration Strategy* (CNVS) and AECOM's previous project experience. If these minimum working distances are complied with no adverse impacts from vibration intensive works are likely in terms of human response or cosmetic damage. Based on the indicative construction activities assessed for the proposed development, works are unlikely to occur within the minimum working distances.

Table 21 Recommended minimum working distances for vibration intensive plant

Plant	Rating/description	Minimum working distance	
		Cosmetic damage	Human response
Plate Compactor	Handheld	1 m nominal	Avoid contact with structure

5.3 Construction traffic

The construction work would be undertaken in stages and would require a number of trucks, to deliver materials including concrete to the site. During early stages of construction workers may be able to park on site, during later stages they would park away from the site and either walk or use public transport to get to the site.

The Transport and Accessibility Impact Assessment prepared by TTW dated 05 November 2021 for Glenwood High School provided modelling for the intersection of Glenwood Park Drive and Forman Avenue recorded on Wednesday 16 June 2021.

The traffic modelling indicates that up to 574 vehicles used Glenwood Park Drive during the School afternoon peak period of 2.45 pm to 3.45pm.

The Traffic assessment assumes that approximately 10 vehicles per day will visit the construction site resulting in 20 vehicle movements. The trucks visiting the site may gain access from either Forman Avenue or Glenwood Park Drive.

Given the volumes of existing traffic, construction traffic would have a negligible impact, increasing road traffic noise levels by significantly less <1 dB(A). This complies with RNP requirements.

6.0 Construction Noise and Vibration Mitigation

Given that NMLs are likely to be exceeded, reasonable and feasible noise mitigation measures and work practices would need to be considered. Where receivers are predicted to be 'noise affected' the ICNG states that all feasible and reasonable works practices should be applied to meet the NMLs. It is recommended that a construction noise and vibration management plan (CNVMP) be prepared which details which feasible and reasonable works practices are to be implemented to achieve NMLs .

Details of noise and vibration mitigation measures and management practices which should be considered for each CNVMP are detailed below.

The CNVMP should include the following:

- Identification of nearby residences and other sensitive land uses
- Description of approved hours of work
- Description and identification of all construction activities, including work areas, equipment and duration
- Description of what work practices (generic and specific) would be applied to minimise noise and vibration
- A complaint handling process
- Noise and vibration monitoring procedures
- Overview of community consultation required for identified high impact works.

Noise and vibration mitigation measures which should be considered in the CNVMP are detailed in Table 22.

Table 22 Recommended noise mitigation measures

Action required	Safeguard details
Management measures	
Implement community consultation measures	Notification (letterbox drop or equivalent), website, Project Infoline, Construction Response Line, email distribution list and community and stakeholder meetings.
Site inductions	All employees, contractors and subcontractors are to receive an environmental induction.
Behavioural practices	No swearing or unnecessary shouting or loud stereos/radios on site. No dropping of materials from height, throwing of metal items and slamming of doors.
Monitoring	A noise monitoring program should be considered.
Attended vibration measurements	Attended vibration measurements are recommended at the commencement of vibration generating activities to determine site specific minimum working distances. Vibration intensive work should not proceed within the minimum working distances unless a permanent vibration monitoring system is installed approximately a metre from the building footprint, to warn operators (via flashing light, audible alarm, SMS etc.) when vibration levels are approaching the peak particle velocity objective.
Source controls	
Construction hours and scheduling	Where feasible and reasonable, construction should be carried out during the standard daytime working hours. Work generating high noise and/or vibration levels should be scheduled during less sensitive time periods. Consideration should be given to avoiding examination periods.
Equipment selection and maintenance	Use quieter and less vibration emitting construction methods where feasible and reasonable. Equipment would be regularly inspected and maintained to ensure it is in good working order.
Maximum noise levels	The noise levels of plant and equipment must have operating sound power or sound pressure levels that would meet the predicted noise levels.
Rental plant and equipment	Noise emissions should be considered as part of the selection process.
Use and siting of plant	Avoid simultaneous operation of noisy plant within discernible range of a sensitive receiver. The offset distance between noisy plant and adjacent sensitive receivers is to be maximised. Plant used intermittently to be throttled down or shut down. Plant and vehicles to be turned off when not in use. Noise-emitting plant to be directed away from sensitive receivers.

