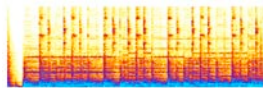


O'CONNELL STREET PRIMARY SCHOOL PARRAMATTA

ACOUSTIC ASSESSMENT OF OPERATION AND CONSTRUCTION NOISE AND VIBRATION FOR PLANNING APPLICATION

Issued

24 March 2016

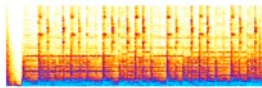


acoustic studio

abn 76 106 325 982
address Unit 27, 43-53 Bridge Road, Stanmore NSW 2048 Australia
tel (+61) 2 9557 6421
fax (+61) 2 9557 6423
email mail@acousticstudio.com.au

Contact for this Report

Jason Cameron
jason.cameron@acousticstudio.com.au

**acoustic studio**

abn 76 106 325 982
address Unit 27, 43-53 Bridge Road, Stanmore NSW 2048 Australia
tel (+61) 2 9557 6421
fax (+61) 2 9557 6423
email mail@acousticstudio.com.au

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Author(s)	Jason Cameron & Anthony Cano		
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Jarrod Hughes	Tonkin Zulaikha Greer	Sydney	e-mail
John Bohane	Tonkin Zulaikha Greer	Sydney	e-mail
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1 Introduction

The Department of Education and Communities (DEC) proposes to develop a new primary school on a site in Parramatta bounded by O'Connell Street and Marsden Street (known as the Old Kings School site).

Acoustic Studio has been commissioned to carry out a noise impact assessment for the proposed O'Connell Street Primary School (OSPS) by the NSW Department of Education and Communities.

This acoustic assessment has been prepared in support of the planning application for the OSPS project and addresses the requirements outlined in the Secretary's Environmental Assessment Requirements issued for the project.

The objectives of this assessment are to:

- Identify noise sensitive receivers that will potentially be affected by the operation and construction of the school.
- Carry out noise surveys to determine existing ambient and background noise levels at the nearest noise sensitive receivers that surround the site.
- Establish the appropriate noise assessment criteria in accordance with the relevant standards and guidelines. Including:
 - NSW Industrial Noise Policy 2000
 - Interim Construction Noise Guideline 2009
 - Assessing Vibration: A Technical Guideline 2006
- Carry out a quantitative assessment to determine whether the relevant criteria can be achieved based on proposed operations and construction methods. Where applicable, provide recommendations for any necessary acoustic control measures that will need to be incorporated into the development in order to ensure compliance with the assessment criteria.

This report presents the findings of both the operational and construction noise and vibration assessments. It includes measured environmental noise survey data and environmental noise limits based on the measured noise levels in the area. Compliance with these limits will ensure that any noise from the overall development will not impact negatively on the nearest existing receivers and receivers which have been proposed for development. The report also provides recommendations for appropriate vibration level criteria during construction.

2 Project Overview

2.1 Description of the proposal

The Department of Education and Communities (DEC) proposes to develop a new primary school on a site in Parramatta bounded by O'Connell Street and Marsden Street (known as the Old Kings School site). This forms a key project in the planning strategy to meet projected increases in student enrolments and demand for additional teaching facilities in Parramatta into the future.

The new school will inhabit a key heritage site overlooking the Parramatta River.

The proposal includes the fit out and refurbishment of existing buildings plus a new hall to provide 5 key building areas including:

- Building A and B – Admin, Resource Centre, Home Bases / Classrooms
- Building C and D – Home Bases / Classrooms
- Building H – New Hall and Covered Outdoor Learning Area

The proposal is shown in Figure 1 and Figure 2.

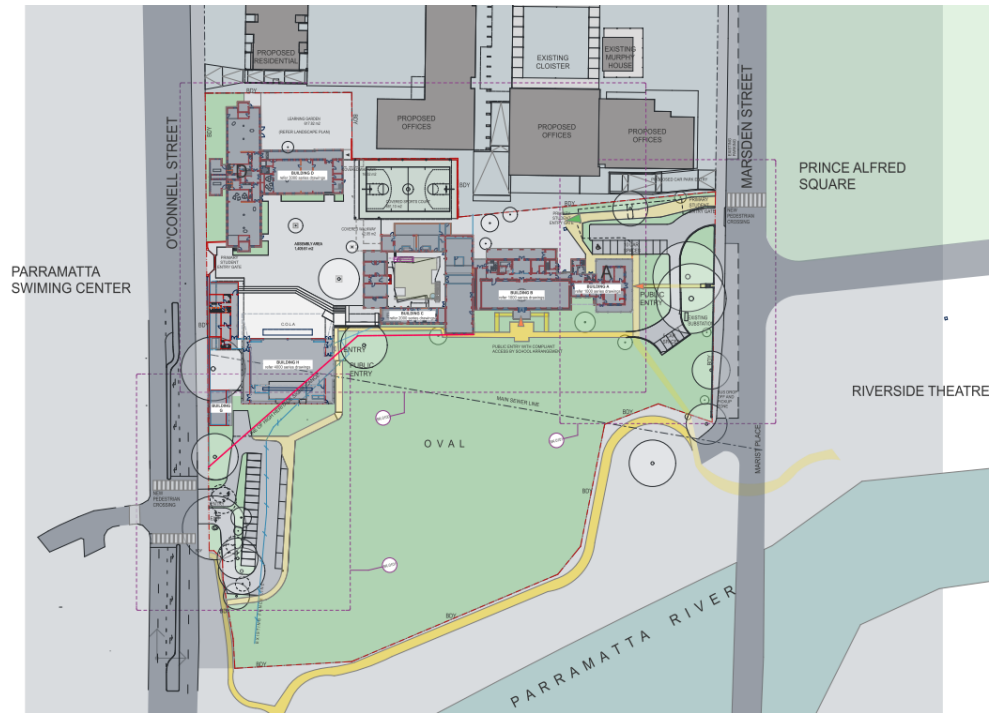


Figure 1: Site Plan

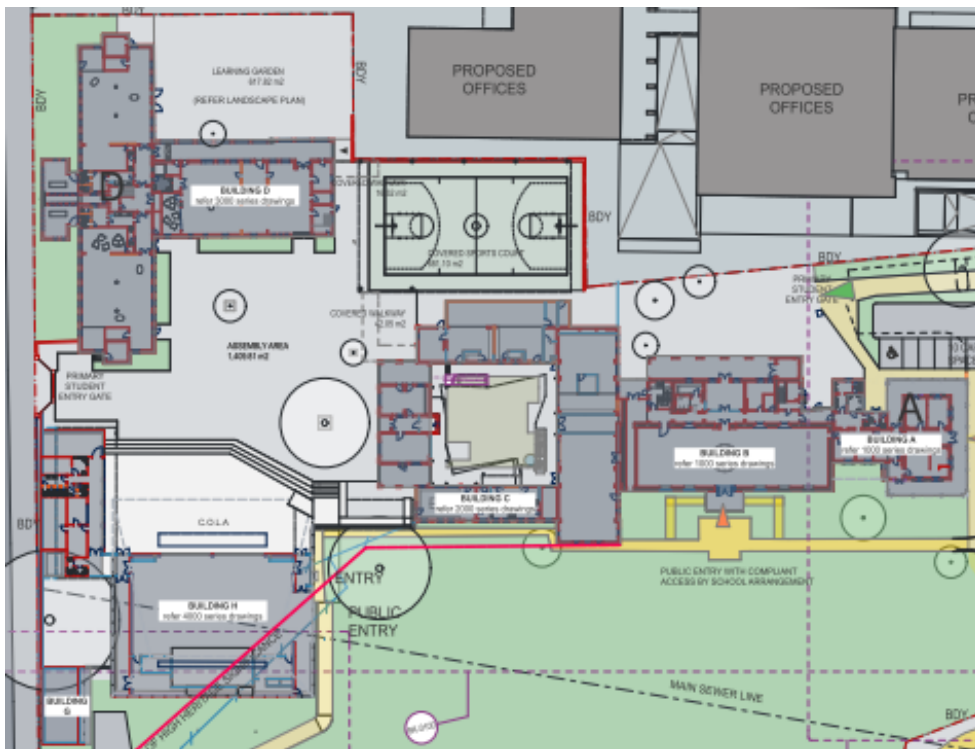


Figure 2: O'Connell Street Primary School – New and Refurbished Buildings

2.2 Operating hours

O'Connell Street Primary School will generally operate within typical school hours. These will include:

- School hours are from 9:00 am to 3:00 pm on school term weekdays
- Recess bell times are 10:45 am to 11:00 am
- Lunch bell times are 12:45 pm to 1:15 pm
- The schools multipurpose hall will be used for the following:
 - Typical school use during school hours
 - Out Of School Hours care which will operate between 7:00am and 9:00am, and 3:00 pm and 6:00 pm
- Cleaning is typically undertaken out of school hours, from 3:00pm to 9:00pm on weekdays.
- Maintenance is carried out during and after school hours, up to 5:00pm.
- There will also be occasions for out of hours use which may include the hall, resource centre and oval by the school

2.3 Site details

The site is located within an urban environment on the outskirts of Parramatta Central Business District, characterised by medium to high levels of activity throughout the day and decreasing noise levels in the evening and night.

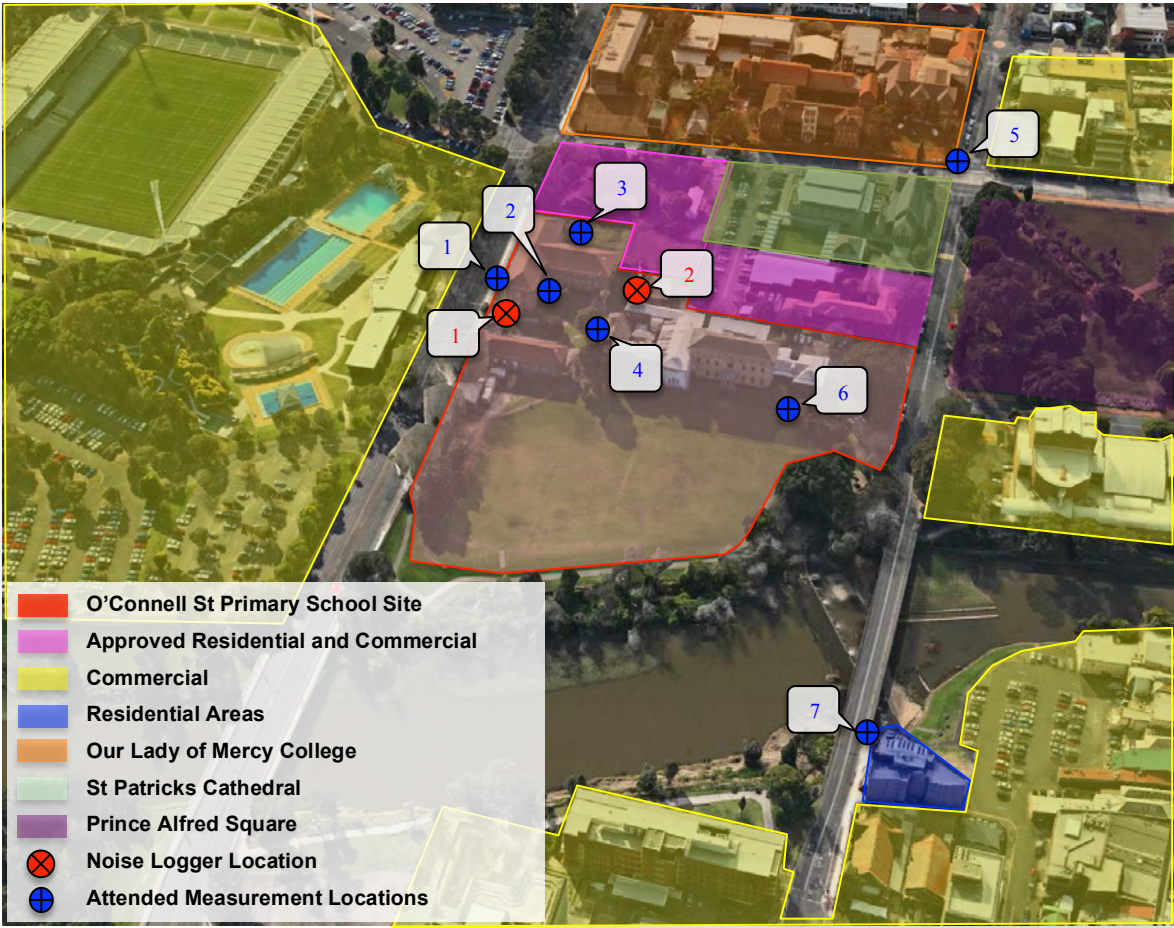


Figure 3: Proposed O'Connell Street Primary School Site in relation to noise-sensitive receivers.

Existing neighbouring buildings that surround the site are as follows:

- Pirtek Stadium and Parramatta Swimming Centre to the west across O'Connell Street.
- Our Lady of Mercy College across Victoria Road to the North
- St Patricks Cathedral adjacent to the North East
- Commercial properties across the intersection of Victoria Road and Marist Place to the North East
- Prince Alfred Square (park area) and the Riverside Theatre to the East across Marist Place.
- Residential to the South East across Parramatta River
- Commercial to the south and southeast across Parramatta River

In addition to existing neighbouring buildings, we understand that a commercial and residential building has been approved adjacent to the proposed school site to the north. The potential noise impacts from the proposal on future receivers have been considered in the assessment.

3 Existing Noise Environment

3.1 General survey information

A survey of the existing noise environment around the O'Connell Street site was conducted with two unattended noise monitors used to continuously record the noise levels on the site. Long term noise monitoring was carried out from Monday 16th November to Monday 23rd November 2015 to establish the typical range of ambient noise levels of the proposed site and surrounds.

Long term noise monitoring was carried out with the following noise loggers:

- Logger 1: Rion NL-42EX 521656.
- Logger 2: Rion NL-42EX 521657.

The loggers recorded L_{A1} , L_{A10} , L_{A90} , and L_{Aeq} noise parameters at 15-minute intervals continuously for the 7-day measurement period. The calibration of the logger was checked before and after use and no variation was noted.

Operator attended short-term monitoring was also carried out on Monday 16th and Monday 23rd November 2015 in order to supplement the long-term outdoor data across the site and at key surrounding receivers, plus to and obtain spectral noise data for traffic and aircraft noise at the proposed development site.

Short-term measurements were made with a Brüel & Kjær Hand-held Analyser Type 2250 (Serial Numbers 2446899 and 2832406). The calibration of the analyser was checked before and after the survey and no variation in level occurred.

A windshield was used to protect the microphone of both the logger and the analyser. Weather conditions were calm and dry during the attended noise survey.

Anthony Cano and Saiham Siraj of Acoustic Studio Pty Ltd carried out the surveys.

The long and short-term noise monitoring locations are shown in Figure 3.

3.2 Long-term monitoring results

The loggers were located at the proposed development site at the following locations:

- Logger 1 – at the western end of the proposed development site to capture existing **traffic noise** along O’Connell Street.
- Logger 2 – at the centre of the proposed development site to capture existing ambient and **background noise** levels at the site.