Action required	Safeguard details
Plan works site and activities to minimise noise and vibration	Plan traffic flow, parking and loading/unloading areas to minimise reversing movements within the site.
Non-tonal reversing alarms	Non-tonal reversing beepers (or an equivalent mechanism) should be fitted and used on all construction vehicles and mobile plant regularly used on site and for any out of hours work, subject to work health and safety requirements.
Minimise disturbance arising from delivery of goods to construction sites	Loading and unloading of materials/deliveries is to occur as far as possible from sensitive receivers. Select site access points and roads as far as possible away from sensitive receivers. Dedicated loading/unloading areas to be shielded if close to sensitive receivers. Delivery vehicles to be fitted with straps rather than chains for unloading, wherever possible.
Construction related traffic	Schedule and route vehicle movements away from sensitive receivers and during less sensitive times. Limit the speed of vehicles and avoid the use of engine compression brakes. Maximise on-site storage capacity to reduce the need for truck movements during sensitive times.
Silencers on Mobile Plant	Where possible reduce noise from mobile plant through additional fittings including: • Residential grade mufflers • Damped hammers such as “City” Model Rammer Hammers • Air parking brake engagement is silenced
Path controls	
Shield stationary noise sources such as pumps, compressors, fans etc.	Stationary noise sources should be enclosed or shielded whilst ensuring that the occupational health and safety of workers is maintained.
Shield sensitive receivers from noisy activities	Use structures to shield residential receivers from noise such as site shed placement; earth bunds; fencing; erection of operational stage noise barriers (where practicable) and consideration of site topography when situating plant.

6.1 Complaints handling procedure

A complaint handling procedure should be developed and documented within each CNVMP. The following section outlines items to be considered for inclusion in the procedure.

If complaints are received, an Environmental Incident Report Form should be completed to record details of the occurrence and actions taken. Where applicable, completed forms should detail the following:

- the date and time of the complaint
- the method by which the complaint was made

- any personal details of the complainant which were provided by the complainant or, if no such details were provided, a note to that effect
- the nature of the complaint
- description of noise source that is the subject of complaint, duration of event
- location of complainant during time of incident, and general area in which the noise source was located
- identification of project related noise activities and locations that could have or are known to have contributed to the incident
- if known, identification of non-project related noise emission activities and location at time of incident
- meteorological conditions at the time of the incident
- the action taken in relation to the complaint
- any follow-up contact with the complainant
- if no action was taken, the reason why no action was taken.

All records are to be kept in a legible form, or in a form that can readily be reduced to a legible form and kept for at least 4 years after the complaint or event to which they relate took place.

The Site Environmental Officer should make available a report on complaints received to the relevant Government Agencies upon request. A response should be provided to the complainant within 24 hours. Corrective actions may involve supplementary monitoring to identify any non-compliances, and/or may involve modification of construction techniques to avoid any recurrence or minimise impacts.

A noise monitoring program should be implemented as a result of construction noise and vibration complaints.

7.0 Operational Noise and Vibration Assessment

The operational noise assessment, including assessment of noise emission and noise intrusion, is detailed in this section of the report with regard to the established criteria presented in Section 4.0. The acoustic assessment is based on the architectural drawing set issued by PTW Architects for SSDA Submission dated 1 November 2021.

7.1 Assessment receivers

The locations of the nearby sensitive receivers are shown in Figure 2. The sensitive receiver locations along with the land use classification are presented in Table 23.

Table 23 Assessment receiver locations

Receiver	Address	Land use classification
R1	9 Kidman Street, Glenwood	Residential
R2	21 Kidman Street, Glenwood	Residential
R3	98 Forman Avenue, Glenwood	Residential
R4	78 Forman Avenue, Glenwood	Residential
R5	58 Forman Avenue, Glenwood	Residential
R6	1 Shaun Street, Glenwood	Residential
R7	278 Glenwood Park Drive, Glenwood	Residential
R8	11 Honeyeater Terrace	Residential
AR1	Glenwood Reserve Playing Fields	Active recreation
PR1	Glenwood Reserve	Passive recreation

Figure 2 Assessment receiver locations

7.2 Building services noise emission assessment

7.2.1 Equipment selections and noise levels

Details of indicative proposed major plant items and their associated sound power levels are provided below in Table 24.

Table 24 Major plant items and associated sound power levels, dB

Location	Plant item	Octave band centre frequency, Hz							Overall, dBA
		125	250	500	1k	2k	4k	8k	
Building N North	REYQ20TAY1	87	87	87	83	77	73	68	88
	REYQ40TAY1-AU	90	90	90	86	80	76	71	91
	REYQ32TAY1	89	87	90	89	88	84	78	94
	REYQ20TAY1	87	87	87	83	77	73	68	88
Building N South	REYQ28TAY1	89	88	87	82	76	71	67	88
	REYQ34TAY1	90	89	89	84	78	74	70	89
	REYQ10TAY1	81	78	78	74	69	64	60	79
Building N East	REYQ20TAY1	87	87	87	83	77	73	68	88
	REYQ20TAY1	87	87	87	83	77	73	68	88
Building N West	REYQ20TAY1	87	87	87	83	77	73	68	88
	REYQ16TAY1	87	86	85	81	75	70	66	86
Building J	REYQ14TAY1	84	83	80	75	71	66	61	81
Building E	RXYMQ3AV4A	71	68	68	64	59	54	50	69
	RXYQ12AYM	0	60	62	58	50	44	37	62
	RXYMQ4AV4A	72	69	69	65	60	55	51	70
	RXYMQ5BVM	73	70	70	66	61	56	52	71

For the purposes of this noise and vibration impact assessment, it has been assumed that all units will be operating during the daytime.

7.2.2 Acoustic treatments

The following acoustic treatments would be incorporated into the GHS design:

- Internally lined ductwork comprising minimum 0.5 metres straight duct to be applied to each outdoor condenser unit discharge. Internal lining to be minimum 50 mm thick.
- Noise barriers of 2.5 m height on the eastern and northern side of the outdoor condenser units located on the east of Building N east, the barrier may be formed by acoustic louvres with an insertion loss equivalent to that shown in Table 25.

Table 25 Acoustic Louvre Insertion loss

Description	Octave band centre frequency, Hz							
	63	125	250	500	1k	2k	4k	8k
300 mm acoustic louvres	7	9	11	16	19	23	24	21

Where the barrier is formed by a sold material, The side of the solid barrier facing the units must be lined with absorptive material with an NRC of 0.5.

7.2.3 Predicted operation noise levels

Incorporation of the above treatments results in building services meeting the applicable project trigger noise levels presented in Section 4.0 for noise sensitive receivers. The predicted noise levels from the operational scenario has been presented in Table 26 below.

Table 26 Building services noise emission

Receiver	Project noise trigger level ($L_{Aeq\ 15\ minutes}$), dB(A)	Predicted noise level ($L_{Aeq\ 15\ minutes}$), dB(A)
R1	43	45
R2	43	42
R3	43	37
R4	43	32
R5	43	<30
R6	43	42
R7	43	43
R8	43	<30
AR1	53	<30
PR1	48	<30

It is noted that the noise level at R1 exceed the project noise trigger level by 2 dB. This level of exceedance is imperceptible and is therefore considered acceptable.

Operational noise contours for building services noise emission are presented in Appendix B

7.2.4 Childcare centre

The predicted level of noise from the new mechanical plant is 40 dBA at the worst affect façade of the Childcare Centre within the site. Assuming a 10 dB reduction from outside to inside with windows open, the predicted noise level inside the Childcare Centre is 30 dBA. This level of noise is within the criteria for sleeping areas in AS2107:2016 and is considered acceptable.

7.3 Out of School Hours Care outdoor area usage noise emission assessment

Outdoor areas of the proposed school grounds would be utilised for the purposes of Out of School Hours Care (OSHC). It is understood that the OSHC operates from 3.00 pm to 6.00 pm and does not operate before school care. The operation of the OSHC will therefore be assessed against the daytime criteria applicable from 7am to 6pm.

Below presents the assessed scenario that is considered representative of the worst-case for the above activity is as follows:

- Out of School Hours Care
  - 104 students located in the north west corner of the site and COLA
  - $L_{Aeq,15min}$ 10 children: 87 dB(A)
  - Occurs during the daytime (7am to 6pm) period only

The predicted noise levels from these three scenarios has been presented in Table 27.