These positions were chosen as it represented a secure place to leave the noise loggers unattended whilst obtaining typical representative traffic plus background and ambient noise levels at the nearest noise sensitive receivers. The long-term noise monitoring locations are shown in Figure 3.

The detailed results of the long term noise monitoring at both logger locations are shown graphically in Appendix A.

Weather patterns were monitored during the survey period and were typically calm and dry during the unattended noise survey.

3.2.1 Traffic Noise

Traffic noise monitoring results are summarised in Table 1 below.

Location	Traffic Noise Levels, dB(A)			
	Period		Noisiest 1 Hour Period	
	Day	Night	Day	Night
	L _{eq} , (15 hr)	L _{eq} , (9 hr)	L _{eq} , (1 hr)	L _{eq} , (1 hr)
O’Connell St Facade ¹	70	66	72	71

Table 1: Long-term traffic noise levels measured – O’Connell St – includes façade reflection

3.2.2 Background and Ambient Noise

The logged data shows the background and ambient noise levels representative of the area. The recorded background noise levels have been used to establish a limiting criteria for noise emitted from the operation of the new buildings.

The background sound level is defined as the sound level exceeded 90% of the time, and is designated as the L₉₀. The ambient noise level impacting on the buildings is referred to as the equivalent continuous sound level (L_{eq}). This parameter is commonly used to describe a time varying noise such as traffic noise.

¹ Noise logger values adjusted to reflect noise levels incident on façade based on correlation with attended measurements.

The background sound levels have been established in general accordance with the methodology described in the NSW INP, i.e. the 10th percentile background sound level for each period for each day of the ambient noise survey. The median of these levels is then presented as the background sound level for each assessment period. These background noise levels are shown in Table 2 below together with the L_{Aeq} ambient noise levels measured for each period.

In accordance with the INP, any data likely to be affected by rain, wind or other extraneous noises has been excluded from the calculations.

Location	Background Noise Levels (RBL), dB(A)			Leq Ambient Noise Levels, dB(A)		
	Day 7am-6pm	Evening 6pm-10pm	Night 10pm-7am	Day 7am-6pm	Evening 6pm-10pm	Night 10pm-7am
Logger 1 O'Connell Street	54	52	40	67	66	63
Logger 2 Centre of Development Site	47	46	37	53	54	50

Table 2: Long-term background and ambient noise levels

From observations during our site visit, it is noted that both ambient and background noise levels around the proposed development site is generally dominated by traffic noise around the site.

3.3 Short-term monitoring results

Seven (7) short-term noise monitoring locations were chosen as representative of the site and surrounds as follows:

- **Location 1** on the footpath in front of the existing Building D fronting O'Connell Street
- **Location 2** in front of the existing Building C with a direct line of site to O'Connell Street.
- **Location 3** at the rear of Building D to capture indirect traffic noise levels at the rear of the building plus background and ambient noise levels at the site.
- **Location 4** to the north of Building D to capture existing background and ambient noise.
- **Location 5** at the intersection of Victoria Road and Marist Place to the North East to capture background and ambient noise levels at the nearest school and commercial receivers.
- **Location 6** at the southern boundary of the site fronting Parramatta River.
- **Location 7** at the nearest residential noise receiver.

The measured values of the short-term traffic, background and ambient noise monitoring around the existing site are shown in Table 3.

Location	Time	Descriptor	Measured sound level, dB re 20 μ Pa									
			Overall dB(A)	Octave band centre frequency ¹ , Hz								
				31.5	63	125	250	500	1k	2k	4k	8k
1 (O'Connell Street)	16/11/15 11:50am	L _{eq} 15 min	73	71	79	72	69	69	71	66	58	51
		L ₉₀ 15 min	63	62	61	57	57	55	61	55	42	30
	23/11/15 14:15pm	L _{eq} 15 min	72	70	75	70	67	66	69	64	55	47
		L ₉₀ 15 min	61	60	60	57	56	55	58	53	43	34
2	16/11/15 11:30 am	L _{eq} 15 min	56	59	63	64	56	50	52	47	38	37
		L ₉₀ 15 min	50	56	57	53	50	44	46	41	32	23
	23/11/15 14:31pm	L _{eq} 15 min	55	61	65	58	53	50	52	47	40	32
		L ₉₀ 15 min	51	57	58	53	50	47	48	43	35	25
3	23/11/15 14:47pm	L _{eq} 15 min	55	61	63	59	53	51	51	46	39	31
		L ₉₀ 15 min	51	58	58	54	50	48	48	43	33	22
4	23/11/15 15:02pm	L _{eq} 15 min	54	64	65	62	52	49	49	44	38	30
		L ₉₀ 15 min	48	59	58	52	45	44	44	40	33	24
5	23/11/15 16:05pm	L _{eq} 15 min	69	72	75	72	67	64	65	60	53	46
		L ₉₀ 15 min	58	66	66	62	58	55	54	50	44	35
6	23/11/15 13:39pm	L _{eq} 15 min	58	64	67	61	57	56	54	49	43	32
		L ₉₀ 15 min	55	60	62	57	53	52	51	47	39	27
7	23/11/15 13:15pm	L _{eq} 15 min	67	70	68	66	63	62	64	60	52	44
		L ₉₀ 15 min	55	61	61	58	54	52	50	47	42	33

Table 3: Short-term traffic, background and ambient noise levels – Day time survey

4 Key Acoustic Considerations

The following acoustic issues are to be addressed as part of the Noise Impact Assessment for the O'Connell Street Primary School:

External Noise Intrusion - For each building, the building envelope must limit external noise intrusion levels so that appropriate internal noise levels are achieved within the sensitive spaces. In particular, this applies to traffic noise intrusion from O'Connell Street and the impact on accommodation in each building.

External Noise Emissions - Noise emissions from the proposed development will need to be managed to limit environmental noise impacts on nearby buildings resulting from the operation of the proposed development. In particular this applies to:

- Building services and plant - The impact of mechanical noise generated by any new mechanical. The mechanical plant noise levels are to be assessed against the NSW Industrial Noise Policy (INP) 2000.
- Traffic noise generation - The impact of traffic noise on surrounding receivers from changes in traffic flow as a result of the new development.
- Operational noise – associated with noisy activities, particularly noise associated with the use of the proposed multipurpose hall.

Construction Noise and Vibration - The impact of noise and vibration generated during the construction stage of the project on surrounding noise sensitive premises.

The development will contribute noise and vibration to the surrounding environment during the construction stage of the school. Typically, this will result from intermittent noise from construction equipment and plant commonly used on construction sites.

Design noise and vibration limits have been set for the project and construction noise impacts have been anticipated from standard construction procedures.

The construction noise and vibration limits and expected impacts are reported in Section 9 of this report.

5 Relevant Standard and Guidelines

5.1 Guidelines used for the operational acoustic assessment

The following standards and guidelines are considered relevant to the project and have been referenced in developing the project noise criteria:

- Parramatta Council Development Control Plan (DCP) 2011
- Parramatta Council Local Environment Plan (LEP) 2011
- Protection of the Environmental Operations (POEO) Act 1997
- NSW *Industrial Noise Policy* (INP) 2000
- NSW State Environmental Planning Policy (SEPP), Infrastructure 2007
- NSW Department of Planning, *Development Near Busy Roads and Rail Corridors*, 2008
- NSW Department of Education and Communities – DG11 Acoustics
- Australian Standard AS 2107:2000
- NSW EPA Road Noise Policy, 2011
- NSW Environmental Protection Authority (EPA) *Noise Guide for Local Government* (NGLG) 2013.

6 Acoustic Design Criteria

6.1 External Noise Intrusion

6.1.3 Traffic Noise

SEPP INFRASTRUCTURE 2007

Clause 102 of SEPP 2007 outlines requirements related to the assessment of noise impact from non-road developments that are adjacent to road corridors with traffic volumes of more than 40,000 vehicles.

Objective criteria for internal noise levels that must be achieved are provided for residential development only.

In the absence of objective criteria for the educational facilities, reference is made to NSW Department of Planning (DoP), *Development Near Busy Roads and Rail Corridors – Interim Guideline* and Australian Standard AS2107, which recommend internal design noise levels within occupied spaces and are detailed below.

NSW DoP, Development Near Busy Roads and Rail Corridors

For airborne noise from road traffic, the NSW DoP Interim Guideline sets an internal noise target of 40 dB(A)² for educational institutions.

NSW Department of Education and Communities – Educational Facilities and Standards Guidelines DG11 Acoustics

The NSW DEC DG11 guideline (found at <https://efsg.det.nsw.edu.au>) provides internal noise levels that should be achieved within educational facilities which are generally consistent with the recommended satisfactory design sound levels from Australian Standard 2107.

The DEC, requires that recommended internal noise levels in DG 11 be achieved in all relevant spaces within the proposed development. Therefore the criteria outlined in DG 11 have been adopted for this project.

² Airborne noise is from traffic is calculated as $L_{eq\ 15\ hr\ Day}$ and $L_{eq\ 9\ hr\ night}$.

6.2 External noise emission criteria

6.2.4 General

Local Development and Environment Plans

Parramatta Council Development Control Plan (DCP) 2011 and Local Environment Plan (LEP) 2011 refer to environmental noise impacts in qualitative terms. The DCP does not provide specific objective criteria related to schools. It does however make reference to a number of guidelines and references for “Further Information”.

The following sections provide detail on the guidelines and standards relevant to this project, which are used to establish thorough and objective criteria.

Environmental Planning and Assessment Act (EP&A) 1979

The Environmental Planning and Assessment Act 1979 (EP&A Act) regulates the majority of planning approval and environmental impact assessment (EIA) requirements in NSW. Section 111 of the Act requires examination and consideration to the fullest extent possible of all matters affecting or likely to affect the environment by reason of its activities. Acoustic impacts are a common community concern to be addressed in an EIA.

6.2.5 Protection of the Environment Operations Act (POEO) 1997

The Protection of the Environment Operations (POEO) Act 1997 defines “Offensive Noise” as follows:

“ ...

- (a) *that, by reason of its level, nature, character or quality, or the time at which it is made, or any other circumstances:*
 - (i) *is harmful to (or is likely to be harmful to) a person who is outside the premises from which it is emitted, or*
 - (ii) *interferes unreasonably with (or is likely to interfere unreasonably with) the comfort or repose of a person who is outside the premises from which it is emitted, or*
- (b) *that is of a level, nature, character or quality prescribed by the regulations or that is made at a time, or in other circumstances, prescribed by the regulations. ...”*

Further advice on the assessment of “Offensive Noise” is provided in the Noise Guide for Local Government (NGLG), 2010, which provides a checklist (shown in Table 4 below), of items that may be considered.

Offensive noise test: Checklist of considerations

Q1: Is the noise loud in an absolute sense? Is it loud relative to other noise in the area?

This establishes that the noise is likely to be heard by neighbours. Its volume alone may be annoying. An example would be music being played at a very high volume in a residence so it can be heard over very noisy activity outside, such as construction work. The noise may also be loud relative to the background noise. An example would be loud fireworks set off late at night. Noise measurements using a sound level meter would help to determine how loud the noise is relative to the background noise level in the area.

Q2: Does the noise include characteristics that make it particularly irritating?

The presence of tones, impulses or fluctuations in volume can make people more likely to react to the noise. These can be judged subjectively but noise measurements will help to quantify the extent of these characteristics. Examples might be screeching sounds from poorly maintained equipment or a 'beeper' alarm that uses a pulsed sound made up of one or two alternating frequency tones, usually higher pitched, that are louder than the background noise in the area.

Q3: Does the noise occur at times when people expect to enjoy peace and quiet?

People usually expect their surroundings to be quieter during the evening and at night. Talk to the complainants about how the noise affects them to see if it is interfering unreasonably with their comfort at home. Is it regularly disturbing their sleep, making it difficult to have a conversation, study, read or hear the TV? Noise that regularly disturbs sleep is likely to be considered offensive by complainants and this should be taken into account in your assessment.

Q4: Is the noise atypical for the area?

Where noise from an activity that is causing nuisance is new or unusual for an area, people are more likely to react. Look at the typical uses of the area and determine whether the activity is consistent with the local environmental plan. An example might be a rock drill used on a residential construction site.

Q5: Does the noise occur often?

Noise can be more annoying when it occurs frequently. Examples might be a leaf blower used every morning or a band that practises frequently without regard to the impact on neighbours.

Q6: Are a number of people affected by the noise?

Only one person needs to be affected by the noise for it to be deemed offensive. However, talking to other neighbours likely to be exposed to the same noise about how it affects them may assist in deciding what action to take. Some councils have a policy of requiring a minimum number of complaints from different individuals before taking formal action.

Table 4: NGLG Offensive Noise Checklist

6.2.6 Defining environmental noise criteria

The noise definitions and conditions provided by the Parramatta DCP, LEP and POEO are generally focused around a subjective assessment.

Acoustic Studio recommends determining suitable objective criteria for assessing offensive noise, for noise emissions from mechanical plant, sound systems, students and staff.

Compliance with the criteria described in the sections that follow will ensure that the general noise conditions described in this section will be met.

6.2.7 NSW Road Noise Policy

The NSW Road Noise Policy (RNP) provides criteria for traffic noise from new roads or additional traffic generated on roads from land use development.

When considering land use redevelopment and the impact on sensitive land uses (residential / schools / hospitals / recreational) the guideline states that “ *In assessing feasible and reasonable mitigation measures, an increase of up to 2 dB*”... (in relation to existing noise levels).. “*represents a minor impact that is considered barely perceptible to the average person*”.

6.2.8 Mechanical plant

New South Wales Industrial Noise Policy (INP)

The INP provides the framework and process for deriving noise goals for consents and licences that enable the EPA to regulate industrial premises that are scheduled under the *Protection of the Environment Operations Act 1997*. The EPA INP Application Notes provides additional guidance on elements of the INP, including assessment of changes to existing premises (infrastructure and / or operations).

The INP applies to fixed facilities, commercial premises and individual industrial sources such as heating, ventilating and air conditioning (HVAC) equipment. It is also typically applied for general maintenance noise such as cleaning activities. It provides guidance on the methodology for determining limiting noise criteria designed for external noise emissions typically associated with mechanical plant.

The NSW INP defines environmental industrial noise goals in two ways. The goals apply at the most-affected point on or within the residential boundary and are location-dependent. They also depend on the occupancy: residential, commercial, educational, etc.

The INP considers the following when establishing the criteria:

- The *time of day* that the noise generating development will be in operation, defined by the following:
 - Day (7am to 6pm)

- Evening (6pm to 10pm)
- Night (10pm to 7am)
- The existing *Ambient* (L_{eq}) and *Background* noise levels (L_{90}) that surround the site.
- The *type of noise source* and its characteristics. The INP provides modifying factors for noise sources with certain characteristics that may potentially cause greater annoyance than other noise sources of the same level.