Table 27 Out of hours school care

Receiver	Project noise trigger level ($L_{Aeq\ 15\ minutes}$), dB(A)	Predicted noise level ($L_{Aeq\ 15\ minutes}$), dB(A)
Out of school hours care scenario		
R1	43	<30
R2	43	<30
R3	43	<30
R4	43	<30
R5	43	<30
R6	43	<30
R7	43	<30
R8	43	<30
AR1	53	33
PR1	48	30

It is predicted that noise from the Out of Hours School Care scenario would comply with the relevant NPfI criteria at residences, therefore, not further consideration to outdoor area usage is required.

OSHC Operational noise contours for outdoor area use noise emission are presented in Appendix B.

7.3.1 School use of Outdoor areas

It is noted, that the NPfI is not applicable to noise emission from the use of outdoor play areas and sports fields and therefore compliance with these criteria is not mandatory.

The proposed new buildings and refurbishments will increase the capacity of the school from 1,410 students to 1,820 students. This will result in a predicted increase of approximately 1 dB from existing capacity to the proposed new capacity. This increase in noise level is imperceptible and is therefore considered acceptable.

In consideration of the above, it is unlikely that the use of outdoor areas will cause significant disturbance to nearby noise sensitive receivers.

7.4 Indoor area usage noise emission assessment

The majority of the proposed new rooms will consist of teaching spaces. It is likely that the major noise sources associated with these spaces will be teacher speaking in a raised voice. The predicted noise level assumed that a teacher is speaking for the entire 15 minute period. While it is likely that all teachers will not speaker for the entire 15 minute period, this approach represents a conservative assessment of the noise from the classroom activities. The noise level of a teacher speaking with a raised voice is presented in Table 28.

Table 28 Summary of noise source levels

Source	Sound power level, L_{10}, dB								Total sound power level, dB(A)
	Octave band centre frequency, Hz								
	63	125	250	500	1000	2000	4000	8000	
1 person raised vocal effort (Male)[1]	63[2]	63	68	72	67	62	57	52	72

Notes:

1. *Derived from Table 16.1 and Figure 16.1 in the "Handbook of Acoustical Measurements and Noise Control" (Third Edition, 1998) by C.M. Harris.*
2. *No data was available for these octave bands in the reference document, and so a conservative approximation has been made.*

It is assumed that all doors and windows are open during classroom activities. It is noted that the NPfI is not applicable to noise emission from the school activity such as the use of the indoor classrooms and therefore compliance with these criteria is not mandatory. The NPfI criteria however has been used in this case as a benchmark to determine whether use of the hall is likely to cause disturbance to nearby sensitive receivers.

The predicted noise levels from use of classrooms has been presented in Table 29 below.

Table 29 Classroom noise emission

Receiver	Project noise trigger level ($L_{Aeq\ 15\ minutes}$), dB(A)	Predicted noise level ($L_{Aeq\ 15\ minutes}$), dB(A)
	Daytime	
Classroom noise emission		
R1	43	<30
R2	43	<30
R3	43	<30
R4	43	<30
R5	43	<30
R6	43	<30
R7	43	<30
R8	43	<30
AR1	53	<30
PR1	48	32

It can be seen in Table 29, that no exceedances are predicted at receivers during from the use of the classrooms.

Operational noise contours for hall use, with the above noise emission controls, are presented in Appendix B.

7.5 School bell and public address operation noise emission

Speakers types, locations and orientation for the school bell and/or public address systems have not been determined at this stage of the design. The speaker design must be assessed during the detailed design stage and appropriate acoustic measures incorporated to meet the relevant criteria presented in 4.0. The following should be considered in the design of the speaker system to reduce noise emission to nearby receivers:

- Speaker location and direction
- Use of directional speakers
- The use of more speakers, set at lower volume levels, closer to the listeners will reduce noise emission outside of school grounds.

7.6 Cumulative emission from school grounds

The cumulative noise level from noise emission sources assessed above will be higher than the noise emission from any of the individual sources. However, it is unlikely that most noise sources will not be in operation simultaneously, for example use of the classrooms will occur at different time of the day than outdoor play.

It is noted that the operation of building services would occur during the same periods as one of the outdoor area usage scenarios, however, due to the relative locations and orientations of the relative activities and plant, it is not likely that the combined noise emission will result in exceedances of the NPfI criteria additional to those already noted in Section 7.2.3 above.

7.7 Road traffic noise intrusion assessment

As previously discussed, due to the COVID-19 lockdown occurring in Sydney at present, the amount of road traffic, school activities and pedestrian traffic which would normally contribute to the local noise environment are currently absent to a large extent. As a result, it was not considered reasonable to conduct noise monitoring in order to establish road traffic noise levels, as they would not be considered indicative of 'normal' traffic flows.

The Transport and Accessibility Impact Assessment prepared by TTW dated 05 November 2021 for Glenwood High School provided modelling for the intersection of Glenwood Park Drive and Forman Avenue recorded on Wednesday 16 June 2021.

The traffic modelling indicates that up to 574 used Glenwood Park Drive during the School afternoon peak period of 2.45 pm to 3.45pm.

It is possible that road traffic would result in noise intrusion into the proposed new building within the school. The façade of the building will be designed to attenuate traffic noise intrusion to meet the criteria presented in Section 4.3.

The road traffic noise level at the façade of the proposed new buildings was predicted using the Calculation of Road Traffic Noise 1988 (CoRTN) algorithms. It is assumed that the number of vehicles during the School afternoon peak period accounts for 20% of the daytime traffic volume on Glenwood Park Drive.

Based on the assumption of vehicles per day, using the CoTRN calculation method, the predicted traffic noise level at the eastern façade of the proposed new building is presented in Table 30.

Table 30 Road traffic noise levels at eastern façade, $L_{Zeq,15hr}$ levels, dB

Location	Octave Band Centre Frequency, Hz							Overall, L_{Aeq} level, dB(A)
	63	125	250	500	1k	2k	4k	
Eastern façade of the proposed new buildings	65	66	56	53	53	49	45	58

The previously referenced noise monitoring conducted by Day Design for a proposed childcare centre located at 174 Glenwood Park Drive, Glenwood reported a daytime $L_{Aeq,15hr}$ of 57dB(A), therefore 58 dB(A) is considered a conservative road traffic noise level.

The following minimum acoustic performances for the façade are recommended to meet the traffic noise intrusion requirements:

- Glazed elements

  - Minimum R_w 37 acoustic performance
  - Indicative construction: 10.5 mm VLam Hush glazing
  - Sliding doors must be closed to meet traffic noise intrusion requirements
- Ventilation louvres
  - Minimum R_w 33 acoustic performance
  - Indicative construction: 6.38 mm laminated glass
- Opaque elements
  - Minimum R_w 45 acoustic performance
  - Indicative construction:
    - 60 mm thick panelised brick, 28 mm furring channel with 25 mm bulk insulation in cavity and 13 mm plasterboard; OR
    - 9 mm fibre cement sheet, 64 mm steel stud with 50 mm bulk insulation in cavity and 13 mm fire rated plasterboard.

7.8 Traffic generation noise assessment

As discussed in 7.3.1, the capacity of the school will increase from 1,410 students to 1,820 students. It is understood the existing staff may increase from 106 to 133 on a typical day.

According to the Transport and Accessibility Impact Assessment prepared by TTW dated 05 November 2021, the proposal will increase drop-off and pick-up from 564 to 728 vehicles and student and staff vehicles parking from 238 to 304.

The increase in traffic to the site as a result in student and staff numbers is site is expected to be approximately 1 dB, which is considered insignificant. Therefore the traffic impact on access roads from the project would be acceptable.

7.9 Operational vibration

Items installed as part of GHS are not expected to produce any significant vibration, therefore no further assessment has been undertaken.

8.0 Conclusion

This report presents the results of a noise and vibration impact assessment of the proposed Glenwood High School Upgrade.

Operational noise emission from the development has been assessed with consideration to the project noise trigger levels established in accordance with the NSW NPfI and assumptions of the noise levels at the development site. The impact of noise emission from new developments can be widespread when noise issues are not correctly considered, however, this assessment indicates that standard amelioration strategies including the preparation of a construction noise and vibration management plan will sufficiently treat noise emission to minimise possible acoustic impacts on neighbouring areas.

Noise and vibration intrusion to the development from road traffic has been assessed and complies with the criteria established in accordance with *Development Near Rail Corridors and Busy Roads – Interim Guideline* subject to amelioration measures.

Traffic generation as a result of the proposed development is predicted to be minimal and predicted traffic noise increases would comply with the applicable criteria outlined in the NSW Road Noise Policy.