The residential ***intrusiveness*** criterion aims to control short duration noise impacts and is based on the existing background noise level, and is defined as:

$$L_{Aeq,15 \text{ minute}} \text{ from new noise source} \leq \text{Existing long-term } L_{A90, \text{Day/Evening/Night}} + 5.$$

The ***amenity*** criterion aims to maintain noise amenity for a particular land use, including non-residential uses. It defines recommended noise levels, called Acceptable Noise Levels (ANL), for different neighbourhood types. The urban residential ANLs are:

- Day time (7am to 6pm): 60 dBL_{Aeq (11hrs)}
- Evening (6pm to 10pm): 50 dBL_{Aeq (4hrs)}
- Night time (10pm to 7am): 45 dBL_{Aeq (9hrs)}

Modification factors apply to the amenity criterion when existing industrial noise exceeds the acceptable noise levels (refer Table 2.2 and Section 2.2.3 of the NSW INP). No industrial noise corrections are required for this location. A modified ANL may be applied where the industrial noise exceeds the ANL but is inaudible above the traffic noise. This is not the case for O'Connell Street Primary School, and the standard INP ANL applies.

The NSW INP applies “penalty” or “correction” factors to account for particular noise characteristics such as tonal, low frequency dominant, or intermittent noise (refer Table 4.1 of the NSW INP). No penalty factors have been applied in this assessment, based on the assumption that mechanical plant will be controlled at source to avoid intermittent, tonal, or low-frequency-dominant noise emissions.

Any non-operational period is excluded from an INP assessment. For the O'Connell Street Primary School, it is assumed that the mechanical plant may be in operation during the day and evening time periods 7am to 10pm, including for facility maintenance purposes (such as cleaning activities). The night-time hours between 10pm and 7am are excluded from the assessment.

Based on the measured noise levels detailed in Section 6, and in accordance with the methodology outlined in the NSW INP, Table 5 details the corresponding limits of allowable noise emission from mechanical plant and general maintenance activities associated with the development at the nearest receiver boundaries.

Receiver Type	Period	INP Criteria			
		Acceptable Noise Level	Amenity Leq (period), dBA	Intrusiveness Leq (15-minute), dBA	INP Project Specific ³
Residential	Day (7am-6pm)	60	60	52	51
	Evening (6pm-10pm)	50	44	51	44
	Night (10pm to 6am)	45	40	42	40
Place of Worship	When in use	50 ⁴	43	-	43
Passive Recreation Area	When in use	50	43	-	43
Commercial premises	When in use	65	65	-	65
School Classroom	Noisiest 1-hour period When In Use	45 ⁴	43	-	43

Table 5: INP project specific criteria for external noise emissions from mechanical plant

³ Project Specific Criteria are based on the more stringent of the Amenity and Intrusiveness Criteria.

⁴ The NSW INP specifies an internal ANL of 35 and 40 for school classrooms and places of worship respectively. The NSW INP also states that where internal noise levels are specified, external noise 10 dB above internal noise levels can be applied which should achieve an internal noise level where a window is adequately opened to provide natural ventilation.

6.2.9 Performance Noise – Hall

There is no state or national equivalent guideline for assessing noise emissions from educational facilities such as primary schools and halls associated with schools.

The relevant criterion applicable to the hall is “Offensive Noise” however this is generally based on a subjective assessment.

Acoustic Studio considers the “Intrusive Noise” criteria (as described in the NSW INP) a suitable objective measure to assess offensive noise in relation to the pre-existing background noise level.

Where the intrusive noise is greater than the pre-existing background noise level, the potential exists for disturbance and annoyance. However, the impact is considered marginal if the difference between the pre-existing background noise level and the intrusive noise is 5 dB(A) or less. This concept has resulted in the commonly used criterion of “*background noise level + 5dB*” – applicable between 7.00 am and midnight.

Often the criterion becomes more stringent after midnight, recognising the increased sensitivity of this late night period in residential neighbourhoods. This has resulted in the commonly used criterion of “*background noise level + 0dB*” between midnight and 7.00 am.

As the use of the hall can include amplified music, it is also relevant to consider noise in octave bands.

The Office of Liquor, Gaming and Racing (OLGR) and the City of Sydney (CoS) both apply similar octave band criteria to assess a licenced premises (OLGR) and “Entertainment Use” (CoS).

Whilst the activities of the OSPS do not fall under the authority of the OLGR or the CoS, the assessment methodology recommended by these authorities is considered appropriate for assessment of activities associated with the new hall, as they relate to the perceived intrusiveness of amplified and live music noise.

The OLGR and CoS criteria is defined as follows:

- 7am to 12am (midnight): L_{A10} from the premises (in this case the School Hall activities and events) is not to exceed the existing background noise level by more than 5dB, in any octave band from 31.5 Hz to 8 kHz inclusive.
- 12am (midnight) to 7am: L_{A10} from the premises (in this case the School Hall activities and events) is not to exceed the existing background noise level, in any octave band from 31.5 Hz to 8 kHz inclusive.

Aspects to note regarding the application of the above are:

- A 15-minute measurement period has been adopted for the OLGR limits.
- The existing background noise level has been determined in accordance with the NSW Industrial Noise Policy (INP) 2000. The Day and Evening background noise levels are used to determine environmental noise criteria in accordance with the proposal hours of operation of the School.

Based on the measured noise levels detailed in Section 6, and in accordance with the methodology outlined above, Table 6 details the corresponding limits of allowable noise emissions from performance noise from the hall at the nearest receiver boundaries.

Note: The following criteria only consider the proposed use of the school hall for day and evening periods only. Criteria between 10pm and 7am have not been considered, as the hall will not be used during these times.

Location	Time	Descriptor		Measured sound level, dB re 20 μ Pa									
				Overall dB(A)	Octave band centre frequency ¹ , Hz								
					31.5	63	125	250	500	1k	2k	4k	8k
Residential/ Commercial	Day (7am- 6pm)	Background Noise Level	L ₉₀	47	58	57	51	44	43	43	39	32	23
		Corresponding Project Criteria (OLGR/CoS)	$L_{10} \leq L_{90} + 5\text{dB}$	52	63	62	56	49	48	48	44	37	28
	Evening (6pm- 10pm)	Background Noise Level	L ₉₀	46	57	56	50	43	42	42	38	31	22
		Corresponding Project Criteria (OLGR/CoS) ²	$L_{10} \leq L_{90} + 5\text{dB}$	53	64	63	57	50	49	49	45	38	29

Table 6: Hall Performance Noise Criteria based on OLGR and CoS recommendations

7 Traffic Noise Intrusion

Noise from O'Connell Street will be the key traffic noise source affecting the development.

Based on long term unattended and short term attended noise data, a summary of traffic noise levels at O'Connell Street are provided in Table 7.

Location	Traffic Noise Levels, dB(A)			
	Period		Noisiest 1 Hour Period	
	Day Leq, (15 hr)	Night Leq, (9 hr)	Day Leq, (1 hr)	Night Leq, (1 hr)
O'Connell Street Facade	67	63	68	67

Table 7: Day and night traffic noise levels based on attended measurements and logger data

Note: Grey highlights show night period, which is outside school operating hours.

Acoustic Studio has carried out a review of traffic noise impacts with consideration of the following:

- Noise levels are based on measurement data for the worst-case 1-hour noise level
- Internal noise levels for existing buildings and facades are based on measurements carried out within internal spaces on site and are adjusted to consider the long-term noise data from the logger.
- Internal noise levels for new buildings such as the hall are predicted based on levels incident at the façade of each space, which are based on both attended and unattended measurements. The measurements are adjusted to consider site-specific factors such as distance attenuation (building setback), shielding and building reflections.
- Attenuation provided by the building envelope construction, with the weakest elements being:
 - Existing external glazing.
 - The building envelope construction for the new Hall.
- Internal noise levels have been considered (or measured in existing buildings) for two scenarios:
 - Windows closed.
 - Windows opened sufficiently to provide cross ventilation, where it is understood that the open area requirements for natural ventilation (5% of floor area) will be provided along the north and eastern facades facing into the school grounds.

From the assessment Acoustic Studio has identified that achieving internal noise levels in accordance with DG11 will typically require the following:

- Windows to be kept closed where required.
- Windows to be repaired where required to seal any gaps or broken glass.
- Windows in Building D with a line of site to O'Connell Street will require thick secondary glazing with a large air cavity to be detailed so that the relevant criteria is achieved.
- The proposed hall roof will require a construction consisting of metal deck roof, air cavity filled with acoustic insulation and plasterboard ceiling.

Final details and extent of treatments to the façade and roof of relevant buildings will be determined with input from Acoustic Studio at the detailed design stage to ensure the requirements of DG 11 are achieved.

8 Operational Noise Impact Assessment (External Noise Emissions)

8.1 Traffic Noise Generation

Acoustic Studio has considered noise associated with additional traffic generation on streets surrounding the proposed development site.

Following a review of the Traffic Impact Assessment prepared by Thompson Stanbury Associates (ref: *Traffic and Parking Assessment, Proposed Primary School, Marist Place, Parramatta*) we have carried out predictions of the likely increase in noise associated with the traffic noise generation predicted for the development.

Table 4 from the traffic assessment report provides a summary of the existing and projected mid-block traffic volumes during peak periods:

TABLE 4 EXISTING AND PROJECTED LOCAL ROAD MID-BLOCK PEAK HOUR TRAFFIC DEMANDS				
	AM Peak		PM Peak	
	Existing	Projected	Existing	Projected
O'Connell Street (north of Victoria Road)				
Northbound	633	633	677	677
Southbound	952	993	752	773
Total	1585	1626	1429	1450
O'Connell Street (south of Victoria Road)				
Northbound	1179	1179	929	929
Southbound	1266	1342	1156	1212
Total	2445	2521	2085	2141
Victoria Road (east of Marist Place)				
Eastbound	678	678	643	643
Westbound	519	582	592	655
Total	1197	1260	1235	1298
Victoria Road (west of Marist Place)				
Eastbound	614	634	456	477
Westbound	490	546	580	636
Total	1104	1180	1036	1113
Marist Place				
Northbound	318	374	497	553
Southbound	279	363	295	379
Total	597	737	792	932
Marsden Street				
Northbound	460	516	721	777
Southbound	373	373	382	382
Total	833	889	1103	1159
Market Street				
Eastbound	174	258	315	399
Westbound	126	126	158	158
Total	300	384	473	557

Table 8: Traffic Assessment – Projected Traffic Demands

Based on the predicted peak traffic demands, the corresponding noise level increase has been predicted in Table 9 below.

Street	Predicted Noise Level Increase, dB	
	AM Peak	PM Peak
O'Connell Street (north of Victoria Road)		
Northbound	0	0
Southbound	< 1	< 1
O'Connell Street (south of Victoria Road)		
Northbound	0	0
Southbound	< 1	< 1
Victoria Road (east of Marist Place)		
Eastbound	0	0
Westbound	< 1	< 1
Victoria Road (west of Marist Place)		
Eastbound	< 1	< 1
Westbound	< 1	< 1
Marist Place		
Northbound	< 1	< 1
Southbound	< 1	< 1
Marsden Street		
Northbound	< 1	< 1
Southbound	0	0
Market Street		
Eastbound	< 2	< 1
Westbound	0	0

Table 9: Predicted Traffic Noise Increase

Based on the above, the relative increase in traffic noise levels from the proposed development is less than 2 dB and would be barely perceptible resulting in a negligible impact from the development.

8.2 Mechanical Plant

Plant associated with the operation of the proposed O'Connell Street Primary School should be controlled to ensure external noise emissions are not intrusive and do not impact on the amenity of neighbouring receivers with the relevant criteria in Section 6 of this report.

At this stage, final plant selections have not been made; therefore a detailed assessment has not been carried out. Any new items of plant will be reviewed to ensure that noise emissions meet the applicable environmental noise criteria.

In the absence of preliminary plant noise data or final locations, Acoustic Studio makes the following general comments:

- Air conditioning is proposed for some buildings.
- The nearest potentially affected receivers are the recently approved residential and commercial buildings adjacent to the north.
- The plant will operate during normal school hours and potentially operate into the evening period, to accommodate extra-curricular school activities, and maintenance and cleaning.
- The most restrictive criterion for the plant operating up to 10pm is 44 dB(A) at the nearest residential receivers. Achieving this criterion will ensure compliance with the relevant criteria at all other receivers.
- Plant will generally be switched off at night (10pm to 7am). If not, the most restrictive night time criterion of 40dB(A) shall apply at the nearest residential receivers.
- Enclosure, attenuation and / or internally lined ductwork may be required for fans in order to meet both the internal and environmental noise criteria.

During the detailed design stage, Acoustic Studio will provide detailed design advice to the architect and mechanical engineer to ensure that noise emissions from mechanical plant are effectively controlled to meet the relevant criteria at the nearest receiver boundaries.

Noise emissions from general maintenance and cleaning activities may need management controls such as time restrictions particularly for external area maintenance activities, and keeping doors and windows closed during internal maintenance at more sensitive early morning and late evening hours.

General design considerations and controls that may need to be implemented typically include, but are not limited to:

- Strategic selection and location of plant to ensure the cumulative noise contribution at the receiver boundary is achieved, and/or
- Noise control measures to be put in place to minimise noise impacts such as:
 - Noise enclosures as required
 - Noise barriers as required
 - Acoustic louvres as required
 - In-duct attenuation

8.3 Hall Use

The hall will be used for typical school activities and after school care including after hours events.

Acoustic Studio has carried out a preliminary assessment of noise emissions associated with the use of the hall for a school performance with amplified music as a worst case noise generating event.

8.3.10 Assessment methodology

The acoustic assessment has considered the following:

- Use of the hall will typically occur during school hours with extra curricular activities that may occur into the evening period. Therefore the assessment considers the worst-case evening criteria.
- Noise levels from the use are considered over a worst case – 15-minute period.
- The assessment considers the worst-case (closest noise sensitive) proposed residential noise receiver development adjacent to the site to the north at a distance of 90m from the closest point of the proposed hall. Compliance at this location will result in compliance at all other locations.
- The assessment considers a diffuse reverberant field breaking out thorough the weakest building elements, namely the roof.
- Acoustic performance of the building envelope is based on the required constructions to control traffic noise intrusion, which is noted to be the determining factor in the acoustic design for the hall.
- The assessment considers distance attenuation, shielding and reflections plus directivity.

8.3.11 Source Noise Levels

Amplified Sound

Description	Sound pressure level, dB re 20µPa									
	Overall dB(A)	Octave band centre frequency, Hz								
		31.5	63	125	250	500	1k	2k	4k	8k
Reverberant noise level from school performance with amplified sound	95	66	94	91	93	93	91	84	76	68

Table 10: Amplified music source noise level

8.3.12 Noise Emission Predictions

Calculation	Sound pressure level, dB re 20µPa									
	Octave band centre frequency, Hz									
	31.5	63	125	250	500	1k	2k	4k	8k	
Reverberant noise level from school performance with amplified sound	66	94	91	93	93	91	84	76	68	
Distance Attenuation / Building attenuation / shielding / reflections / directivity	-33	-37	-41	-46	-55	-59	-64	-64	-74	
Resulting level at the residential boundary	33	57	50	47	38	32	20	12	-	
COS/OLGR Criteria - External (6pm to 10pm)	64	63	57	50	49	49	45	38	29	
Complies?	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	

Table 11: Noise assessment at nearest residential receivers from worst case after hours school events within the hall

Based on the predictions detailed above, it is expected that there will be no adverse noise impacts as a results of the use of the hall for school events outside of school hours, and noise emissions are expected to comply with the relevant criteria.

8.4 Offensive Noise

From the preliminary assessment and details provided in the previous sections, we make the following comments with respect to offensive noise.