Construction noise has been assessed in accordance with the EPA's Interim Construction Noise Guideline. The worst case construction scenarios have been considered. Construction works would be undertaken during standard hours. The level of exceedances of the construction noise management levels are provided in Section 5.1.4. It should be noted that the exceedances presented are the highest on each residential street during the construction phase and would generally be significantly lower for significant periods of time. Mitigation measures suchas equipment selection and maintenance, siting of plant and management of construction traffic and a complaints handling procedure should be considered to reduce the impact of construction works on adjacent residential recievers.

Given the large distances from the construction works to residential receivers, vibration from construction works is unlikely to impact residences. Set back distances have been provided to reduce the likelihood of human response or cosmetic damage.

Based upon this assessment documented above, all environmental noise and vibration impacts can be appropriate managed in accordance with the relevant guidelines and standards.

Appendix A

Glossary of Acoustic Terminology

Appendix A Glossary of Acoustic Terminology

The following is a brief description of acoustic terminology used in this report.

Sound power level	The total sound emitted by a source.
Sound pressure level	The amount of sound at a specified point.
Decibel [dB]	The measurement unit of sound.
A Weighted decibels [dB(A)]	The A weighting is a frequency filter applied to measured noise levels to represent how humans hear sounds. The A-weighting filter emphasises frequencies in the speech range (between 1kHz and 4 kHz) which the human ear is most sensitive to, and places less emphasis on low frequencies at which the human ear is not so sensitive. When an overall sound level is A-weighted it is expressed in units of dB(A).
Decibel scale	The decibel scale is logarithmic in order to produce a better representation of the response of the human ear. A 3 dB increase in the sound pressure level corresponds to a doubling in the sound energy. A 10 dB increase in the sound pressure level corresponds to a perceived doubling in volume. Examples of decibel levels of common sounds are as follows:

0dB(A)	Threshold of human hearing
30dB(A)	A quiet country park
40dB(A)	Whisper in a library
50dB(A)	Open office space
70dB(A)	Inside a car on a freeway
80dB(A)	Outboard motor
90dB(A)	Heavy truck pass-by
100dB(A)	Jackhammer/Subway train
110 dB(A)	Rock Concert
115dB(A)	Limit of sound permitted in industry
120dB(A)	747 take off at 250 metres