- The primary noise emissions from the proposed building will be mechanical plant and performance noise associated with the use of the hall.
- Mechanical plant will be selected and noise controls implemented to ensure that the noise emitted is not loud in an absolute sense and not loud relative to the pre-existing ambient and background noise levels that surround the site.

The hall's building envelope acoustic performance requirements are driven by traffic noise intrusion. This in turn limits noise emissions from the use to surrounding noise sensitive receivers so it is not loud in an absolute sense and not loud relative to the pre-existing ambient and background noise levels that surround the site.

- Noise from mechanical plant is generally broadband, and will be controlled so that there are no characteristics that will make it particularly irritating.

There is potential for annoyance from low frequency noise emitted from amplified music however, provided noise emissions are adequately controlled, this should not be intrusiveness or impact on the amenity of surrounding receivers.

- Noise associated with the operation of the new building will be during normal school hours and on occasion may operate for extended periods when out of school activities are carried out (such as use of the hall out of hours). When considering other schools surrounding the site plus the Parramatta Swimming Centre (which would operate a significant number of plant) noise emitted from the proposed OSPS can be considered typical for the area.
- By controlling noise emissions (associated with the operation of the proposed development) in accordance with the relevant criteria, amenity of noise sensitive receivers will be maintained and noise emissions should not be intrusive, therefore it is not expected that people and noise sensitive receivers will be adversely affected by the development.

Based on the comments above, the development is able to satisfy the requirements of the POEO for "Offensive Noise" provided the relevant criteria outlined in Section 6 are achieved.

9 Construction Noise and Vibration Assessment

The following provides a preliminary construction noise and vibration assessment based on an indicative construction description provided by Root Projects and will be developed further once a contractor is appointed to confirm methodology and equipment.

9.1 Relevant codes and standards

In preparing this construction noise and vibration assessment, the following legislation, codes and standards have been found to be relevant for the O'Connell Street Primary School project:

- NSW Department of Environment and Climate Change “Interim Construction Noise Guideline”, 2009.
- NSW Department of Environment and Conservation (DEC) “Assessing Vibration: A Technical Guideline”, 2006
- Australian Standard “AS 2436 : Guide to Noise Control on Construction, Maintenance & Demolition Sites”, 1981
- Australian Standard “AS 1055 : Acoustics – Description and Measurement of Environment Noise”, 1997
- Australian Standard “AS 2670.2 : Evaluation of human exposure to whole-body vibration – Part 2: Continuous and shock-induced vibration in buildings (1 to 80 Hz)”, 1990
- British Standards Institution “BS 6472 – Evaluation of human exposure to vibration in buildings (1 Hz to 80 Hz)”, 1992
- German Institution for Standardisation “DIN 4150.3 : Structural vibration – Effects of vibration on structures”, 1999
- Protection of the Environment Operations Act 1997

9.2 Criteria and limits

9.2.1 Airborne noise

OEH Interim Construction Noise Guideline (OEH ICNG)

The relevant guideline applied for the assessment of construction noise is the Department of Environment and Climate Change⁵ (DECC) NSW, “*Interim Construction Noise Guideline (ICNG), 2009*”. This guideline provides construction noise criteria for Residential, Commercial and Industrial noise receivers as follows.

Residential Receivers

Section 4 of the ICNG provides recommendations for standard hours of work and suggests construction noise management levels that aim to minimise the likelihood of annoyance caused to noise sensitive receivers. These consider both airborne and ground borne noise level impacts.

Table 12 below outlines the methodology for determining construction noise criteria at nearby residential receivers surrounding the development site based on existing background noise levels.

Time of Day	Management level L _{Aeq} (15 min)	How to Apply
Recommended standard hours: Monday to Friday 7 am to 6 pm Saturday 8 am to 1 pm No work on Sundays or public holidays	Noise affected RBL ⁶ + 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 75dB(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: - 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 + 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.

Table 12: Residential construction noise criteria for airborne noise

⁶ The RBL is the overall single figure background dlevel representing each assessment period (day/evening/night) over the whole assessment period. This is the level used for assessment purposes and is further described in the Environmental Protection Authority (EPA) “NSW Industrial Noise Policy, 2000”

Based on the requirements detailed in Table 12 above and the measured data of existing conditions at the site (Section 3), the RBL has been calculated over the relevant periods and the corresponding project specific noise criteria levels for residential airborne noise has been determined. These are detailed in Table 13 below.

Location	Period	Rating Background Level RBL, dB(A)	Criteria L_{eq} (15 min) dBA
Residential Receivers	Recommended Standard Hours	Monday to Friday 7am-6pm	47
		Saturday 8am-1pm	49
	Outside Recommended Standard Hours	Saturday 1pm-6pm	49
			RBL + 10
			57
			59
			RBL + 5
			54

Table 13: Project specific residential noise criteria for airborne noise

Other Sensitive Land Uses

OEH's "Interim Construction Noise Guideline" suggests construction noise management levels for other sensitive land uses surrounding construction sites. They are as follows:

- Offices, retail outlets: $L_{Aeq,15min}$ 70dBA (external)
- Classrooms: $L_{Aeq,15min}$ 45dBA (internal)
- Places of Worship: $L_{Aeq,15min}$ 45dBA (internal)
- Passive recreation areas: $L_{Aeq,15min}$ 60dBA (external)

Where reference is made to an internal noise level, an external noise level 10 dB above the internal noise levels are applied which should achieve the internal noise level where a window is adequately opened to provide natural ventilation. The NSW Industrial Noise Policy supports this methodology.

9.2.2 Ground-borne noise

The ICNG recommends internal ground-borne noise maximum levels at residences affected by nearby construction activities. Ground-borne noise is noise generated by vibration transmitted through the ground into a structure and can be more noticeable than airborne noise for some sensitive receivers. The ground-borne noise levels presented below from the OEH / EPA ICNG are for residential receivers during evening and night-time periods only, as the objective is to protect the amenity and sleep of people when they are at home.

- Evening: $L_{eq,15min}$ 40 dB(A) (internal)
- Night: $L_{eq,15min}$ 35 dB(A) (internal)

The internal noise levels are assessed at the centre of the most affected habitable room.

9.2.3 Construction Vibration

There are three key items that should be considered in the assessment of vibration impacts from construction works. These include vibration impacts in terms of:

- Human comfort
- Sensitive equipment and processes (where applicable)
- Structural damage

Relevant criteria for each of these are detailed in the sections that follow.

9.2.4 Human Comfort

The Department of Environment and Conservation (DEC) “Assessing Vibration: A Technical Guideline”, (2006) provides suitable criteria that can be applied to the assessment of vibration and human comfort. The guideline makes reference to the British Standard BS 6472: 1992, which shares many similarities to the Australian Standards AS 2670.2: 1990. This guideline presents preferred and maximum vibration values for use in assessing human responses to vibration plus limits for critical areas in hospital buildings, and provides recommendations for measurement and evaluation techniques.

Vibration in buildings can be caused by many different external sources, including industrial, construction and transportation activities. The vibration may be continuous (with magnitudes varying or remaining constant with time), impulsive (such as in shocks) or intermittent (with the magnitude of each event being either constant or varying with time). Vibration in buildings may also occur from internal sources (within a building structure), such as building services and plant. As well as being sensitive to vibration, medical equipment can also be the source of vibration within the building.

Vibration and its associated effects are usually classified as continuous, impulsive or intermittent:

- **Continuous vibration** continues uninterrupted for a defined period (usually throughout daytime and/or night-time). This type of vibration is assessed on the basis of weighted rms acceleration values.
- **Impulsive vibration** is a rapid build up to a peak followed by a damped decay that may or may not involve several cycles of vibration (depending on frequency and damping). It can also consist of a sudden application of several cycles at approximately the same amplitude, providing that the duration is short, typically less than 2 seconds.
- **Intermittent vibration** can be defined as interrupted periods of continuous (e.g. a drill) or repeated periods of impulsive vibration (e.g. a pile driver), or continuous vibration that varies significantly in magnitude. It may originate from impulse sources (e.g. pile drivers and forging presses) or repetitive sources (e.g. pavement breakers), or sources which operate intermittently, but which would produce continuous vibration if operated continuously (for example, intermittent machinery, railway trains and traffic passing by). This type of vibration is assessed on the basis of vibration dose values.

The criterion also considers the type of vibration being assessed, namely continuous, impulsive and intermittent vibration. Examples of these vibration types are provided in **Table 14** below.

Continuous	Impulsive	Intermittent
Machinery, steady road traffic, continuous construction activity (such as tunnel boring machinery).	Infrequent: Activities that create up to 3 distinct vibration events in an assessment period, e.g. occasional dropping of heavy equipment, occasional loading and unloading.	Trains, nearby intermittent construction activity, passing heavy vehicles, forging machines, impact pile driving, jackhammers. Where the number of vibration events in an assessment period is three or fewer this would be assessed against impulsive vibration criteria.

Table 14: Examples of vibration types

The relevant criteria for human exposure to continuous and impulsive vibration are detailed in Table 15. Vibration levels are assessed through the consideration of the summation of effects for vibration levels at frequencies from 1 to 80 Hz for all axes.

Human exposure to intermittent vibration is assessed using the Vibration Dose Value (VDV). The VDV accumulates the vibration energy experienced over an extended period (daytime and night-time periods) from intermittent events. Table 15 sets out the acceptable VDV values for intermittent vibration.

Location	Assessment period	Preferred Values		Maximum Values	
		z-axis	x- and y-axes	z-axis	x- and y-axes
Continuous vibration					
Critical areas	Day or night time	0.10	0.072	0.20	0.14
Residences	Day time	0.20	0.14	0.40	0.28
	Night time	0.14	0.10	0.28	0.2
Offices, schools, educational institutions and places of worship	Day or night time	0.40	0.28	0.80	0.56
Workshops	Day or night time	0.80	0.58	1.6	1.16
Impulsive vibration					
Critical areas	Day or night time	0.10	0.072	0.20	0.14
Residences	Day time	6.0	4.2	12.0	8.4
	Night time	2.0	1.4	4.0	2.8
Offices, schools, educational institutions and places of worship	Day or night time	13.0	9.2	26.0	18.4
Workshops	Day or night time	13.0	9.2	26.0	18.4

Table 15: Preferred and maximum weighted rms values for continuous and impulsive vibration velocity (mm/s) 1-80 Hz

Location	Daytime		Night-time	
	Preferred value	Maximum value	Preferred value	Maximum value
Critical areas	0.10	0.20	0.10	0.20
Residences	0.20	0.40	0.13	0.26
Offices, schools, educational institutions and places of worship	0.40	0.80	0.40	0.80
Workshops	0.80	1.60	0.80	1.60

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

9.2.5 Sensitive Equipment

Neighbouring vibration receivers with sensitive equipment are likely to require a higher degree of vibration isolation than the values outlined in Table 15 and Table 16.

Vibration Criterion (VC) curves are used to provide the basis for the design and protection of highly vibration sensitive equipment. Table 17 details the VC curves applicable to a range of highly sensitive equipment that should be referred to and considered in conjunction with manufacturer guidelines specific to each type of equipment.

Curve	Max Value 8-80Hz	Detail Size	Equipment Types / Requirements
	Microns / sec, rms	Microns	
VC-A	50	8	Bench Microscopes < 400 x Magnification, optical and other precision balances, coordinate measuring machines and optical comparators
VC-B	25	3	Bench Microscopes > 400 x Magnification, microsurgery and neurosurgery
VC-C	12.5	1	Electron Microscopes < 30,000 x magnification, magnetic resonance imagers and microelectronics manufacturing equipment
VC-D	6	0.3	Electron Microscopes > 30,000 x magnification, mass spectrometers and cell impact equipment
VC-E	3	0.1	Un Isolated laser and optical research systems

Table 17: VC Curves for Highly Sensitive Equipment

Figure 4 shows the relationship between criteria for highly sensitive equipment and human exposure criteria shown in Table 15.

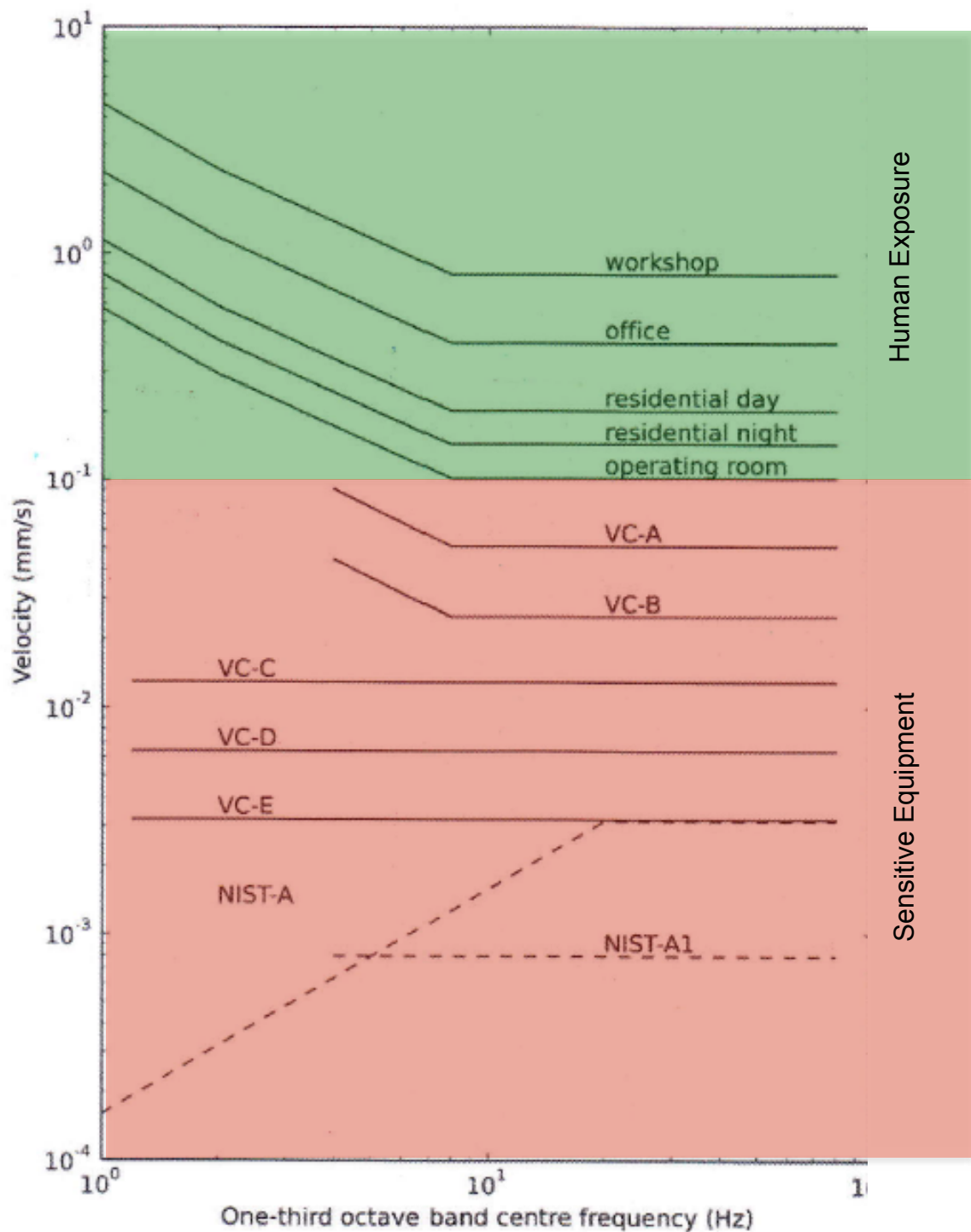


Figure 4: VC Curves - Source: *ANC Guidelines – Measurement and Assessment of Ground-borne Noise & Vibration*, Association of Noise Consultants (2012)

At this stage no structures at or surrounding the site have been identified as having particularly vibration sensitive equipment.

9.2.6 Structural Damage

Criteria to prevent building damage and disruption to equipment and processes are discussed in Appendix C.

Recommended approach to vibration management

The criteria given in Table 15 for Human Comfort shall generally form the limiting vibration criteria for the Project.

It is recommended that a precautionary approach for managing vibration-induced damage be taken for this project, whereby conservative vibration criteria are adopted in the first instance. It would be possible to relax these criteria if required, subject to review of specific buildings by a structural engineer and a regime of vibration monitoring.

The recommended precautionary criteria are:

- 3 mm/s (130 dB re 10^{-6} mm/s) for buildings surrounding the project site identified as “sensitive”, which may include heritage. At this stage no structures at or surrounding the site have been identified as particularly sensitive to vibration-induced damage.
- 5 mm/s (134 dB re 10^{-6} mm/s) for residential dwellings
- 20 mm/s (146 dB re 10^{-6} mm/s) for classrooms, commercial premises

9.3 Construction noise and vibration assessment

9.3.1 Proposed Hours

Proposed construction hours for the project are as follows:

- 7am to 6pm Monday to Friday
- 8am to 3.30pm Saturday

9.3.2 Description of proposed works

The Project Manager has developed a construction program that outlines the key construction activities in each particular location. Based on this, it is anticipated that the key construction activities to occur for each area / stage are as follows:

Stage of Works (Period)	Main Tasks	Itemised Activities ⁷	Typical Plant
Main Works (July 2016 to July 2017)	Internal refurbishment		Angle grinder / jackhammers / hand tools / drills
	Deliveries		Delivery trucks / Hiab trucks / mobile cranes
	Ground excavation		Excavator with bucket and hammer / bobcats / tip trucks / bin lift trucks
	Decontamination Activities		Hand tools
	Construction of new hall and covered structures		Mobile cranes / hand tools / circular saw / cement mixer / drill
	In – Ground Concrete Pours for courts and other areas		Concrete trucks / concrete vibrator / concrete pumps
	External works (Landscaping and footpaths)		Demo saw / excavator / hand tools / drills / angle grinders / hammer drill / mobile crane / concrete truck / concrete vibrator
Note: Items shaded in grey are works to be carried out internally within the building			

Table 18: Proposed Works

⁷ Where applicable

9.3.3 Construction noise and vibration sources

The key construction noise sources for the works occurring during the project and the associated equipment noise levels are listed in **Table 19** below. These values are based on Acoustic Studio's database plus Australian and International Standards.

Equipment Type	Item	Typical Noise Level
		LA10,15min SWL
Heavy Vehicles	Tipper Truck	114
	Bin Lift Truck	114
	Hiab Truck	116
	Delivery trucks (semi-trailers, rigid trucks)	108
	Concrete Mixer trucks	112
Site Machinery	Mobile Crane	111
	Bobcat	113
	Excavator (with rock breaker / rock saw)	119
	Excavator (8 Tonne w/bucket)	108
	Concrete Vibrator	104
	Concrete pump	113
Hand Held Tools	Angle Grinder	104
	Drill	94
	Hammer Drill	107
	Jackhammer	113
	Hand Tools (Electric)	102
	Circular saw	115
	Demo Saw	122

Table 19: Anticipated airborne noise levels for construction noise equipment / plant

Potential sources of vibration and ground-borne noise during the construction works include:

- Demolition and excavation plant including rock-breakers and jack hammers.
- Installation of structure
- Grinding, cutting and drilling of existing building structures.

Vibration and ground-borne noise impacts are likely to be highest during the demolition and excavation stages of the project, when equipment such as rock breakers and jackhammers are used.

9.3.4 Sensitive receivers

Nearest sensitive receivers to the O'Connell Street Primary School site that will be potentially affected by noise and vibration associated with proposed construction are shown in Table 20.

Receiver	Location	Approximate Distance from construction site (closest point)
Residential ⁸	South West	200m
Our Lady of Mercy College	North	80m
Parramatta Swimming Centre	West	40m
Prince Alfred Square	East	40m
Riverside Theatre	East	70m
Commercial ⁸	North East	150m
St Patricks Cathedral	North East	25m

Table 20: Noise sensitive receivers and approximate distance (closest point) to Project site

⁸ It is understood that the approved residential and commercial developments to the north will not be occupied during the construction phase of the OSPS project.

9.3.5 Methodology

A preliminary assessment of the likely noise impacts of the proposed works on the most-affected receivers surrounding the site has been carried out.

The assessment has considered the following:

- Typical construction activities considered in the noise impact assessment are as detailed in Table 18.
- Project specific criteria at each sensitive receiver location as outlined in Section 9.2.
- Noise level predictions are calculated using the noise data provided in Table 19.
- Noise level predictions consider for:
 - Distance attenuation
 - Ground and building reflections
- L_{Aeq} noise levels are predicted for the operations of the nearest construction area on the site to each sensitive residential receiver location.
- The predictions consider a range from individual tasks and associated equipment up to the cumulative noise contribution from all key activities and corresponding equipment with plant running simultaneously for each phase and main task.
- The predictions assume continuous operation of equipment / plant over the 15-minute assessment period.
- For the purposes of this assessment, predictions have only been undertaken for worst-case external activities to be carried out at the site. Continuous construction noise associated is expected to comply with stated criteria for nearest residential and educational receivers when these activities occur indoors.

9.3.6 Noise assessment results

The following section presents the results of the preliminary noise assessment carried out for external construction works scheduled for the project.

This construction noise assessment determines the potential noise impact of activities and associated plant and equipment at the most affected receivers.

Table 21 below presents the predicted construction noise levels at the nearest affected locations, with comparison against the relevant criteria.

Location and Construction Activity	Predicted equipment noise level, in dBL _{A10,15min}						
	Residential	Our Lady of Mercy College	Parramatta Swimming Centre	Prince Alfred Square	Riverside Theatre	Commercial	St Patricks Cathedral
Main Works							
Deliveries	51 to 63	59 to 71	65 to 77	65 to 77	60 to 72	54 to 65	69 to 81
Ground Excavation	51 to 65	59 to 73	65 to 79	65 to 79	60 to 74	54 to 68	69 to 83
Decontamination Activities	43 to 48	51 to 56	57 to 62	57 to 62	52 to 57	46 to 51	60 to 65
Construction of new hall and covered structures	37 to 58	45 to 66	51 to 72	51 to 72	46 to 67	40 to 60	55 to 76
In-ground concrete pours for courts and other areas	50 to 59	58 to 67	64 to 73	64 to 73	59 to 68	53 to 61	77 to 88
External walls	50 to 66	58 to 74	64 to 80	64 to 80	59 to 75	52 to 69	68 to 84

Table 21: Predicted equipment/plant noise levels at nearest sensitive residential and educational receiver locations – Levels predicted to exceed the worst case criteria are in red

There will be times / situations when demolition and new-build works are likely to exceed stated criteria, particularly when works occur in the areas closer to sensitive receivers (St Patricks Cathedral).

For each of these activities and assuming that, in fact, these activities are found to exceed the noise criteria, then the noise control measures in 9.4.1 shall be considered and implemented wherever reasonable and feasible. In addition, the construction best practices

presented in Section 9.4.4 shall be considered to minimise the noise impacts on the neighbourhood.

9.4 Control elements

9.4.1 Noise

As a general rule, prevention should be applied as universal work practice at any time of day, but especially for the occasional construction works to be undertaken at critical times outside normal daytime/weekday periods.

It is noted that the reduction of noise at the source and the control of the transmission path between the construction site and the receiver(s) are the preferred options for noise minimisation. Providing treatments at the affected residences or other sensitive land uses should only be considered as a last resort. Construction noise shall be managed by implementing the strategies listed below:

- Plant and equipment
 - Use quieter methods.
 - Use quieter equipment.
 - Operate plant in a quiet and effective manner.
 - Where appropriate, limit the operating noise of equipment.
 - Maintain equipment regularly.
 - Where appropriate, obtain acoustic test certificates for equipment.
- On site noise management
 - Strategically locate equipment and plant.
 - Avoid the use of reversing alarms or provide for alternative systems.
 - Maximise shielding in the form of existing structures or temporary barriers.
 - Schedule the construction of barriers and structures so they can be used as early as possible.
- Consultation, notification and complaints handling
 - Provide information to neighbours before and during construction.
 - Maintain good communication between the community and Project staff.
 - Have a documented complaints process and keep register of any complaints.
 - Give complaints a fair hearing and provide for a quick response.
 - Implement all feasible and reasonable measures to address the source of complaint.
- Work scheduling
 - Schedule activities to minimise noise impacts.
 - Ensure periods of respite are provided in the case of unavoidable maximum noise levels events.

- Keep truck drivers informed of designated routes, parking locations and delivery hours.

9.4.2 Vibration

At this stage, we anticipate that construction works will result in no adverse vibration impacts at surrounding receivers.

The Contractor shall carry out a preliminary vibration assessment at the commencement of operations for each vibration generating to determine whether the existence of significant vibration levels justifies a more detailed investigation.

A more detailed investigation will involve methods of constraining activities generating high vibration levels. A method of monitoring vibration levels will then need to be put in place. Vibration mitigation measures and a review of vibration criteria may then be necessary.

All practical means should be used to minimise impacts on the affected buildings and occupants from activities generating significant levels of vibration on site.

The following considerations shall be taken into account:

- Modifications to construction equipment used.
- Modifications to methods of construction.
- Rescheduling of activities to less sensitive times.

If the measures given above cannot be implemented or have no effect on vibration levels or impact generated, a review of the vibration criteria should be undertaken and the vibration management strategy amended.

9.4.3 Vibration surveys

Since the actual vibration levels experienced will be dependent upon the site characteristics and the specific equipment being used, early vibration level checks should be carried out on site at the outset of each key vibration generating activity (if vibration is considered to be an issue).

Shortly before the commencement of each activity the background vibration level could be measured and again once the activity has begun. If the survey indicates levels of vibration exceeding those expected, the vibration management strategy for that process could be re-assessed.

9.4.4 Additional noise and vibration control measures

If, during construction, an item of equipment exceeds either the noise criteria at any location or the equipment noise level limits, the following noise control measures, together

with construction best practices presented in Section 9.4.1, shall be considered to minimise the noise impacts on the neighbourhood.

- Schedule noisy activities to occur outside of the most sensitive times of the day for each nominated receiver. For example, residential receivers are likely to be more sensitive to noise before 9 am than the commercial receivers.
- Consider implementing equipment-specific screening or other noise control measures recommended in Appendix E of AS2436.
- Limit the number of trucks on site at the commencement of site activities to the minimum required by the loading facilities on site.
- When loading trucks, adopt best practice noise management strategies to avoid materials being dropped from height into dump trucks.
- Avoid unnecessary idling of trucks and equipment.
- Ensure that any miscellaneous equipment (extraction fans, hand tools, etc.) not specifically identified in this plan incorporates silencing/shielding equipment as required to meet the noise criteria.

Implementation of all reasonable and feasible mitigation measures for all internal and underground works will ensure that any adverse noise impacts to surrounding residential, commercial and recreational receivers are minimised when noise goals cannot be met due to safety or space constraints.

9.5 Noise and vibration monitoring

9.5.1 Noise monitoring

The Contractor should consider implementing environmental noise monitoring at the locations described below.

- The boundary of the construction site at the closest receiver (St Patricks Cathedral)

An allowance of 1.5 days per week, at least, should be dedicated to monitoring of noise and vibration for the first four weeks of demolition and construction. Further monitoring should be reviewed after this time or sooner should it be deemed necessary by the Acoustic Consultant and the Project Manager. This should take place mainly at the above locations although other locations and plant and equipment monitoring should take place as and when necessary. If results indicate vibration levels exceeding allowable limits appropriate action should be taken.

9.5.2 Vibration monitoring

A vibration monitoring system could be implemented. This system would monitor vibration levels when there is potential for them to change. This could happen in various situations, such as, changes in equipment and activities or changes to work procedures that

might affect existing vibration control measures. The monitoring procedure would be carried out with appropriate equipment so that results obtained are readily comparable with results obtained earlier. If results indicate vibration levels exceeding allowable limits appropriate action should be taken.

9.5.3 Reporting

The Contractor should prepare a noise monitoring report each month for review by the Project Manager. The reports should summarise and interpret the results of the noise and vibration monitoring carried out during the past month.

9.6 Communication and complaints

The Contractor should establish a communications register for recording incoming complaints. The registration of a particular item will remain open until the complaint has been appropriately dealt with.

In addition the following procedures are an example of the procedures that should be specifically adopted for complaints relating to noise.

Upon receipt of a complaint The Contractor should:

- Try to ascertain from the complaint which appliance is causing the problem i.e. inside or outside the site and in what position.
- Establish from the monitoring equipment if the allowable noise levels have been complied with.
- Establish if the appliance positioning has previously been highlighted as a problem area. If not and the noise levels are above the allowable limit, then the equipment and its position shall be noted.
- Move machinery if the allowable levels have been exceeded or take other acoustic remedial action.

If the activity is occurring outside normal working hours, the activity should be immediately stopped. Where stopping the activity would create a safety issue the activity may be permitted to continue only as long as is necessary to make the area safe. The activity should then cease.

Any activity which is directed to cease due to excessive noise should not recommence until the Project Manager is satisfied that the noise and vibration limits requirements can be met and has given permission to recommence the activity.

The Site Supervisor should ensure that a report of any incident is provided to the Project Manager.

The Project Manager should provide a report on the incident to the relevant stakeholders.

The Contractor should provide a 24 hour telephone contact number and this number should be prominently displayed on the site.

9.7 Non-compliances

Non-compliance reports can be used as appropriate to deal with failures to meet the construction vibration management and control requirements.

10 Summary and Conclusions

A noise and vibration assessment report has been produced to establish the potential impacts of operational noise plus construction noise for the proposed O'Connell Street Primary School development at the Old Kings School site.

The existing noise environment has been established based on long-term and short-term monitoring data.

Appropriate criteria for both noise and vibration have been established based on relevant guidelines and standards.

A summary of the outcomes and recommendations of this noise and vibration assessment are as follows:

- Traffic Noise Intrusion

Traffic noise intrusion to classrooms and the new Hall have been assessed to ensure that levels will meet applicable criteria for educational buildings.

Recommendations for controls have been provided where required to achieve the relevant criteria.

- Operational Noise Impact

Traffic Noise Generation

The relative increase in traffic noise levels from the proposed development is less than 2 dB and would be barely perceptible resulting in a negligible impact from the development.

Mechanical Plant

At this stage, final plant selections have not been made; therefore a detailed assessment has not been carried out. Any new items of plant will be reviewed to ensure that noise emissions meet the applicable environmental noise criteria.

During the detailed design stage, the acoustic consultant shall provide detailed design advice to the architect and mechanical engineer to ensure that noise emissions from mechanical plant are effectively controlled to meet the relevant criteria at the nearest receiver boundaries.

Multipurpose Hall

There are no adverse noise impacts expected as a result of the use of the hall for school events outside of school hours, and noise emissions are expected to comply with the relevant criteria.

- Construction Noise

There will be times / situations when demolition and new-build works are likely to exceed stated criteria, particularly when works occur in the areas closer to sensitive receivers

If, during construction works, an item of equipment exceeds the stated airborne noise criteria at any sensitive location, the additional noise control measures presented in Section 9.4.4, together with construction best practices presented in Section 9.4.1, shall be considered to minimise the noise impacts on the neighbourhood.

- Construction Vibration

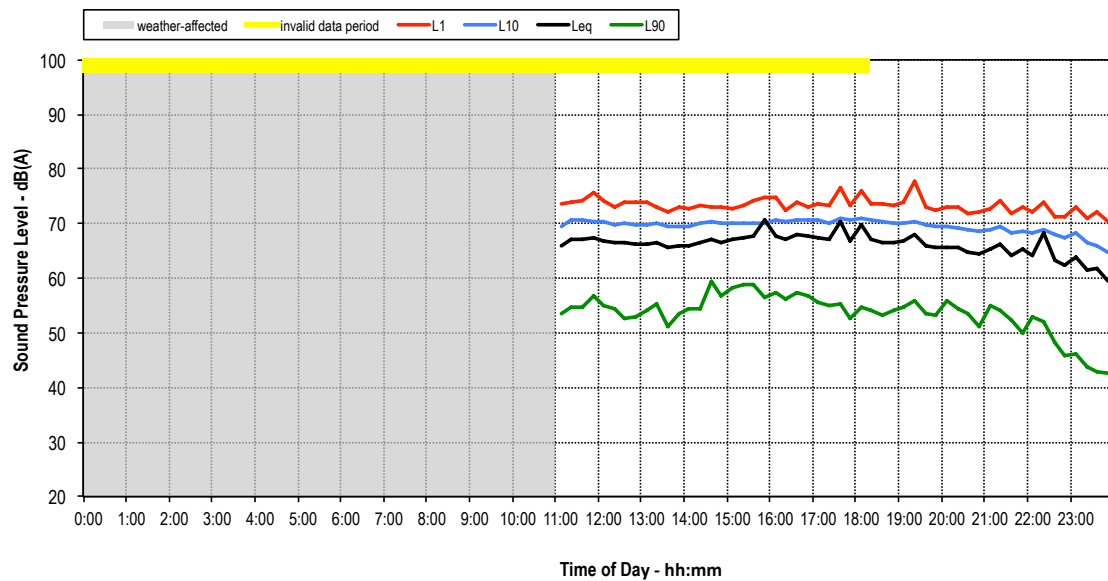
At this stage, we anticipate that construction works will result in no adverse vibration impacts at surrounding receivers.

The Contractor shall carry out a preliminary vibration assessment at the commencement of operations for each vibration generating activity to determine whether the existence of significant vibration levels justifies a more detailed investigation.

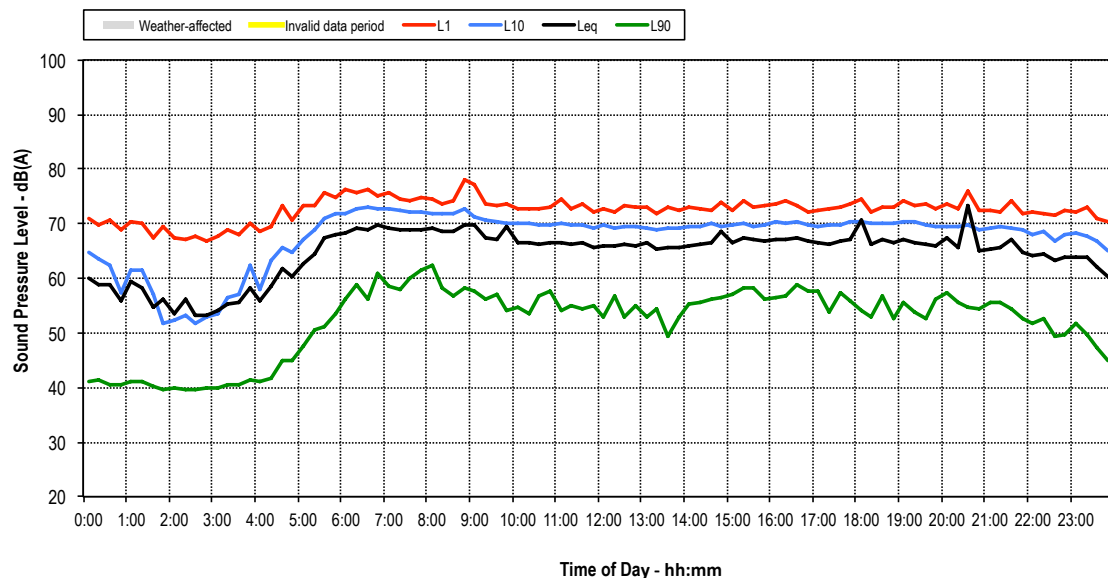
Appendix A : Noise Logger Data

Location 1 - O'Connell St Traffic Noise Logger

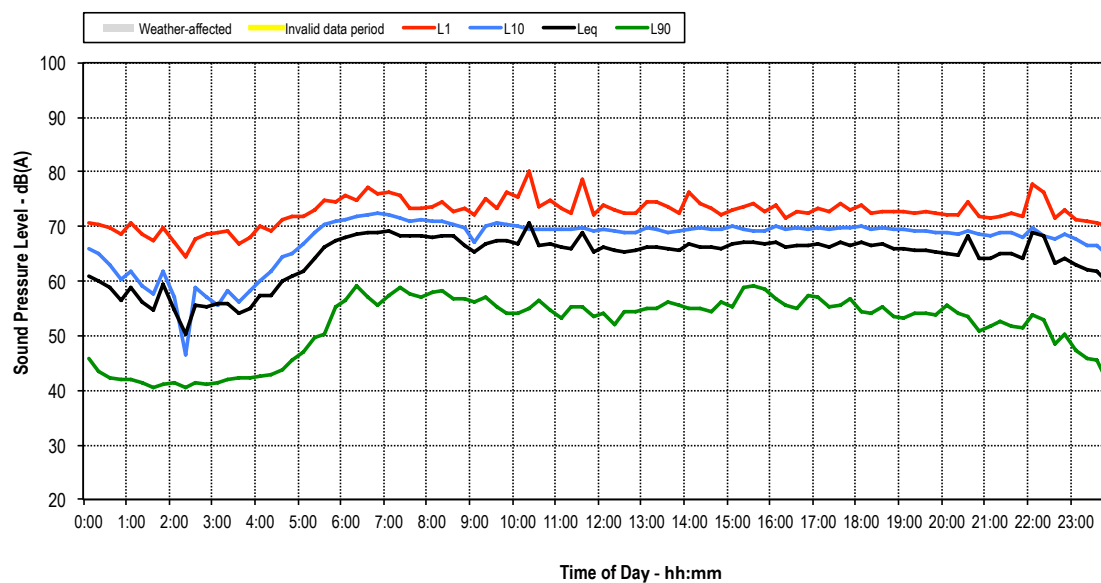
OSPS Location 1 - Monday 16 November 2015



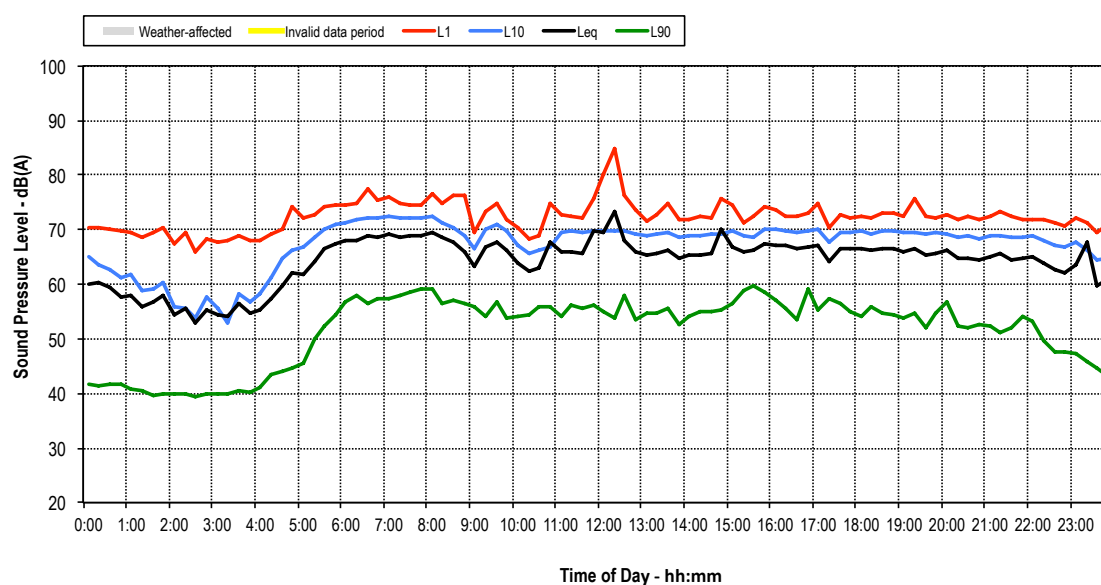
OSPS Location 1 - Tuesday 17 November 2015



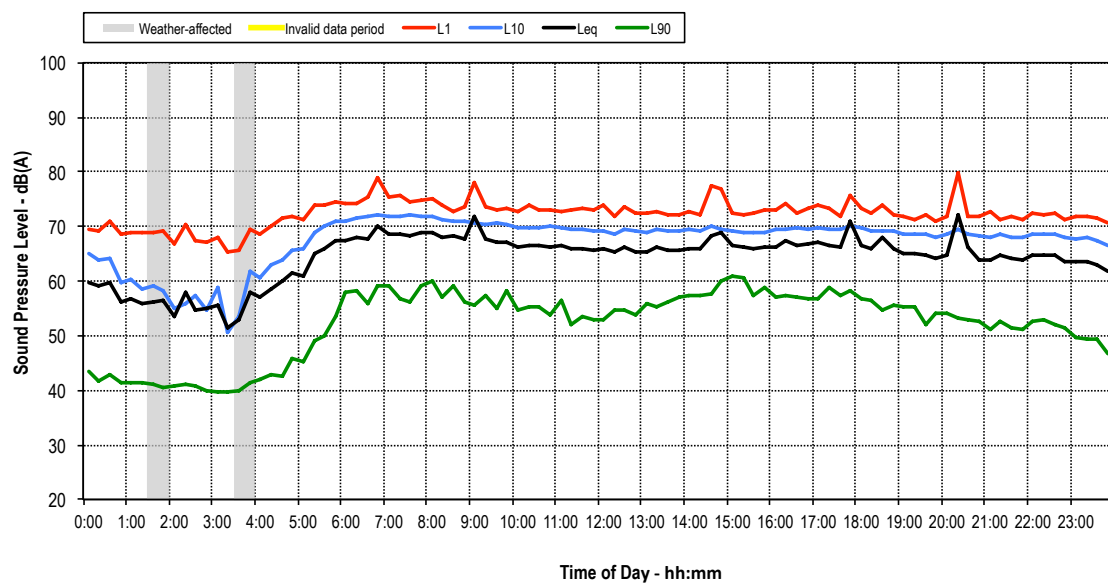
OSPS Location 1 - Wednesday 18 November 2015



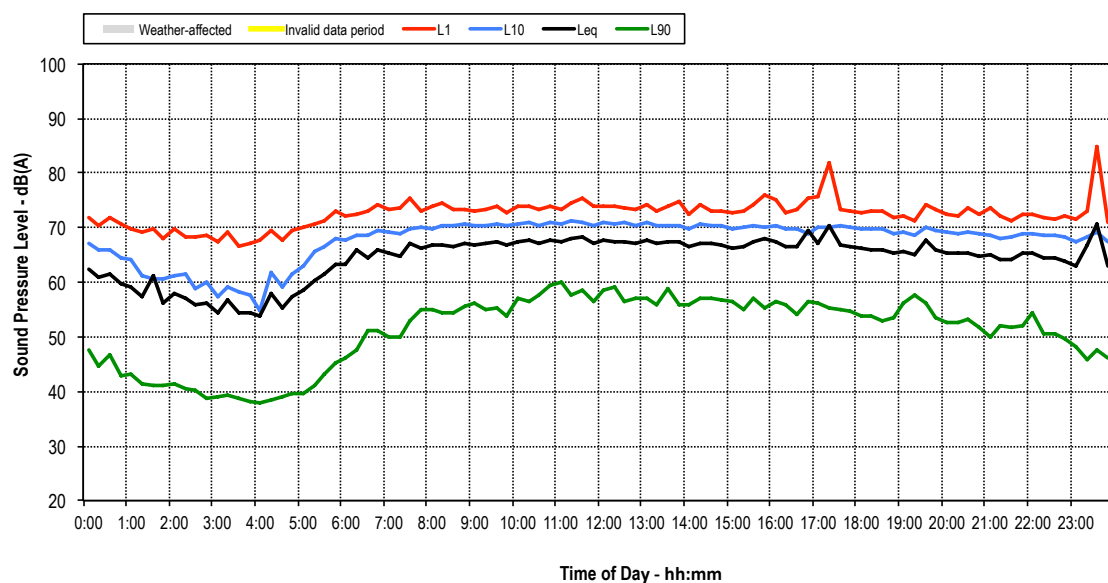
OSPS Location 1 - Thursday 19 November 2015



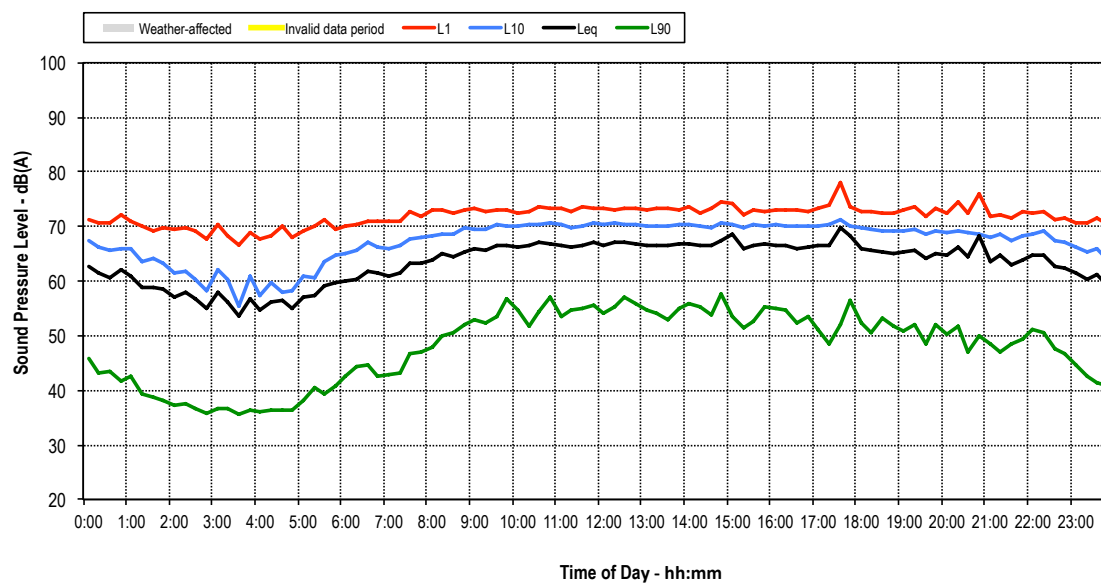
OSPS Location 1 - Friday 20 November 2015



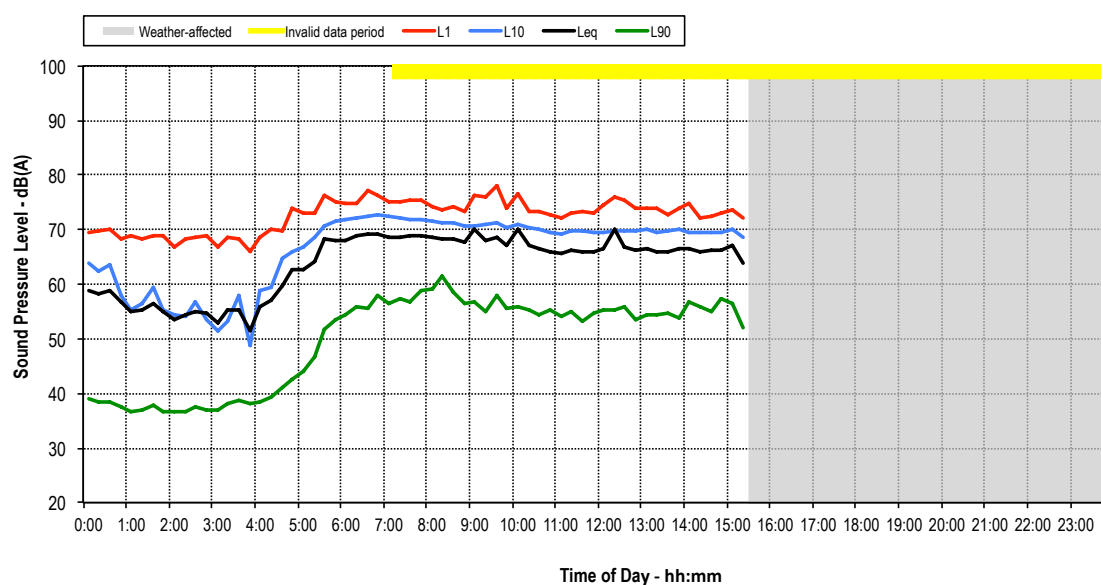
OSPS Location 1 - Saturday 21 November 2015



OSPS Location 1 - Sunday 22 November 2015

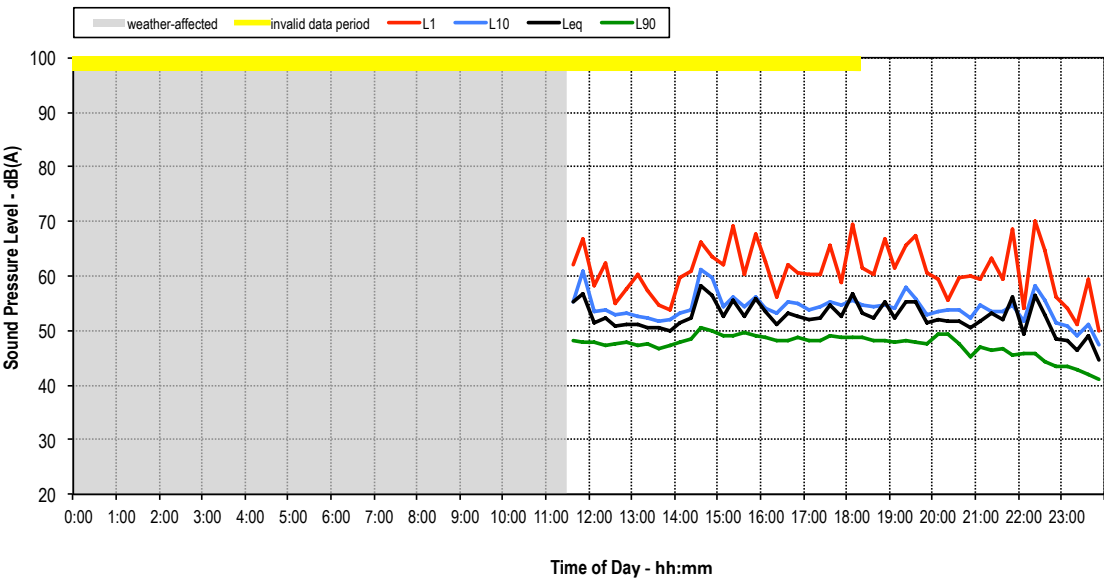


OSPS Location 1 - Monday 23 November 2015

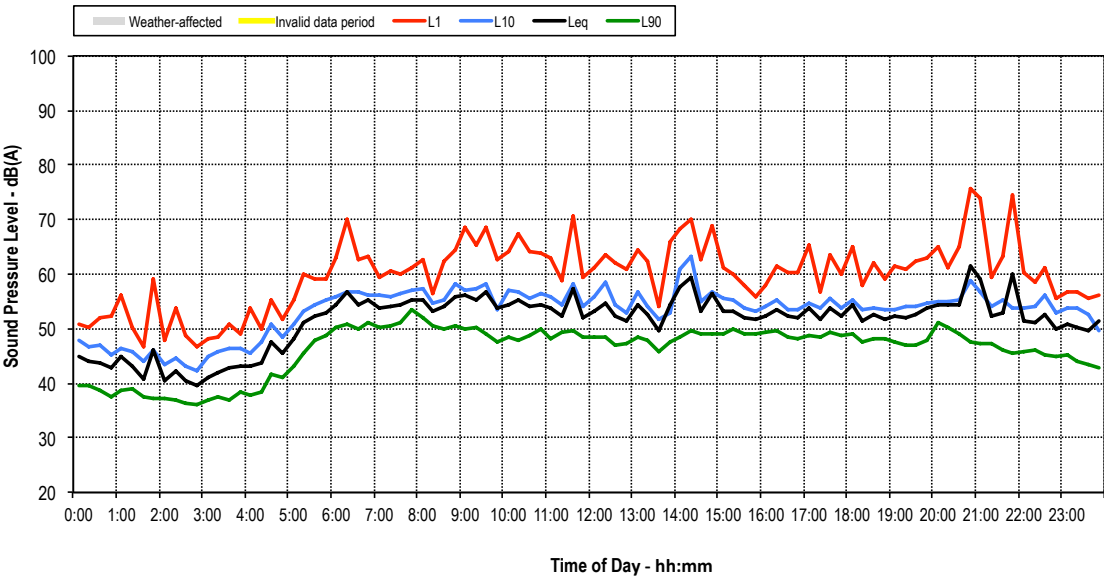


Location 2 – Background Noise Logger

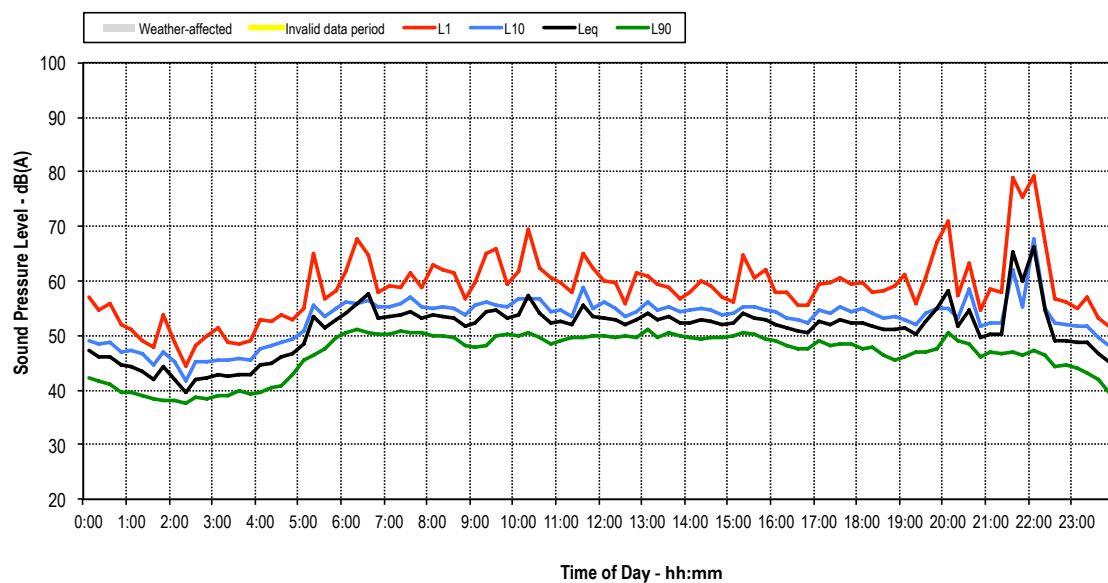
OSPS - Location 2 - Monday 16 November 2015



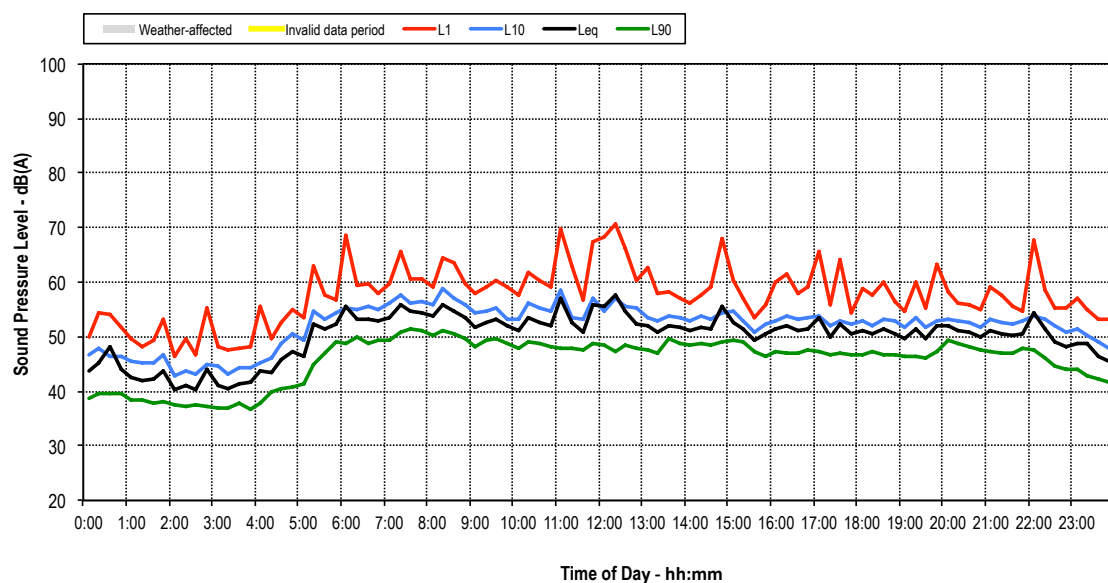
OSPS - Location 2 - Tuesday 17 November 2015



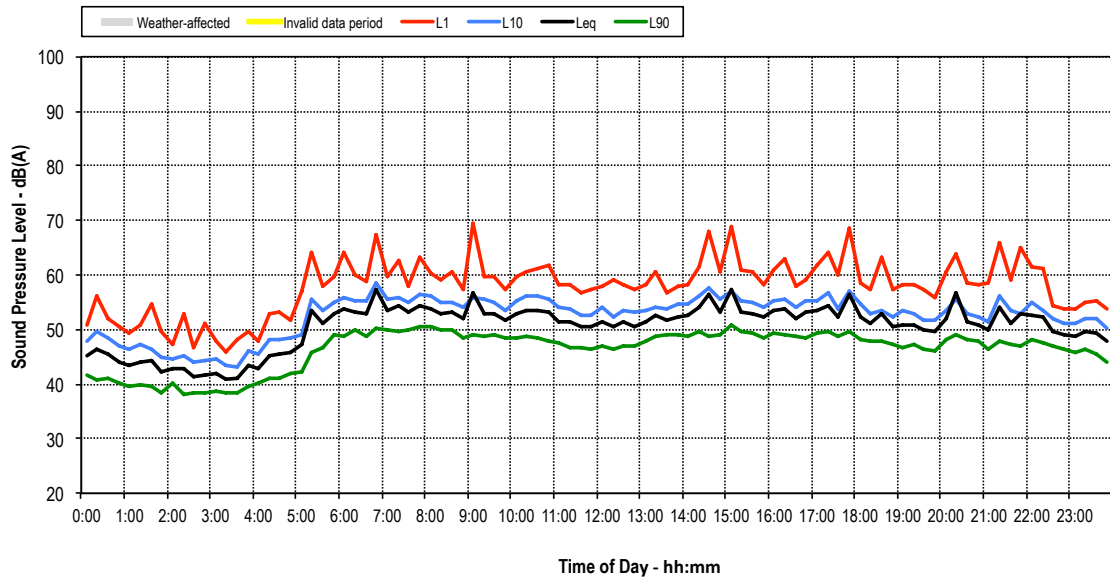
OSPS - Location 2 - Wednesday 18 November 2015



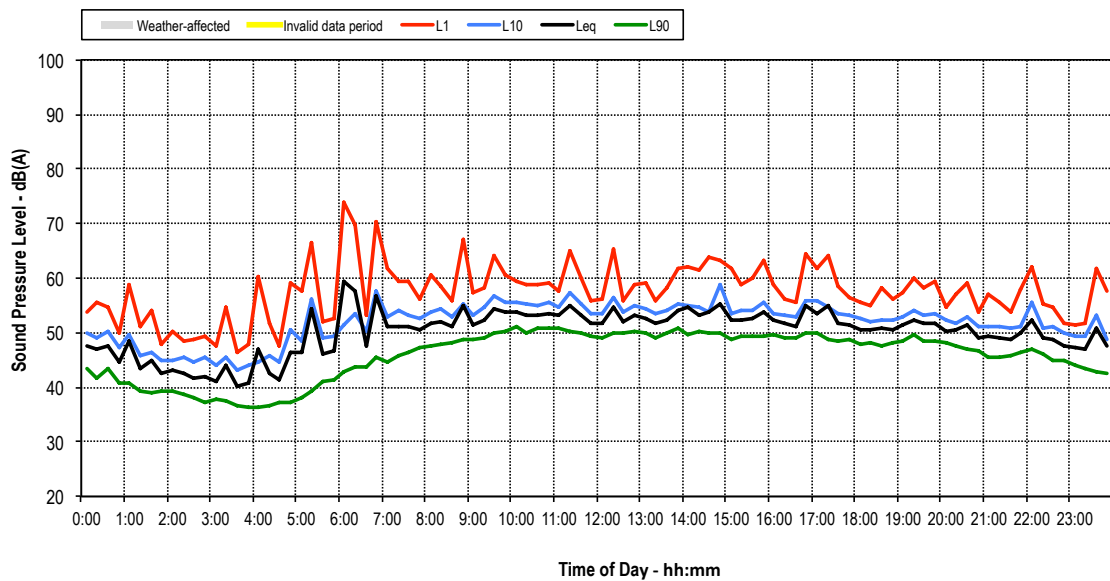
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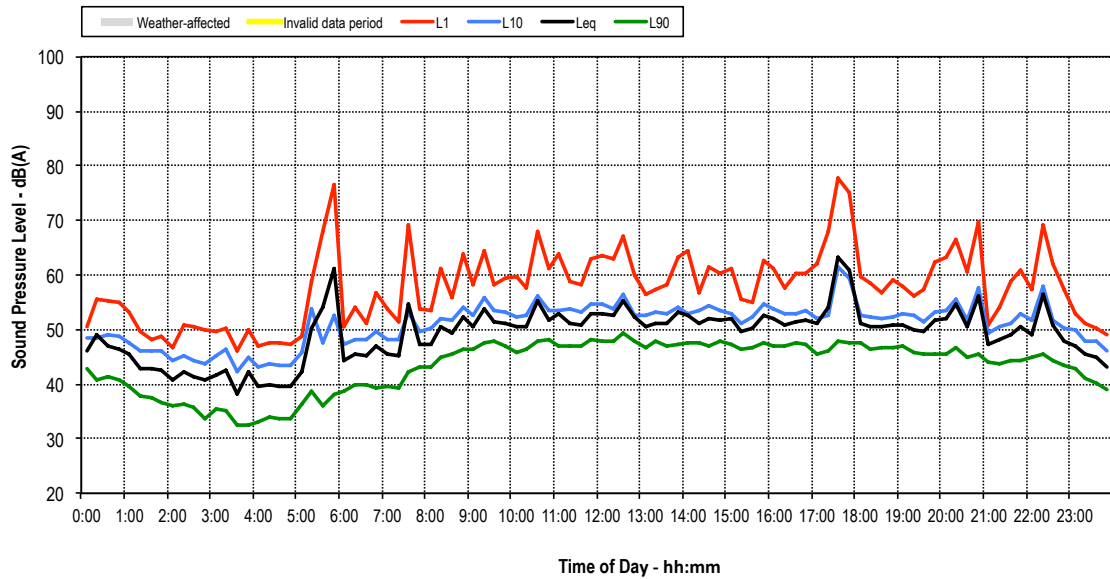
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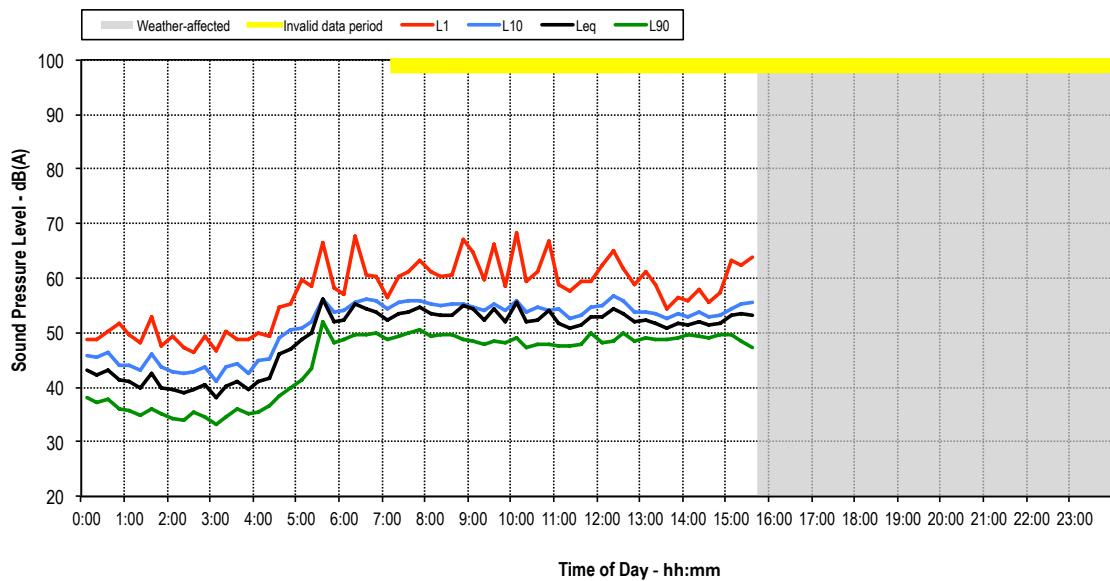
OSPS - Location 2 - Saturday 21 November 2015



OSPS - Location 2 - Sunday 22 November 2015



OSPS - Location 2 - Monday 23 November 2015



Appendix B : Derivation of Environmental Noise Break-out Limits (NSW INP)

The NSW INP sets two separate noise criteria to meet environmental noise objectives: one to account for intrusive noise and the other to protect the amenity of particular land uses. Both are used to derive the project specific noise level.

Assessing intrusiveness

The intrusiveness criterion essentially means that the equivalent continuous noise level of the source should not be more than 5 dB above the measured existing background noise level.

Assessing amenity

The amenity assessment is based on noise criteria specific to land use and associated activities. The criteria relate only to industrial-type noise, including plant. The existing noise level from industry (or plant) is measured - if it approaches the criterion value, then the noise levels from new plant need to be designed so that the cumulative effect does not produce noise levels that would significantly exceed the criterion.

The cumulative effect of noise from all industrial or plant sources is considered in assessing impact.

Project specific noise level

For the new roof plant, the more stringent of the intrusive and the amenity criteria sets the project specific noise level.

The derivation of the project specific noise levels is provided below.

B.1 Existing Background and Ambient Noise Levels

The rating background level (RBL) has been determined from $L_{A90,15min}$ measured during the long-term noise survey in accordance with the methodology prescribed in NSW INP.

Three time periods are considered (consistent with the operating times of the plant associated with the development and the time of day classifications in the Policy):

- Day - 7 am to 6 pm
- Evening - 6 pm to 10 pm
- Night - 10 pm to 7 am

From the noise logged data presented in Appendix A, the calculated RBL's and measured ambient noise levels are shown below in Table B1.

Location	L ₉₀ Background Noise Levels, dB(A)			L _{eq} Ambient Noise Levels, dB(A)		
	Day 7am-6pm	Evening 6pm-10pm	Night 10pm-7am	Day 7am-6pm	Evening 6pm-10pm	Night 10pm-7am
Logger 1 O'Connell Street	54	52	40	67	66	63
Logger 2 Centre of Development Site	47	46	37	53	54	50

Table B1: Long-term background and ambient noise levels measured around the OSPS Site

From observations during our site visit, it is noted that both ambient and background noise levels around the proposed development site is generally dominated by traffic noise around the site.

B.2 Determination of intrusiveness criterion

The intrusiveness criterion is defined as:

$$L_{Aeq,15 \text{ minute}} \leq \text{rating background level plus } 5$$

The intrusiveness criterion has been determined from the RBL's presented in Table B.1 for each period and from the short-term measurements presented in Section 3.3. The intrusiveness criterion is established for residential receivers and in this instance is based on Logger location L2.

- Day Intrusiveness criterion of $47 + 5 = \mathbf{52 \text{ dB(A)}}$
- Evening Intrusiveness criterion of $46 + 5 = \mathbf{51 \text{ dB(A)}}$
- Night Intrusiveness criterion of $37 + 5 = \mathbf{42 \text{ dB(A)}}$

B.3 Determination of amenity criterion

To limit continuing increases in noise levels, the maximum ambient noise levels within an area from industrial noise sources should not normally exceed the acceptable noise levels appropriate for the type of area (e.g. the acceptable noise level in a rural area would be less than that in an urban or industrial area).

Recommended L_{Aeq} noise levels from industrial noise sources within NSW INP

The Acceptable Noise Levels (ANLs) for each land use type under consideration (as detailed in Table 2.1 of the NSW Industrial Noise Policy) are given in Table B2 below.

The nearest residential receivers to the project are considered to be in a Noise Amenity Area characterised by the NSW Industrial Noise Policy as Urban.

Type of Receiver	Period	Recommended $L_{Aeq, period}$ Noise Level (ANL)	
		Acceptable	Recommended Maximum
Residential – Urban (external)	Day	60	65
	Evening	50	55
	Night	45	50
Place of Worship (external)	When in use	50 ⁸	45
Passive Recreation Area	When in use	50	55
Commercial Premises (external)	When in use	65	70
School Classroom (Internal / External)	Noisiest 1-hr period when in use	35 / 45 ⁹	40

Table B2: Recommended L_{Aeq} noise levels from industrial noise sources at residential and commercial receivers

For the purpose of this assessment, “Acceptable” noise levels as presented in the table above are to be adopted.

Existing L_{Aeq} levels

The existing L_{Aeq} levels, determined from the ambient noise level measurements, are as follows:

Type of Receiver	Period	Existing L_{Aeq} Level
Residential – Urban (external)	Day	53
	Evening	54
	Night	50
Commercial / Classroom	When In Use	53 ¹⁰

Table B3: Existing L_{Aeq} Levels for nearest residential receiver location for project

⁹ The NSW INP specifies an internal ANL of 35 and 40 for school classrooms and places of worship respectively. The NSW INP also states that where internal noise levels are specified, external noise 10 dB above internal noise levels can be applied which should achieve an internal noise level where a window is adequately opened to provide natural ventilation.

¹⁰ When considering both day and night

Amenity criterion

The amenity criterion is determined from the relationship of the existing L_{Aeq} noise level from industrial sources and the Acceptable Noise Levels (ANLs) for each land use type under consideration (as detailed in Table 2.1 of the NSW Industrial Noise Policy).

This process is summarised below in Table B4.

Receiver	Period	Existing L_{Aeq} Level	ANL	Adjustment to ANL	Amenity Criterion
Residential	Day	53	60	No Adjustment	60
	Evening	54	50	Existing L_{Aeq} minus 10	44
	Night	50	45	Existing L_{Aeq} minus 10	40
Commercial	When in Use	53	65	No Adjustment	65
Educational	Noisiest 1-hour period	53	45	Existing L_{Aeq} minus 10	43
	When In Use				

Table B4: Determination of amenity criterion for residential receivers

B.4 Project specific noise level

The Project Specific Noise Level is defined as the lower of the intrusiveness and the amenity criteria. On this basis, the Project Specific Noise Levels (PNLs) for new roof plant associated with the site are shown in Table B5 below (PNLs shown shaded in grey).

Type of Receiver	Period	Intrusiveness Criterion	Amenity Criterion
Residential – Urban (external)	Day	52	60
	Evening	51	44
	Night	42	40
Commercial (external)	When in use	-	65
Classroom (Internal)	Noisiest 1-hr period when in use	-	33

Table B5: Determination of project specific noise levels for O'Connell Street Primary School

Appendix C : Building damage vibration criteria

There is little reliable data on the threshold of vibration-induced damage in buildings. Although vibrations induced in buildings by ground-borne excitation are often noticeable, there is little evidence that they produce even cosmetic damage. This lack of data is one of the reasons that there is variation between international standards, why the British Standards Institution (BSI) did not provide guidance before 1992 and why there are still no International Organisation for Standardisation (ISO) guidance limits.

There are however several standards that can be referred to.

German Standard

The relevant German standard is DIN 4150: Part 3: 19862. This standard gives guidelines for short-term and steady state structural vibration. For short-term vibration in buildings the following limits are given:

Structural type	Vibration Velocity, v_i , in mm/s			
	Foundation			Plane of floor of uppermost full storey
	less than 10Hz	10 to 50 Hz	50 to 100 Hz	Frequency mixture
Commercial, Industrial or Similar	20	20 to 40	40 to 50	40
Dwellings or Similar	5	5 to 15	15 to 20	15
Particularly Sensitive	3	3 to 8	8 to 10	8

Table C1: Guideline Values of Vibration Velocity, v_i , for Evaluating the Effects of Short-term Vibration

The guidelines state that:

Experience to date has shown that, provided the values given in Table D2 are observed, damage due to vibration, in terms of a reduction in utility value, is unlikely to occur. If the values of table D2 are exceeded, it does not necessarily follow that damage will occur. Should these values be significantly exceeded, further investigation is necessary.

Swiss Standard

The relevant Swiss standard is SN 640 312:1978. For steady state vibration, form machines, traffic and construction in buildings the following limits are given:

Structural type	Vibration Velocity, v_i , in mm/s	
	Foundation	
	10 to 30Hz	30 to 60Hz
Commercial, Industrial including retaining walls	12	12 to 18
Foundation walls and floors in concrete or masonry. Retaining walls and ashlar construction	8	8 to 12
Foundations and basement floors concrete, with wooden beams on upper floors. Brick walls.	5	5 to 8
Particularly sensitive	3	3 to 5

Table C2: Guideline Values of Vibration Velocity, v_i , for Evaluating the Effects of Steady State Vibration

British Standard

The relevant standard is BS7385: Part 2: 1993¹¹. This standard was developed from an extensive review of UK data, relevant national and international documents and other published data, which yielded very few cases of vibration-induced damage. This standard contains the most up-to-date research on vibration damage in structures. Part 2 of the standard gives specific guidance on the levels of vibration below which building structures are considered to be at minimal risk.

The Standard proposes the following limits on the foundations of the building:

Structural type	Peak component particle velocity in frequency range of predominant pulse	
	4 Hz to 15 Hz	15Hz and above
Unreinforced or light framed structures	15mm/s @ 4Hz increasing to	20mm/s @ 15Hz increasing to
Residential or light commercial type buildings	20mm/s @ 15Hz	50mm/s @ 40Hz and above

Table C3: Transient Vibration Guide Values for Cosmetic Damage

The standard states in Annex A, that ... *the age and existing condition of a building are factors to consider in assessing the tolerance to vibration. If a building is in a very unstable state, then it will tend to be more vulnerable to the possibility of damage arising*

¹¹ British Standards 7385:1993 Part 2 "Evaluation and Measurement for vibration in Buildings. Guide to damage levels from ground-borne vibration"

from vibration or any other ground-borne disturbance. It is recommended that buildings of importance be considered on a case-by-case basis with detailed engineering analysis being carried out if necessary.

Annex B of the Standard gives a breakdown of data that should be recorded. Included in this are details of the building structure, such as general condition of the structure, list of defects, photographs, details of all major extensions, repairs and renovations. A crack exposure report should be prepared both pre and post exposure, both internally and externally.

Australian Standard

There is no specific Australian Standard referring to structural vibration in buildings. There is however AS 2187.2 - 1993¹², which, in Appendix J, recommends maximum peak particle velocities, measured at the ground surface due to blasting. The lower recommended peak particle velocity is 10 mm/s. The standard states however, that structures that may be particularly susceptible to ground-borne vibration should be examined on an individual basis. It is suggested that in the absence of a particular site-specific study then a maximum peak particle velocity of 5 mm/s is used.

¹²AS 2187.2 - 1993 Explosives - Storage, transport and use. Part 2: Use of explosives