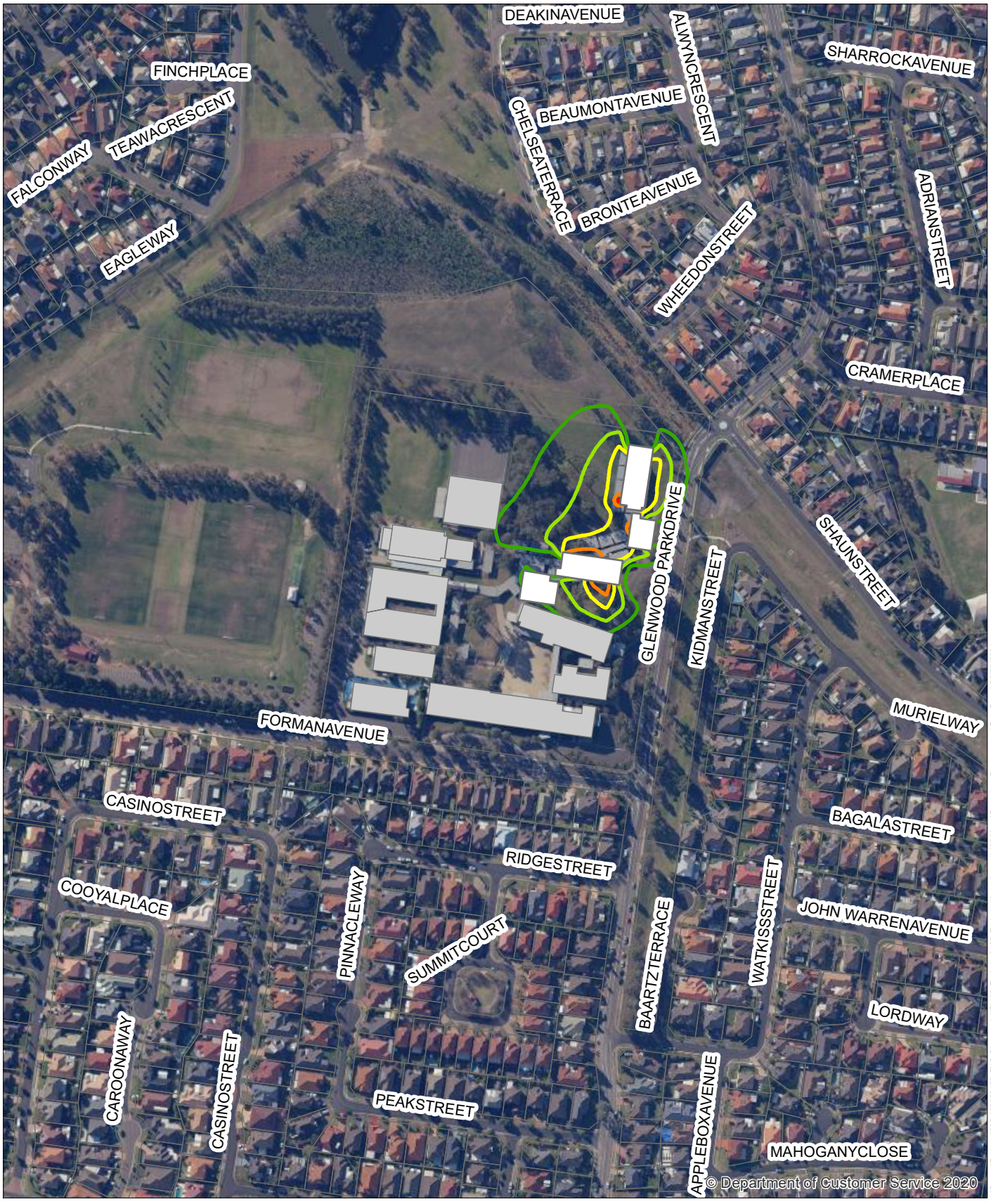
Frequency [f]	The repetition rate of the cycle measured in Hertz (Hz). The frequency corresponds to the pitch of the sound. A high frequency corresponds to a high pitched sound and a low frequency to a low pitched sound.
Equivalent continuous sound level [L_{eq}]	The constant sound level which, when occurring over the same period of time, would result in the receiver experiencing the same amount of sound energy.
L_{max}	The maximum sound pressure level measured over the measurement period.
L_{min}	The minimum sound pressure level measured over the measurement period.
L_{10}	The sound pressure level exceeded for 10% of the measurement period. For 10% of the measurement period it was louder than the L_{10}.

L_{90}	The sound pressure level exceeded for 90% of the measurement period. For 90% of the measurement period it was louder than the L_{90}.
Ambient noise	The all-encompassing noise at a point composed of sound from all sources near and far.
Background noise	The underlying level of noise present in the ambient noise when extraneous noise (such as transient traffic and dogs barking) is removed. The L_{90} sound pressure level is used to quantify background noise.
Traffic noise	The total noise resulting from road traffic. The L_{eq} sound pressure level is used to quantify traffic noise.
Day	The period from 0700 to 1800 h Monday to Saturday and 0800 to 1800 h Sundays and Public Holidays.
Evening	The period from 1800 to 2200 h Monday to Sunday and Public Holidays.
Night	The period from 2200 to 0700 h Monday to Saturday and 2200 to 0800 h Sundays and Public Holidays.
Assessment background level [ABL]	The overall background level for each day, evening and night period for **each day** of the noise monitoring.
Rating background level [RBL]	The overall background level for each day, evening and night period for the **entire length** of noise monitoring.

*Definitions of a number of terms have been adapted from Australian Standard AS1633:1985 *"Acoustics – Glossary of terms and related symbols"*, the EPA's NSW Noise Policy for Industry and Road Noise Policy.

Appendix B

Operational Noise Contours



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N

0 0.065 0.13 km

AECOM

Site Buildings

- Existing Buildings
- New Buildings

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

35 40 45 50 55

Operational Noise Contours - Indoor Classroom

Source:

Site Buildings

- Existing Buildings
- New Buildings

ISOVALUE

40 45 50 55 60

- OSHC

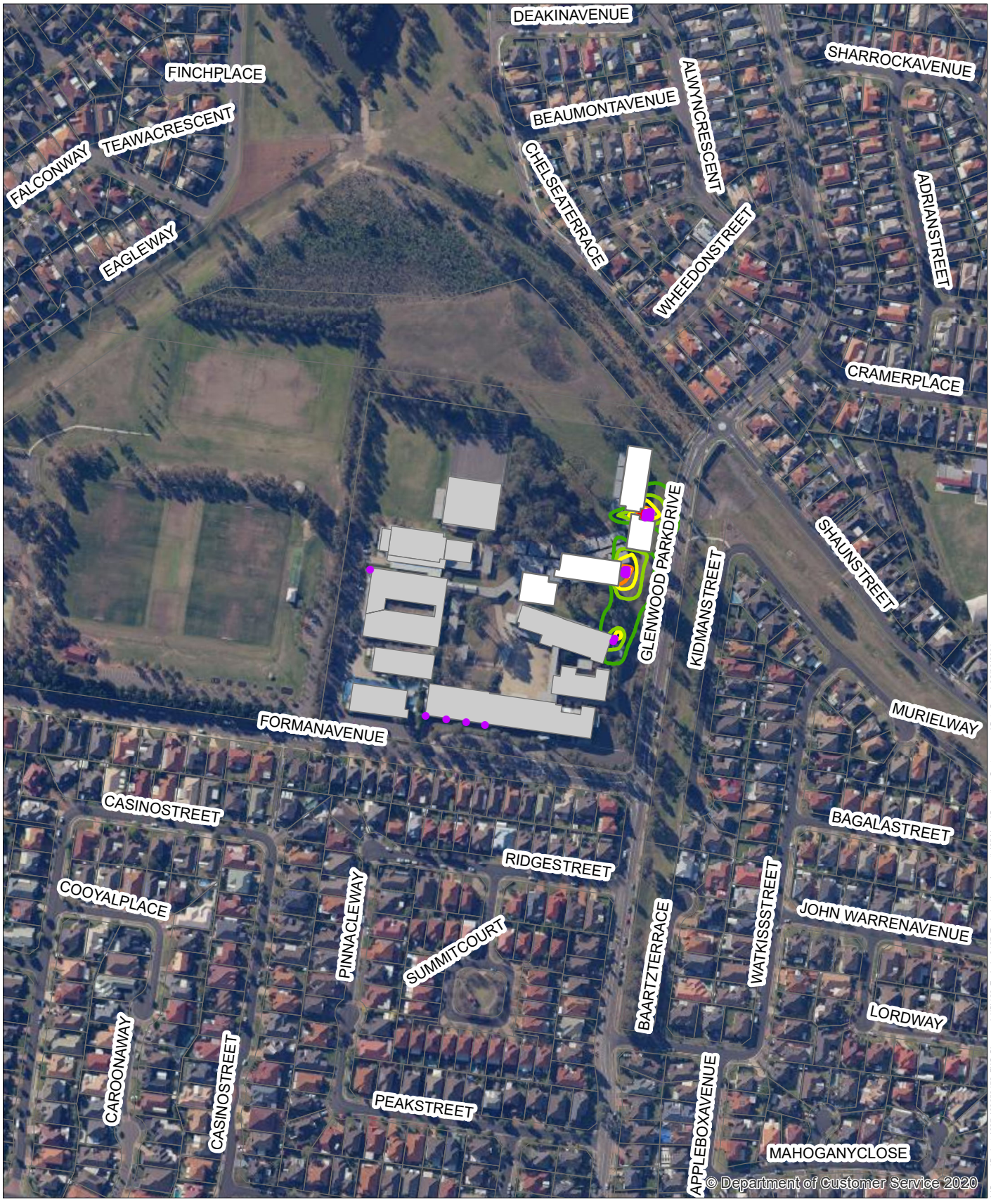
N

0 0.065 0.13 km

AECOM

Operational Noise Contours - OSHC

Source:



N

0 0.065 0.13 km

AECOM

Site Buildings

- Existing Buildings
- New Buildings

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

55 60 65 70 75

- Outdoor Condenser Units
- Noise barrier

Operational Noise Contours - Mechanical Plant

Source:

Appendix C

Construction Noise Contours

Construction Noise Contours - Site Preparation and Excavation

N

0 0.06 0.12 km

AECOM

Site Buildings

Existing Buildings

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

55 60 65 70 75

Source:

Construction Noise Contours - Building Construction

N

0 0.06 0.12 km

AECOM

Site Buildings

Existing Buildings

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

55 60 65 70 75

Source:

Construction Noise Contours - Demountable Demolition

N

0 0.06 0.12 km

AECOM

Site Buildings

Existing Buildings

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

55 60 65 70 75

Source: