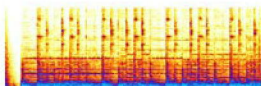


# WALLACIA GOLF COURSE REDEVELOPMENT

## WALLACIA NSW

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

**Issued**  
24 October 2017

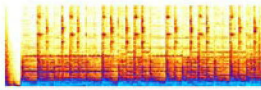


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# Executive Summary

A noise and vibration assessment report has been produced to establish the potential impacts of operational and construction noise for the proposed development.

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 new buildings, including the Chapel and Administration Office, 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*

Based on the traffic generation estimates associated with the proposed development (including internal roads), traffic noise levels in 2027 are predicted to comply with the relevant RNP criteria at the nearest and potentially worst affected receivers.

*Mechanical Plant*

Crematorium furnace and combustion fans have been identified as potential key mechanical noise sources. Typical acoustic treatment of the Crematorium combustion fans has been provided, and preliminary predictions indicate that furnace noise is likely to comply with the relevant criteria at the nearest and potentially worst affected receiver.

Final plant selections of typical building services have not yet been made, therefore, a detailed assessment has not been carried out. Any plant selections 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.

### *Operational use of Chapel*

Based on the predicted noise associated with the typical use of the Chapel, noise emissions are expected to be compliant with the relevant criteria for the day period. Recommendations have been provided in relation to the restriction of Chapel use to between 7am and 6pm.

- 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 9.4.2, 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.

On the basis that the proposed refurbishment of the Wallacia Golf Course clubhouse does not constitute a 'change of use' from current operations, a detailed operational noise assessment has not been carried out. However, should the proposed refurbishment works result in a change to clubhouse operations and use (e.g. patron capacity, sound system design or opening of the facade), then a quantitative noise assessment for impacts to surrounding sensitive receivers may be required.

# 1 Introduction

The Catholic Metropolitan Cemeteries Trust (CMCT) proposes a staged redevelopment of the existing Wallacia Golf Course ('the site'), comprising cemetery and crematorium grounds, approximately 60,000 burial spaces, site buildings and refurbishment of the existing Wallacia Golf Course clubhouse. The project site is situated adjacent to Park Road, Wallacia NSW.

Acoustic Studio has been commissioned by the CMCT to carry out a noise and vibration impact assessment for the construction and operational phase of the proposed redevelopment.

This acoustic assessment has been prepared to accompany the planning application for the proposed development and addresses the submission requirements for Penrith City Council.

The objectives of this assessment are to:

- Identify noise sensitive receivers that will potentially be affected by the operation and construction of the project.
- 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.
- 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 construction and operational noise and vibration assessments of the proposed development. 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 have no negative impact on the nearest existing receivers.

# 2 Project Overview

## 2.1 Description of the proposal

The CMCT proposes to redevelop the existing Wallacia Golf Course, comprising Lot 2 DP110848.

The proposed cemetery and crematorium will 88,000 plots delivered in 3 indicative stages. The following features are proposed for the redevelopment:

- Lawn style cemetery grounds for up to 88,000 burial spaces;
- Refurbishment of the existing Wallachia Golf Course clubhouse, including the player’s lounge and function room;
- Gatehouse at the proposed cemetery grounds entrance on Park Road;
- Chapel with a maximum capacity of 100 visitors in the eastern portion of the site;
- Administration office within the proposed cemetery grounds;
- Crematorium (with furnace facilities) adjacent to the Chapel;
- Ground staff facilities adjacent to the southern boundary of the site;

Figure 1 below provides an aerial view of the site, including lot boundaries and a preliminary road layout.

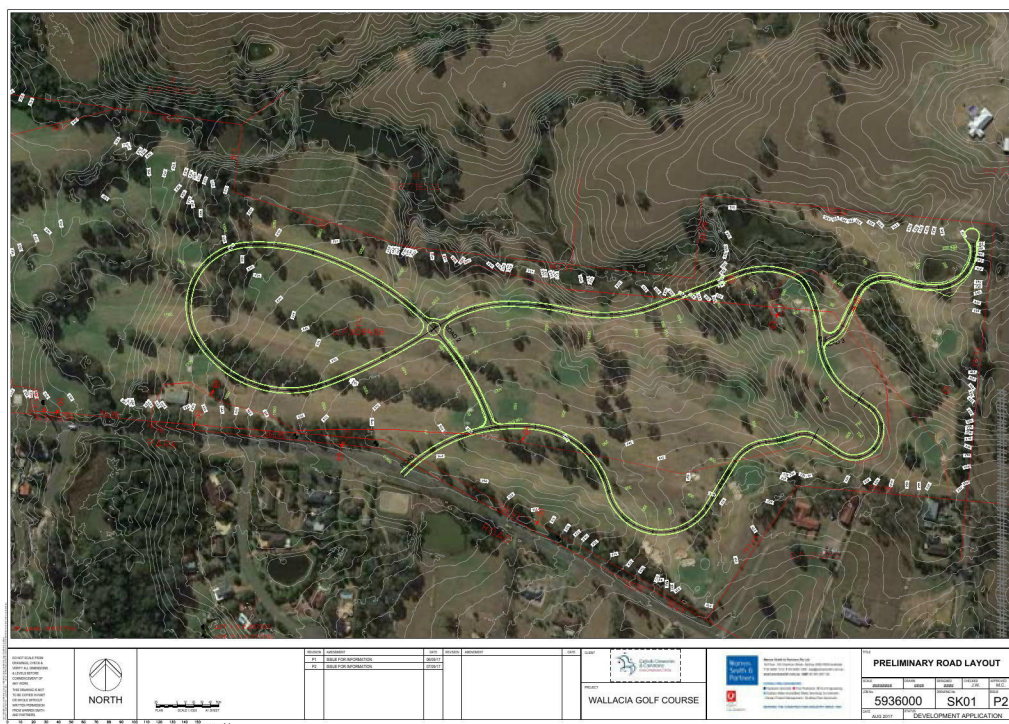


Figure 1: Wallacia Golf Course Redevelopment – Preliminary Road Layout

We understand from CMCT that refurbishment of the of existing Wallacia Golf Course clubhouse does not constitute as a 'change of use'. Operation and use of the refurbished clubhouse will be comparable with or continue as per current, including patron capacity, operating hours, noise sources (e.g. sound system), enclosure of the space (windows and doors open to outside) and building footprint. Based on this, we consider that noise emissions associated with the operational use of the refurbished clubhouse will be no worse than the existing clubhouse and, therefore, are not considered to warrant further assessment.

## **2.2 Opening hours**

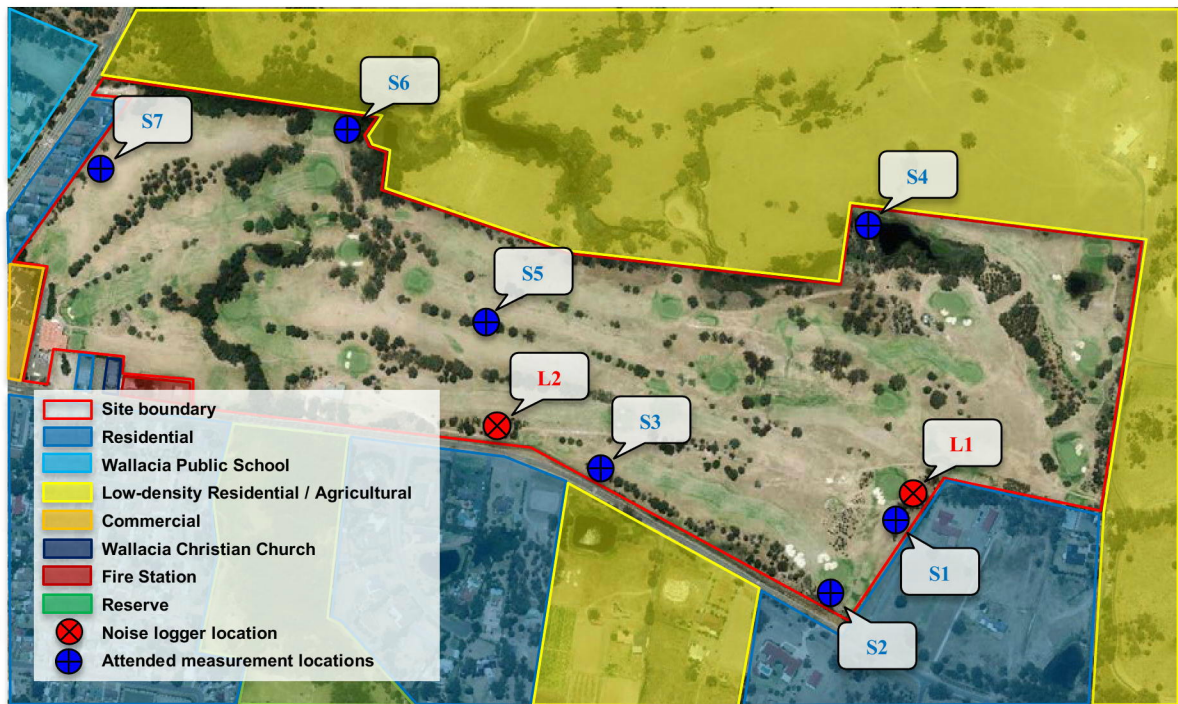
Operating hrs of the cemetery will be 7.00am until 5.00pm mon to Friday and 7.00am until 12.00pm on a Saturday.

For visitation, opening and closing hours will be within sunrise to sunset seven days a week.



## 2.3 Site details

The site is approximately 45 hectares (ha), and is located within a suburban/rural environment of the Penrith City Council Local Government Area (LGA). The site is characterised by low to moderate levels of activity throughout the day and decreasing activity in the evening and night. In the context of the surroundings, the site location is shown in Figure 2 below. Neighbouring properties include places of worship, low density housing and commercial developments.



**Figure 2:** Project site in relation to noise-sensitive receivers and noise monitoring locations.

Existing neighbouring properties that surround the site are as follows:

- Residential and agricultural/low-density residential development to the south of the site, across Park Road;
- Wallacia Christian Church and Fire Station immediately south west of the site;
- Residential and commercial development immediately west of the site;
- Wallacia Public School situated to the west of the site, beyond Mulgoa Road;
- Agricultural/low-density residential development immediately north of the site;
- Agricultural/low-density residential development immediately east of the site.

# 3 Existing Noise Environment

## 3.1 General survey information

A survey of the existing noise environment around the site was conducted at two unattended noise monitoring locations used to continuously record the noise levels at the site. Long term noise monitoring was undertaken on the following dates to establish the typical range of ambient and background noise levels of the proposed site and surrounds.

- Logger 1 – 26 September to 4 October 2017
- Logger 2 – 26 September to 4 October 2017

Long term noise monitoring was carried out with an RTA Technology Environmental Noise Logger Type 02 (Serial Number 38) and an Acoustic Research Laboratories Environmental Noise Logger (Serial number 878197) at locations Logger 1 and Logger 2, respectively. The loggers recorded  $L_{A1}$ ,  $L_{A10}$ ,  $L_{A90}$ , and  $L_{Aeq}$  noise parameters at 15-minute intervals continuously for a 9-day measurement period for background noise (Logger 1) and traffic noise (Logger 2). The calibration of the loggers was checked before and after use and no variations were noted.

Operator attended short-term monitoring was also carried out on Tuesday 26 September and Wednesday 4 October 2017 in order to supplement the long-term outdoor data across the site and at key surrounding receivers, plus obtain spectral noise data around the proposed development site.

Short-term measurements were made with a Brüel & Kjær Hand-held Analyser Type 2250 (Serial Number 3010373). The calibration of the analyser was checked before and after the surveys and no variation in level occurred.

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

Hadi Khairuddin of Acoustic Studio Pty Ltd carried out the surveys.

The long and short-term noise monitoring locations are shown in Figure 2.

## 3.2 Long-term monitoring results

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

- **Logger 1** – at the eastern boundary of the site, intended to capture background and ambient noise levels at the nearest and potentially worst affected residential receiver.
- **Logger 2** – at the southern boundary of the site in close proximity to the proposed main entrance, intended to capture existing traffic noise from Park Road.

These positions were chosen as they represent 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 2.

The detailed results of the long-term noise monitoring at each logger location 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 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  $L_{90}$ . 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.

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 1 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	39	35	29	51	48	48

**Table 1:** Long-term background and ambient noise levels

Based on observations during our site visit, it is noted that both ambient and background noise levels around the proposed development site are generally dominated by industrial noise around the site (e.g. golf course maintenance and neighbouring agricultural operations)

### 3.2.2 Traffic Noise

Traffic noise monitoring results are summarised in Table 2 below.

Location	Traffic Noise Levels, dB(A)			
	Period		1 Hour Period	
	Day Leq, (15 hr)	Night Leq, (9 hr)	Day Leq, (1 hr)	Night Leq, (1 hr)
Logger 2 – Park Road (proposed main entrance)	58	51	59	59

**Table 2:** Long-term traffic noise levels measured (see Figure 2)

### 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 S1** eastern boundary, adjacent to Logger 1 position;
- **Location S2** south eastern boundary, adjacent to Park Road and residential receivers;
- **Location S3** southern boundary, adjacent to Park Road and proposed main entrance;
- **Location S4** northern boundary, adjacent to agricultural/low-density residential receivers;
- **Location S5** centre of proposed redevelopment site;
- **Location S6** northern boundary, adjacent to agricultural/low-density residential receivers;
- **Location S7** western boundary, adjacent to residential receivers;

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

Location	Time	Descriptor	Measured sound level, dB re 20 µPa									
			Overall dB(A)	Octave band centre frequency <sup>1</sup> , Hz								
				31.5	63	125	250	500	1k	2k	4k	8k
S1	26/9/17 10:00am to 12:00pm	L <sub>eq</sub> 15 min	43	50	54	52	41	37	37	35	35	30
		L <sub>90</sub> 15 min	38	47	48	47	34	28	28	25	22	18
S2	26/9/17 10:00am to 12:00pm	L <sub>eq</sub> 15 min	62	64	69	66	59	58	58	54	48	41
		L <sub>90</sub> 15 min	38	47	47	45	35	28	30	28	23	18
S3	26/9/17 10:00am to 12:00pm	L <sub>eq</sub> 15 min	53	54	60	62	57	49	45	41	37	30
		L <sub>90</sub> 15 min	42	45	51	47	40	37	34	29	23	19
S4	4/10/17 10:00am to 12:00pm	L <sub>eq</sub> 15 min	38	49	49	43	37	30	31	31	30	28
		L <sub>90</sub> 15 min	33	44	42	34	27	24	25	22	22	20
S5	4/10/17 10:00am to 12:00pm	L <sub>eq</sub> 15 min	45	52	59	57	48	39	35	34	32	33
		L <sub>90</sub> 15 min	39	47	48	44	35	28	30	28	24	21
S6	4/10/17 10:00am to 12:00pm	L <sub>eq</sub> 15 min	45	52	54	47	36	35	36	34	41	33
		L <sub>90</sub> 15 min	38	47	47	39	30	31	33	28	21	18
S7	4/10/17 10:00am to 12:00pm	L <sub>eq</sub> 15 min	45	56	59	52	43	38	39	36	32	28
		L <sub>90</sub> 15 min	41	49	49	44	36	35	36	32	26	22

**Table 3:** Summary of 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 and Vibration Impact Assessment for the project:

**External Noise Intrusion** - For proposed buildings (e.g. Chapel and Administration Office), 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 the internal and external roads (e.g. Park Road).

**External Noise Emissions** - Noise emissions from the proposed development will need to be managed to limit environmental noise impacts on nearby receivers 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 plant, including furnace noise. 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 buildings and traffic noise impacts from internal roads.

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

The development will contribute noise and vibration to the surrounding environment during the construction. 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:

- Penrith Development Control Plan (DCP) 2014
- Penrith Local Environment Plan (LEP) 2010
- 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
- Australian Standard AS 2107:2016
- NSW EPA Road Noise Policy, 2011
- NSW Environmental Protection Authority (EPA) *Noise Guide for Local Government* (NGLG) 2013

Refer to Section 9.1 for construction noise and vibration related codes and standards.

# 6 Acoustic Design Criteria

## 6.1 External Noise Intrusion

### 6.1.1 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 cemetery developments, reference is made to NSW Department of Planning (DoP), Development Near Busy Roads and Rail Corridors – Interim Guideline and Australian Standard AS2107, which recommend the following recommended internal design sound levels for the applicable building types proposed as part of the project:

- |   |           |              |
|---|-----------|--------------|
| • Places of Worship:                    | $L_{Aeq}$ | 30 to 40 dBA |
| • General office areas / Meeting Rooms: | $L_{Aeq}$ | 40 to 45 dBA |
| • Executive Office:                     | $L_{Aeq}$ | 35 to 40 dBA |
| • Function areas                        | $L_{Aeq}$ | 40 to 45 dBA |

## 6.2 External noise emission criteria

### 6.2.1 General

#### Local Development and Environment Plans

The Penrith Council DCP (2014) provides guidance regarding the preparation of a Noise Impact Statement (Appendix F3 – DA Submission Requirements); these guidelines have been addressed in this assessment. The following sections provide detail on the guidelines and standards relevant to this project, which are used to establish thorough and objective criteria. Compliance with the relevant criteria established below will ensure compliance with the requirements as per the Penrith Council DCP (2014).

#### 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.

### 6.2.2 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



### 6.2.3 Defining environmental noise criteria

The noise definitions and conditions provided 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, functions and visitors.

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

### 6.2.4 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.

Table 5 below provides the RNP criteria for additional traffic generated on local roads from land use development in relation to the applicable receiver types surrounding the site.

Receiver	Assessment Criteria (external)	
	Day (7am to 10pm)	Night (10pm to 7am)
	L <sub>Aeq</sub> (1hr)	L <sub>Aeq</sub> (1hr)
Residential	55	50
Places of worship	50 <sup>1</sup>	40 <sup>1</sup>
School classrooms	50 <sup>1</sup>	-

**Table 5:** RNP assessment criteria for additional traffic on local roads generated by 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*”.

<sup>1</sup> Non-residential external noise criteria is derived from internal noise criteria, assuming windows are open to adequately opened to provide natural ventilation. This methodology is supported by the NSW INP.

## 6.2.5 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 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:

$L_{Aeq,15 \text{ minute}}$  from new noise source  $\leq$  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 rural ANLs are:

- Day time (7am to 6pm): 50  $dB L_{Aeq}$  (11hrs)
- Evening (6pm to 10pm): 45  $dB L_{Aeq}$  (4hrs)
- Night time (10pm to 7am): 40  $dB L_{Aeq}$  (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 INP). Industrial noise corrections have been applied in accordance with the INP for this project.

The 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 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.

Although the operational hours are assumed to be between 7am and 8pm, it is considered likely that some mechanical plant could be operational for 24hrs to accommodate specific building use requirements (e.g. the Crematorium or Mortuary facilities) and after hours maintenance activities (such as cleaning). Therefore, for the purposes of this assessment, all time periods have been considered.

Based on the measured noise levels detailed in Section 3, and in accordance with the methodology outlined in the INP, Table 6 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 L <sub>eq</sub> (period), dBA	Intrusiveness L <sub>eq</sub> (15-minute), dBA	INP Project Specific <sup>2</sup>
Residential	Day (7am-6pm)	50	42	44	42
	Evening (6pm-10pm)	45	38	40	38
	Night (10pm to 6am)	40	38	34	34
Place of Worship	When in use	50 <sup>3</sup>	42	-	42
Educational	Noisiest 1-hour period When In Use	45 <sup>3</sup>	41	-	41
Commercial	When in use	65	65	-	65

**Table 6:** INP project specific criteria for external noise emissions from mechanical plant

<sup>2</sup> Project Specific Criteria are based on the more stringent of the Amenity and Intrusiveness Criteria.

<sup>3</sup> 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.

## 6.2.6 Traffic Noise – Internal Roads

The impact of traffic noise from internal roads to the facades of neighbouring sensitive receivers is incorporated in the assessment of traffic noise generated as a result of land use development, as per Section 6.2. above and Section 8.1 below.

## 6.2.7 Function/Event Noise

There is no state or national equivalent guideline for assessing noise emissions from cemetery facilities and places of worship, such as the Chapel.

The relevant criterion applicable to the Chapel 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 Chapel may include amplified music and patron noise, it is also relevant to consider noise in octave bands.

Liquor and Gaming New South Wales (LGNSW) and the City of Sydney (CoS) both apply similar octave band criteria to assess a licenced premises (LGNSW) and “*Entertainment Use*” (CoS).

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

The LGNSW and CoS criteria is defined as follows:

- 7am to 12am (midnight):  $L_{A10}$  from the premises (in this case the Chapel or 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 Chapel 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 LGNSW limits.
- The existing background noise level has been determined in accordance with the NSW Industrial Noise Policy (INP) 2000. The day time background noise levels are used to determine environmental noise criteria in accordance with the proposed hours of operation of the site.

Based on the measured noise levels detailed in Section 3, and in accordance with the methodology outlined above, Table 7 details the corresponding limits of allowable noise from operational use of the Chapel at the nearest receiver boundaries.

Note: The following criteria assumes the proposed use of the Chapel will be between 7am and 8pm only, therefore criteria have only been established for the day period.

Location	Time	Descriptor	Overall dB(A)	Measured sound level, dB re 20 $\mu$ Pa									
				Octave band centre frequency, Hz									
				31.5	63	125	250	500	1k	2k	4k	8k	
Residential	Day (7am-6pm)	Background Noise Level	$L_{90}$	39	48	48	40	31	32	34	29	22	19
		Corresponding Project Criteria (LGNSW/CoS)	$L_{10} \leq L_{90} + 5\text{dB}$	44	53	53	45	36	37	39	34	27	24

**Table 7:** Function Noise Criteria based on LGNSW and CoS recommendations



## 7 Traffic Noise Intrusion

Noise from Park Road and internal roads within the cemetery grounds may result in potential traffic noise impacts affecting the proposed development.

Based on long term unattended noise data, a summary of traffic noise levels at the proposed Park Road entrance are provided in Table 8.

Location	Traffic Noise Levels, dB(A)			
	Period		1 Hour Period	
	Day Leq, (15 hr)	Night Leq, (9 hr)	Day Leq, (1 hr)	Night Leq, (1 hr)
Logger 2 – Park Road (proposed main entrance)	58	51	59	59

**Table 8:** Day and night traffic noise levels based on attended measurements and logger data

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 proposed buildings are predicted based on levels incident at the façade of each space, which are based on the unattended measurements in Table 8. The measurements are adjusted to consider site-specific factors such as distance attenuation (building setback), shielding and building reflections.
- presented in Attenuation provided by the building envelope construction, with the weakest elements being:
  - Existing external glazing;
  - The building envelope construction for the proposed buildings;
- Internal noise levels have been considered (or measured in existing buildings) for two scenarios:
  - Windows closed;
  - Windows opened sufficiently to provide cross ventilation.

Based on the assessment, Acoustic Studio has identified that achieving internal noise levels for noise sensitive buildings in accordance with AS2107:2016 will typically require the following:

- Windows and doors to proposed site buildings may be open when in use;
- New spaces within the refurbished clubhouse, including the Function Room and Players' Lounge, are unlikely to be impacted by the proposed internal roads within the cemetery grounds. Traffic intrusion levels are likely to be consistent with existing.

Final details and extent of treatments to the façades of the new buildings will be determined with input from an acoustic consultant at the detailed design stage to ensure that the requirements of AS2107 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 roads surrounding the proposed development site and internal roads.

Following a review of the DRAFT Traffic Impact Assessment prepared by The Transport Planning Partnership (TTPP) (ref: 17257-Park Road Cemetery, Wallacia TIA\_170829), a worst-case scenario traffic noise impact assessment has been undertaken based on the following methodology:

- Noise predictions carried out for residential properties at 68 to 72 Park Road and the Wallacia Christian Church, considered the nearest and potentially worst affected receivers;
- Traffic volumes predicted for ‘No Build’ and ‘Build’ scenarios in 2027<sup>4</sup> are based on the following:
  - September 2017 Park Road traffic count data (Traffic Impact Assessment);
  - average annual increase of approximately 1% (RMS Traffic Volume Calculator – Parker Street, Kingswood<sup>5</sup>);
  - predicted traffic generation for ‘Build’ scenario (Traffic Impact Assessment).
- ‘Build’ scenario represents a worst-case prediction, based on traffic generation projected at the completion of the project.

The traffic noise predictions for the proposed development are presented in Tables 9 and 10 below.

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<sup>4</sup> Assessment has only been carried out to 2027, due to greater uncertainty and unreliability of both traffic volume and noise generation predictions beyond 10 years.

<sup>5</sup> Nearest available traffic data (RMS Traffic Volume Calculator) to Park Road, Wallacia

Period	Predicted noise levels (2027)		RNP Criteria (Residential)	RNP Criteria exceedance ('Build' Scenario)	Change in noise level (2027)	Consider mitigation?
	'No Build' Scenario (estimated traffic volume / hour)	'Build' Scenario (estimated traffic volume / hour)	Day (LAeq, 1hr External)	Day		
Weekday AM Peak	59 (582)	60 (722)		5	0.9	No
Weekday PM Peak	59 (633)	60 (773)	55	5	0.9	No
Weekend Peak (Sunday)	55 (441)	57 (661)		2	1.8	No

**Table 9:** Predicted traffic generation noise levels at nearest residential receivers (68 to 76 Park Road, Wallacia) – blue indicates exceedance of the RNP noise level criteria; green indicates a >2 dB increase from the 'Build' to 'No Build' option

Period	Predicted noise levels (2027)		RNP Criteria (Places of Worship)	RNP Criteria exceedance ('Build' Scenario)	Change in noise level (2027)	Consider mitigation?
	'No Build' Scenario (estimated traffic volume / hour)	'Build' Scenario (estimated traffic volume / hour)	Day (LAeq, 1hr External)	Day		
Weekday AM Peak	62 (568)	62 (708)		12	1.0	No
Weekday PM Peak	62 (583)	62 (723)	50	12	0.9	No
Weekend Peak (Sunday)	58 (509)	58 (729)		8	1.6	No

**Table 10:** Predicted traffic generation noise levels at Wallacia Christian Church – blue indicates exceedance of the RNP noise level criteria; green indicates a >2 dB increase from the 'Build' to 'No Build' option

In accordance with the RNP, consideration of mitigation is triggered when additional traffic on existing local roads generated by land use developments fails to comply with both the absolute noise level criteria provided in Tables 9 and 10, AND exceeds the ‘No Build’ scenario noise levels by more than 2 dB(A).

The worst-case scenario predictions presented in Tables 9 and 10 indicate an increase between the ‘No Build’ and ‘Build’ scenarios of no more than 2 dB(A) for the identified peak periods.

Compliance at the nearest residential properties (68 to 72 Park Road) and the Wallacia Christian Church indicates compliance at all other receivers. Therefore, in accordance with the RNP, consideration of mitigation is not required for traffic noise generated as a result of the proposed development.

## 8.2 Mechanical Plant

Plant associated with the operation of the proposed site buildings 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.

### ***Crematorium***

Operational noise associated with the Crematorium furnaces and combustion fans have been identified as a potential key source of noise emissions to the surrounding sensitive receivers. Standard furnace noise data is not widely available, nor have specifications for the proposed furnace(s) been provided. However, an indicative assessment of furnace noise impacts to the nearest receiver has been carried out based on a measured overall sound level of one furnace operating (at 1 metre), provided to Acoustic Studio by the furnace supplier on the Woronora Crematorium project (2014). The results are presented in Table 11 below.

Receiver	Period	Source Noise Level Leq (15-minute), dBA	Predicted Noise Level Leq (15-minute), dBA	INP Project Specific Criteria Leq (15-minute), dBA	Complies?
115 Park Road	Day (7am-6pm)	69	38	42	Yes

**Table 11:** Indicative furnace noise impact assessment

The predictions above indicate the noise associated with one furnace is likely to comply with the criteria at the nearest and potentially worst affected receiver. It is noted that the source noise levels presented in Table 11 do not reflect the actual noise levels of the proposed furnace(s), but rather provide an indication of potential noise impacts to the nearest sensitive receiver.

While indicative noise levels for the combustion fans have been provided by the supplier for this project, the location and building construction around the fans have not been finalised, therefore, a detailed assessment has not been carried out. It is understood from the supplier that typical acoustic treatment of the combustion fans will include the following:

- Sound attenuators within ductwork on both the inlet and discharge sides to minimise down duct noise;
- Units are to be mounted on vibration isolation mats and installed within a room of masonry construction or equivalent acoustic performance to minimise structure-borne and airborne noise transmission, both external and internal;
- Acoustic baffle installed at the outside air inlet to the combustion fan room to minimise external noise transmission.

### ***Building Services***

Final plant selections of typical building services have not been made, therefore, a detailed assessment has not been carried out. Any plant selections will be need to 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 all buildings, excluding the Ground Staff facilities;
- The nearest and potentially worst affected receivers are residential properties surrounding the site, particularly to the east, south and west; and the Wallacia Catholic Church immediately south east of the existing clubhouse;
- The plant will potentially operate into the evening and night periods to accommodate specific operational requirements (e.g. the Mortuary), maintenance and cleaning;
- The most restrictive night time criterion for 24hrs plant operations is 34 dB(A) at the nearest residential receivers. Achieving this criterion for each building will ensure compliance with the relevant criteria at all other 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, a qualified acoustic engineer 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.

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

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

- 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 Building Use

Acoustic Studio has carried out a preliminary assessment of noise emissions associated with the typical uses of the proposed Chapel, including the following:

- Events/functions on weekdays between 9am and 4pm; and Saturday mornings, if required;
- Noise sources may include live amplified music;
- Maximum capacity of 100 people.

### 8.3.1 Assessment methodology

The acoustic assessment has considered the following:

- Use of the Chapel during typical operational hours as per Section 8.4 above. The assessment considers the day time criteria.
- Noise levels from the use are considered over a worst-case – 15-minute period;
- The assessment considers the nearest and potentially most affected receiver (residential properties at 115 to 137 Park Road). Therefore, compliance at these locations indicates compliance at all other locations;
- The assessment considers external activities (where applicable) and internal activities with diffuse reverberant field breaking out through the weakest building elements, namely the roof, doors or glazing for internal noise sources; and
- The assessment considers distance attenuation, shielding and reflections plus directivity.

### 8.3.2 Source Noise Levels

Based on the key activities and operational details discussed in Section 8.4, the following source noise levels associated with the Chapel have been estimated below.

The assessment generally assumes a worst-case scenario as per the following:

- Live amplified music of low to moderate noise levels;
- Noise levels from visitors attending the Chapel likely to be minimal and would not contribute to the worst-case noise level;
- At maximum capacity of 100 patrons with windows and doors open;



The L<sub>10</sub> noise source spectra for live amplified music is shown below in Table 12.

Description	Overall dB(A)	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 live performance with amplified sound	<b>80</b>	51	79	76	78	78	76	69	61	53

**Table 12:** Amplified music source noise level

It is assumed that noise from visitors attending the Chapel will be at least 10 dB below the sound levels of live amplified music (Table 12). Therefore, if compliance is achieved for noise levels from live amplified music, then compliance will also be achieved for people attending the Chapel.

### 8.3.3 Noise Emission Predictions

Table 13 details the predicted noise levels at the nearest and potentially worst affected receiver associated with the operation of the Chapel.

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 live performance with amplified sound	51	79	76	78	78	76	69	61	53
Distance Attenuation / Building attenuation / shielding / reflections / directivity	-44	-44	-44	-44	-44	-44	-44	-44	-44
Resulting level at the residential boundary	10	38	35	37	37	35	28	20	12
<b>COS/LGNSW Criteria - External (7am to 6pm)</b>	<b>53</b>	<b>53</b>	<b>45</b>	<b>36</b>	<b>37</b>	<b>39</b>	<b>34</b>	<b>27</b>	<b>24</b>
<b>Complies?</b>	<b>Yes</b>	<b>Yes</b>	<b>Yes</b>	<b>Yes</b>	<b>Yes</b>	<b>Yes</b>	<b>Yes</b>	<b>Yes</b>	<b>Yes</b>

**Table 13:** Noise assessment at nearest receivers from worst-case event within the Chapel

The 1 dB(A) exceedance of the criteria at 250 Hz is considered to be marginal and barely perceptible to the human ear.

Based on the assessment methodology summarised in Section 8.4.1, the predictions presented in Table 13 indicate that noise associated with the operational use of the Chapel is likely to comply with the relevant LGNSW 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 proposal will likely be noise associated with traffic generation and operational use of the Chapel;
- Operational noise from the Chapel is predicted to comply with the relevant criteria, however restrictions to daytime hours (7am to 6pm) are recommended to ensure impacts to surrounding receivers are minimised;
- Traffic noise from external and internal roads noise is predicted to comply with the relevant criteria, however the use of internal roads should be monitored during operations, particularly during peak hours and areas in close proximity to site boundaries/sensitive receivers;
- Mechanical plant for site buildings 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.
- Noise from mechanical plant is generally broadband, and will be controlled so that there are no characteristics that will make it particularly irritating.
- 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 expected that people and noise sensitive receivers will not be adversely affected by the development.

We consider that the proposed development will meet all relevant noise emission criteria and the nearest sensitive receivers.

# 9 Construction Noise and Vibration Assessment

The following provides a preliminary construction noise and vibration assessment based on assumed typical construction activities likely to be undertaken as part of the project, and requires further development once a contractor is appointed and confirms the 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 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

#### **DECC Interim Construction Noise Guideline (ICNG)**

The relevant guideline applied for the assessment of construction noise is the Department of Environment and Climate Change (DECC), 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 14 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 $L_{\text{ea}}$ (15 min)	How to Apply
<b>Recommended standard hours:</b> Monday to Friday 7 am to 6 pm Saturday 8 am to 1 pm No work on Sundays or public holidays	Noise affected RBL <sup>6</sup> + 10 dB	<p>The noise affected level represents the point above which there may be some community reaction to noise.</p> <ul style="list-style-type: none"> <li>Where the predicted or measured <math>L_{\text{Aeq}}</math> (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.</li> <li>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</li> </ul>
	Highly noise affected 75dB(A)	<p>The highly noise affected level represents the point above which there may be strong community reaction to noise.</p> <ul style="list-style-type: none"> <li>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: <ol style="list-style-type: none"> <li>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</li> <li>if the community is prepared to accept a longer period of construction in exchange for restrictions on construction times.</li> </ol> </li> </ul>
<b>Outside recommended standard hours:</b>	Noise affected RBL + 5 dB	<ul style="list-style-type: none"> <li>A strong justification would typically be required for works outside the recommended standard hours.</li> <li>The proponent should apply all feasible and reasonable work practices to meet the noise affected level.</li> <li>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.</li> <li>For guidance on negotiating agreements see Section 7.2.2.</li> </ul>

**Table 14:** Residential construction noise criteria for airborne noise

<sup>6</sup> 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 14 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 15 below.

Location	Period	Rating Background Level RBL, dBA	Criteria $L_{eq}(15\text{ min})$ dBA		
Residential Receivers	Recommended Standard Hours	Monday to Friday 7am-6pm	39	RBL + 10	49
		Saturday 8am-1pm	39		
	Outside Recommended Standard Hours	Saturday 1pm-6pm	40	RBL + 5	45

**Table 15:** 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:

- Classrooms  $L_{Aeq,15min}$  45dBA (internal)
- Places of Worship:  $L_{Aeq,15min}$  45dBA (internal)
- Industrial  $L_{Aeq,15min}$  75dBA (external)
- Offices, retail outlets  $L_{Aeq,15min}$  70dBA (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 INP supports this methodology.

### **9.2.2 Ground-borne noise and vibration**

Due to the distances between the site and anticipated vibratory construction activities associated with the project, ground-borne noise and vibration impacts to neighbouring sensitive receivers are considered unlikely.

## 9.3 Construction noise assessment

At this stage a contractor has not yet been engaged for the construction of the proposed development. Therefore, a detailed assessment of construction noise and vibration has not been carried out.

The following sections provide a high-level review based on assumptions about plant and equipment that may typically be used.

It allows for a broad assessment of the potential noise and vibration impacts to identify where the relevant criteria may be exceeded during the works.

It is recommended that a Construction Noise and Vibration Management Plan (CNMVP) is prepared further to this assessment at the detailed design stage. The contractor would be required to prepare a final Construction Noise and Vibration Management Plan based on their proposed plant, equipment and construction methodology.

### 9.3.1 Proposed Hours

Proposed construction hours for the project are anticipated as follows:

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

### 9.3.2 Noise Sources

The following noise sources are considered to be typical plant and equipment used during earthworks and the construction of buildings.

Equipment Type	Item	Noise Level L <sub>eq</sub> dB(A)	
		SWL	SPL @ 10m dB(A)
Heavy Vehicles	Dump Truck (20 tonne)	107	79
	Concrete Mixer Truck	109	81
Site Machinery/Vehicles	Excavator (20 tonne)	107	79
	Bobcat	107	79
	Compactor	110	82
	Grader	107	79
	Vibratory Roller	107	79

**Table 16:** Anticipated airborne sound power levels for equipment/plant used during the different stages of the Project



### 9.3.3 Sensitive receivers

Nearest sensitive receivers to the project site that will be potentially affected by noise associated with proposed construction works are residential properties, places of worship, commercial, residential and educational premises as presented in Section 2.3.

Table 17 outlines the approximate distances to the nearest noise sensitive receivers in the vicinity of the project.

Receiver	Location	Approximate Distance from construction site	
		Closest Construction Site Boundary (m)	Centre of Construction Site (m)
Nearest residential	Park Road	15	490
Wallacia Christian Church	Park Road	50	530
Wallacia Public School	Mulgoa Road	210	800
Fire Station	Park Road	70	450
Wallacia Hotel	Corner of Park & Mulgoa Roads	45	650
Nearest commercial	Corner of Park & Mulgoa Roads	75	720

**Table 17:** Noise sensitive receivers and approximate distance to Project construction site

## Construction Noise Assessment Methodology

A preliminary assessment of likely noise impacts from various construction activities has been carried out to identify where the relevant criteria may be exceeded during the works.

The assessment has considered the following:

- Typical construction equipment as outlined above.
- For the purposes of a preliminary assessment, the noise impact at each noise sensitive receiver has been carried out based on the expected worst-case construction noise impacts as follows:
  - Project specific criteria at each sensitive receiver location as outlined in Section 9.2.1
  - Noise level predictions are calculated using the noise data provided in Table 16.
  - Noise level predictions consider the following.
    - Distance attenuation.
    - Ground and building reflections.
- The predictions consider the impacts from individual pieces of equipment provided as range which considers the nearest and furthest location within the site from the nearest affected receiver.
- The predictions assume continuous operation of equipment / plant over the 15-minute assessment period, unless otherwise stated.

## 9.3.4 Assessment Results

### Surrounding Receivers

Table 18 presents the results for the construction noise assessment at surrounding community receivers based on typical plant and equipment outlined in Section 9.3.2.

Location and Construction Activity	Predicted equipment noise levels at surrounding community receivers, in dBL <sub>A10,15min</sub>					
	115 Park Road (residential)	Wallacia Christian Church	Wallacia Public School	Fire Station <sup>7</sup>	Wallacia Hotel <sup>9</sup>	Commercial (cnr Mulgoa & Park Roads)
	Criteria, dB(A)					
	49 <sup>8</sup> / 45 <sup>9</sup>	45	45	49 <sup>10</sup> /45 <sup>11</sup>	49 <sup>10</sup> /45 <sup>11</sup>	70
Dump Truck (20 tonne)	45 to 76	45 to 65	41 to 53	46 to 62	43 to 66	42 to 62
Concrete Mixer Truck	47 to 78	47 to 67	43 to 55	48 to 64	45 to 68	44 to 64
Excavator (20 tonne)	45 to 76	45 to 65	41 to 53	46 to 62	43 to 66	42 to 62
Bobcat	45 to 76	45 to 65	41 to 53	46 to 62	43 to 66	42 to 62
Compactor	48 to 79	48 to 68	44 to 56	49 to 65	46 to 69	45 to 65
Grader	45 to 76	45 to 65	41 to 53	46 to 62	43 to 66	42 to 62
Vibratory Roller	45 to 76	45 to 65	41 to 53	46 to 62	43 to 66	42 to 62

**Table 18:** Predicted equipment/plant noise levels at the nearest surrounding community receiver locations – Levels predicted to exceed the residential criteria are in blue (outside of standard hours) and green (standard and outside of standard hours); Levels predicted to exceed criteria for other receiver types are in red.

For any activities/equipment that exceed the relevant criteria, including those identified in Table 18, the control measures discussed in Section 9.4.1 shall be considered and implemented wherever reasonable and feasible. In addition, the construction best practices presented in Section 9.4.2 shall be considered to minimise the noise impacts on the neighbourhood.

<sup>7</sup> Residential criteria adopted to account for potential sleeping quarters within Fire Station and hotel rooms

<sup>8</sup> Project specific “Recommended Standard Hours” criteria for Monday to Friday and Saturday

<sup>9</sup> Project specific “Outside Recommended Standard Hours” for Monday to Friday and Saturday

## 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 Additional noise 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 educational receivers.
- Consider implementing equipment-specific screening.
- 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 (generators, hand tools, etc.) not specifically identified in this plan incorporates silencing/shielding equipment as required to meet the noise criteria.

## 9.5 Noise monitoring

The Contractor should consider implementing environmental noise monitoring at the nearest property boundaries of the sensitive receivers detailed in Section 9.3.3, particular for any works during outside of standard construction hours.

An allowance of 1.5 days per week, at least, should be dedicated to monitoring of noise for the first four weeks of 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.

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 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.

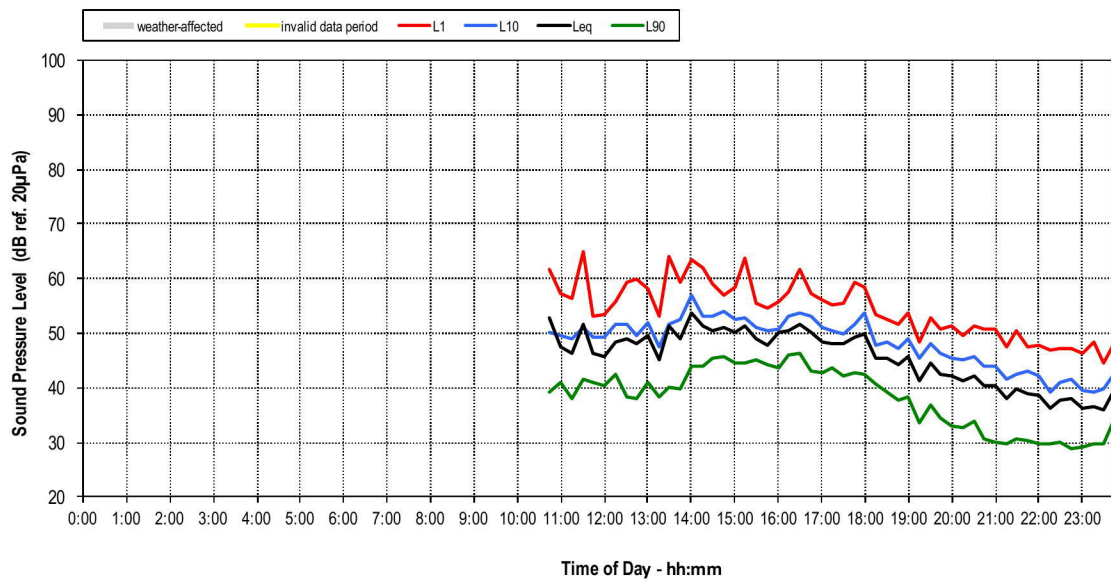
## 9.7 Non-compliances

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

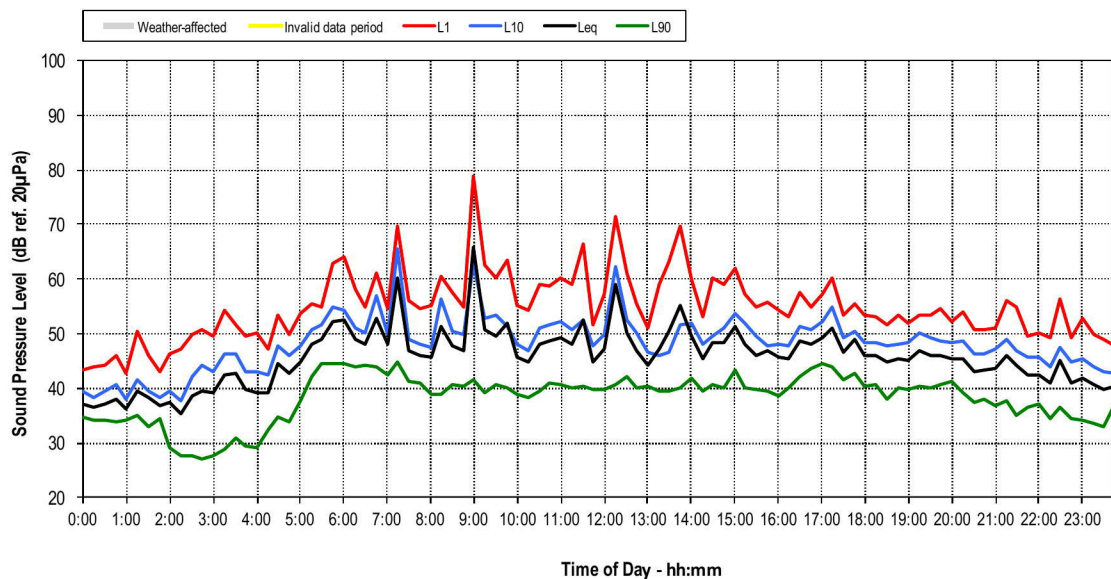
# Appendix A : Noise Logger Data

## Location 1 – Eastern Boundary (Background Noise Logger)

Wallacia Panthers Golf Course Redevelopment - Logger 1 - Tuesday 26 September 2017

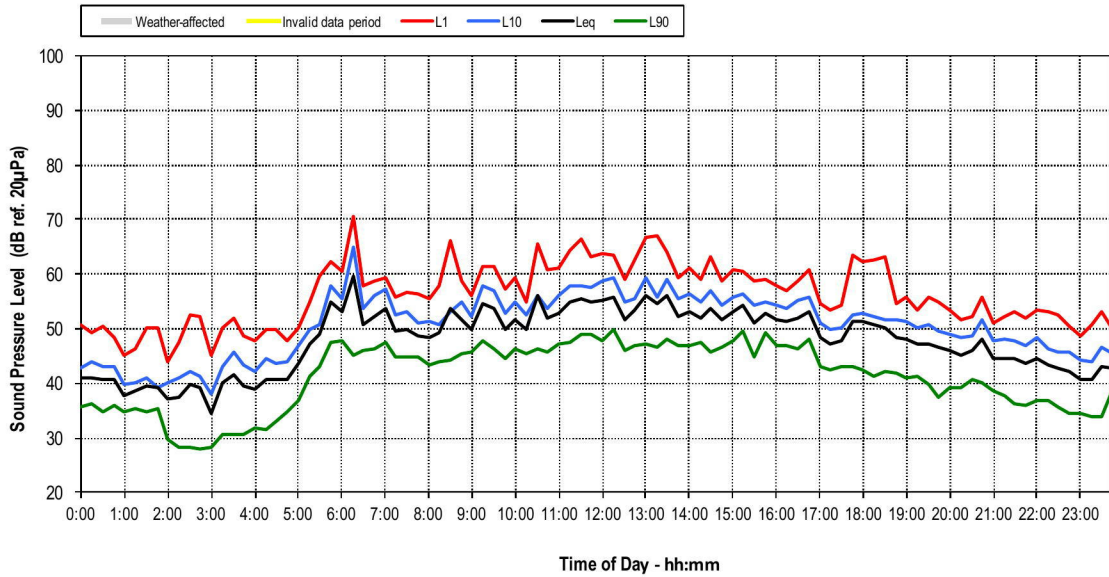


Wallacia Panthers Golf Course Redevelopment - Logger 1 - Wednesday 27 September 2017

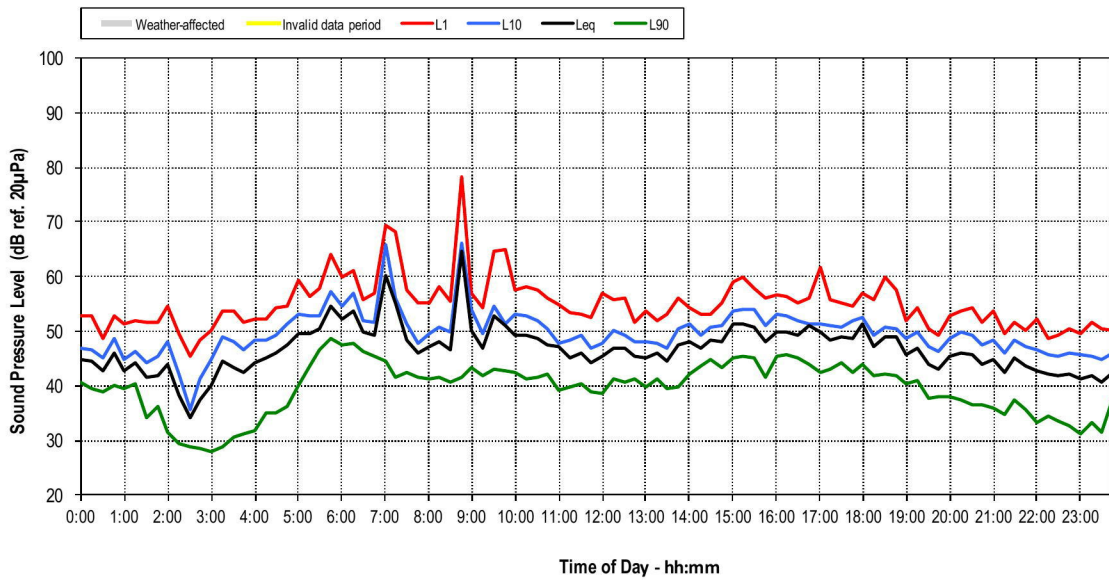




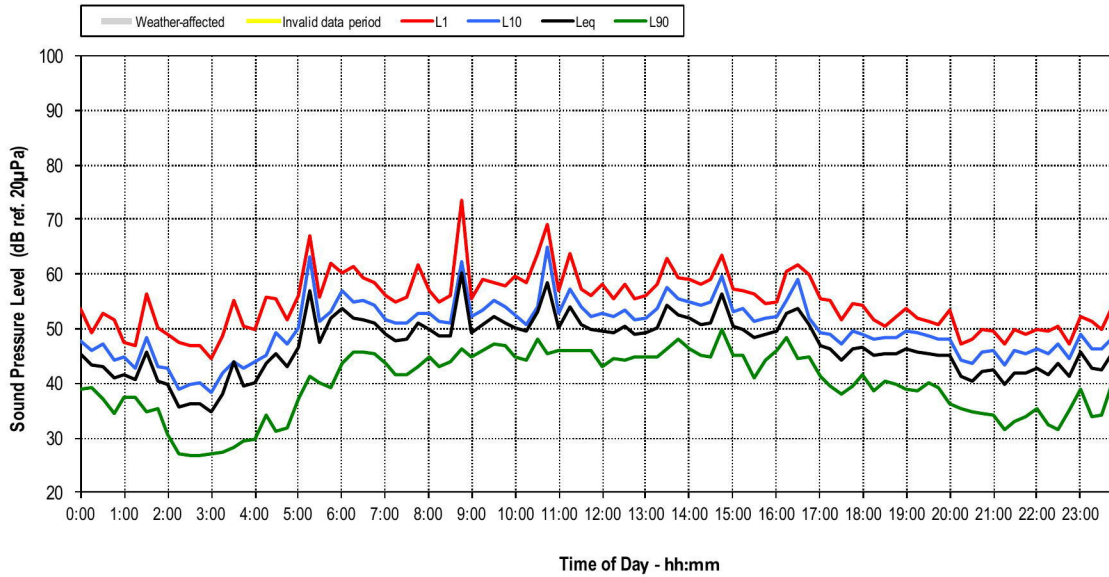
Wallacia Panthers Golf Course Redevelopment - Logger 1 - Thursday 28 September 2017



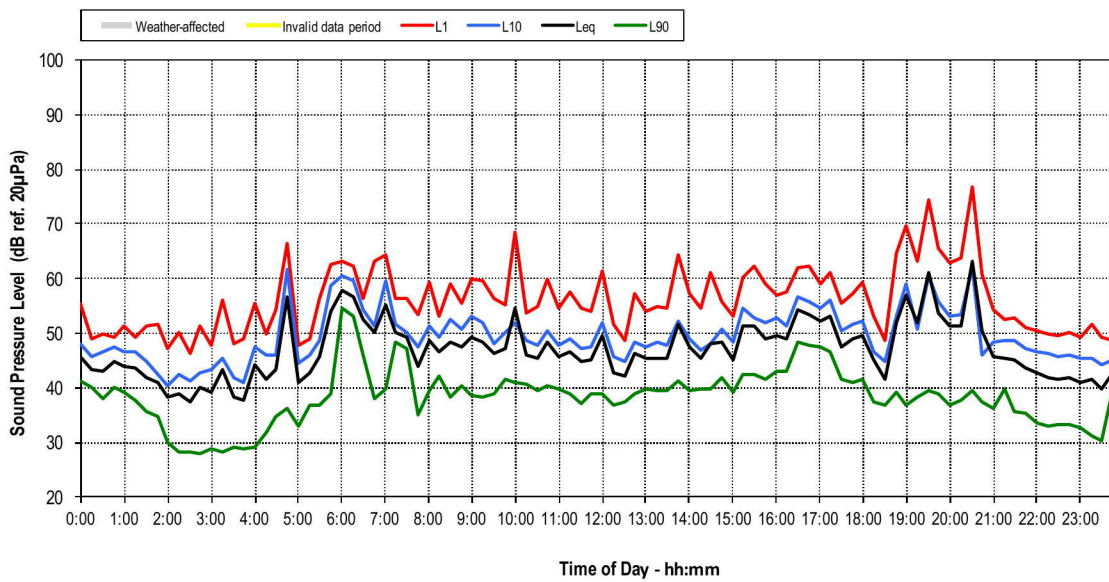
Wallacia Panthers Golf Course Redevelopment - Logger 1 - Friday 29 September 2017



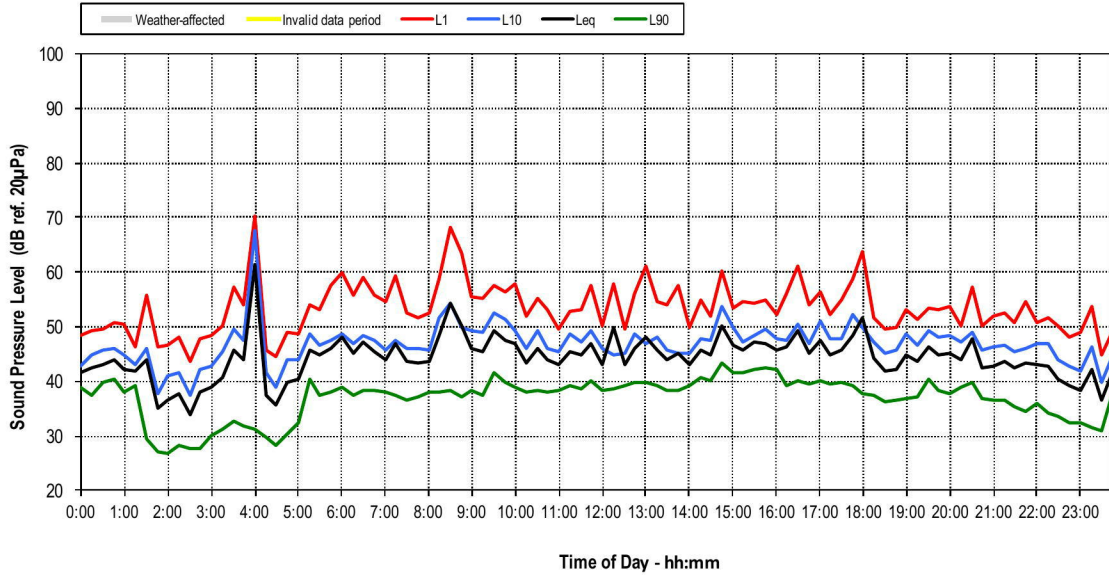
Wallacia Panthers Golf Course Redevelopment - Logger 1 - Saturday 30 September 2017



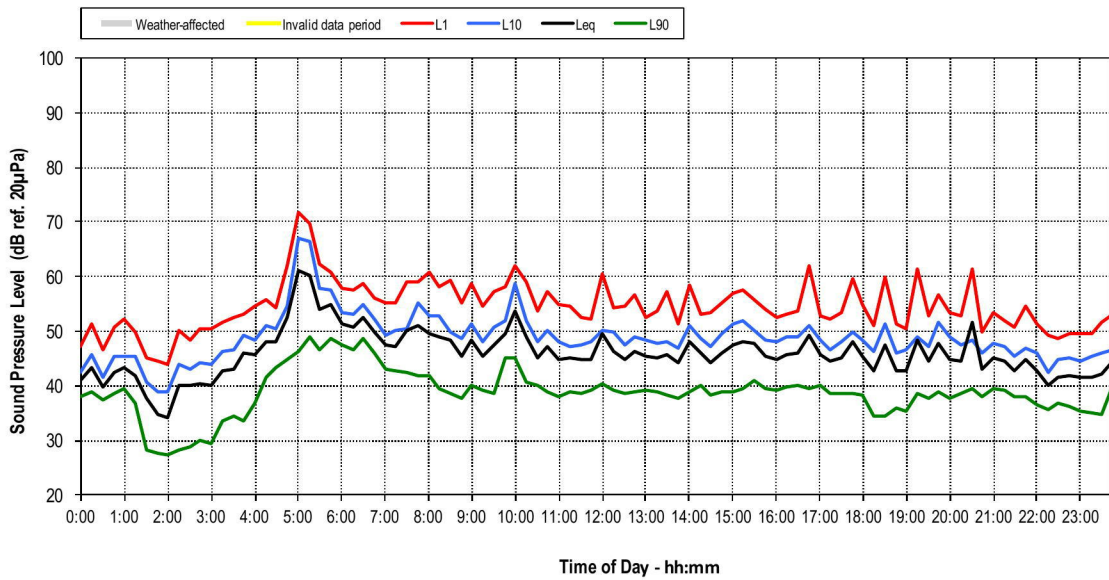
Wallacia Panthers Golf Course Redevelopment - Logger 1 - Sunday 01 October 2017



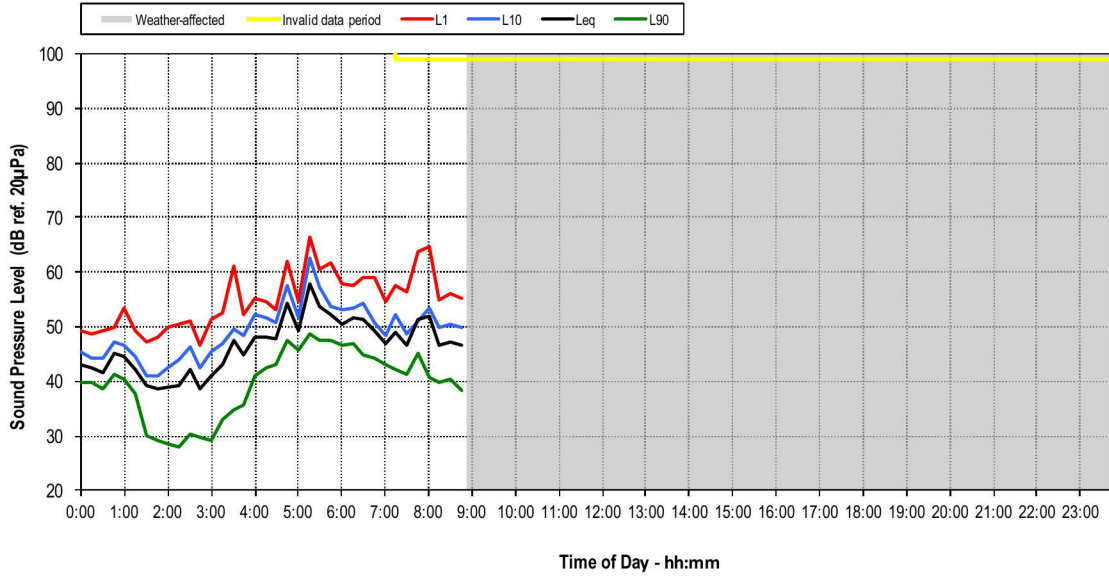
Wallacia Panthers Golf Course Redevelopment - Logger 1 - Monday 02 October 2017



Wallacia Panthers Golf Course Redevelopment - Logger 1 - Tuesday 03 October 2017



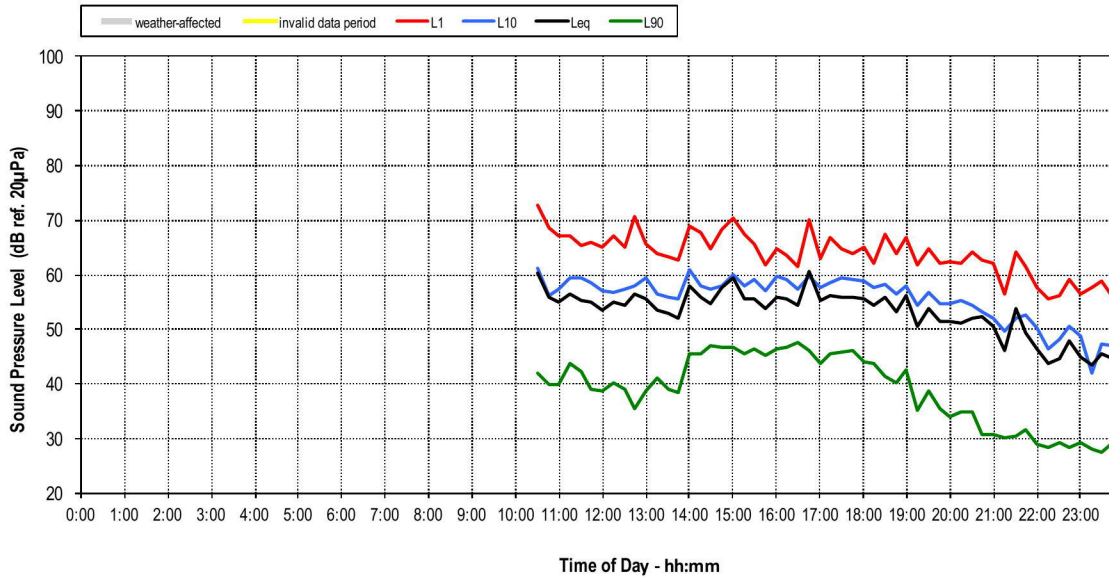
Wallacia Panthers Golf Course Redevelopment - Logger 1 - Wednesday 04 October 2017



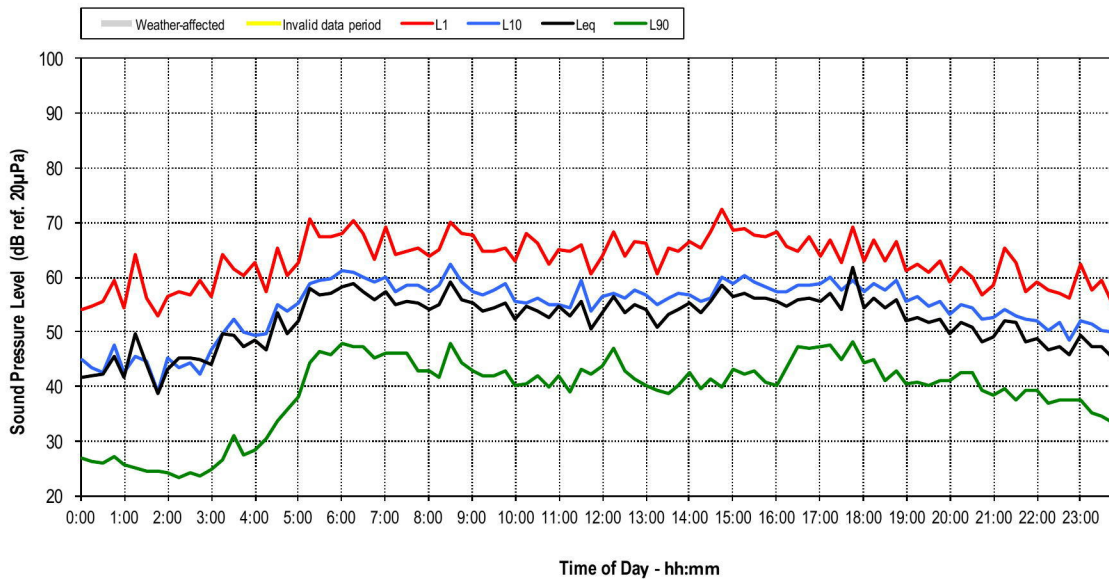


# Location 2 – Park Road (Traffic Noise Logger)

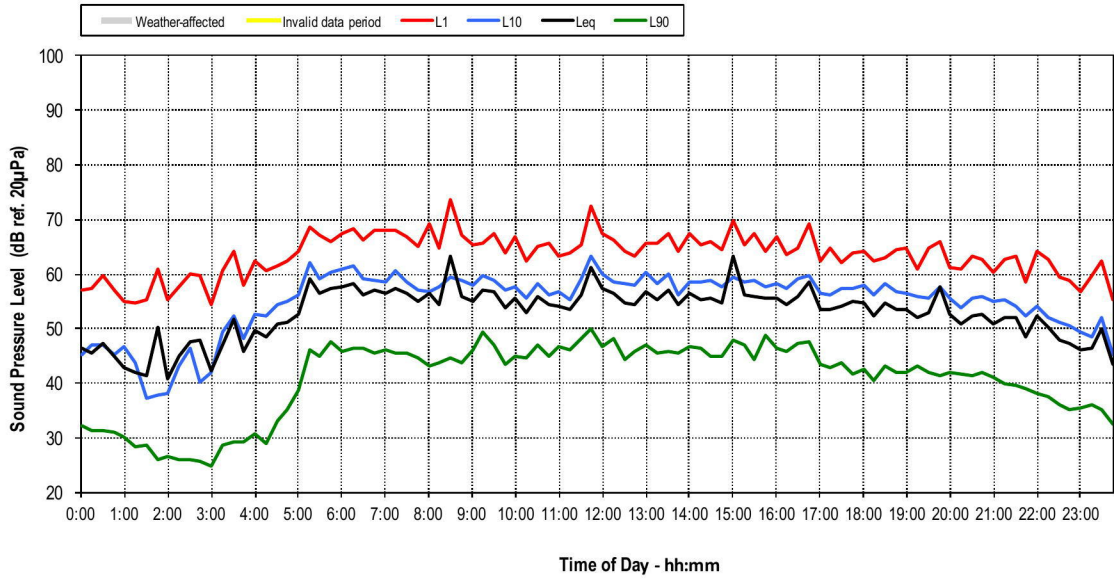
Wallacia Panthers Golf Course Redevelopment - Logger 2 - Tuesday 26 September 2017



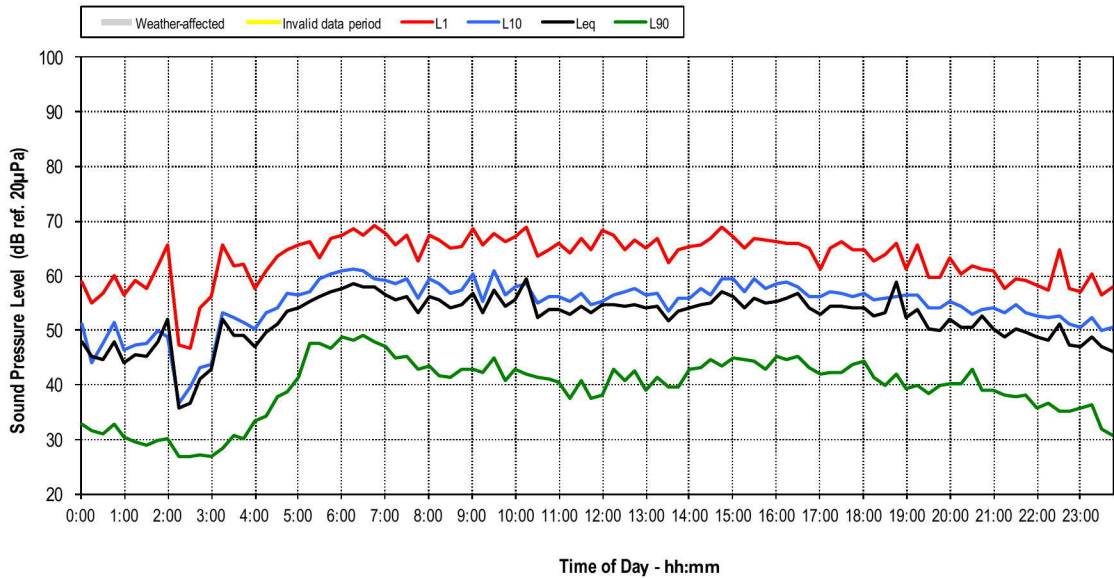
Wallacia Panthers Golf Course Redevelopment - Logger 2 - Wednesday 27 September 2017



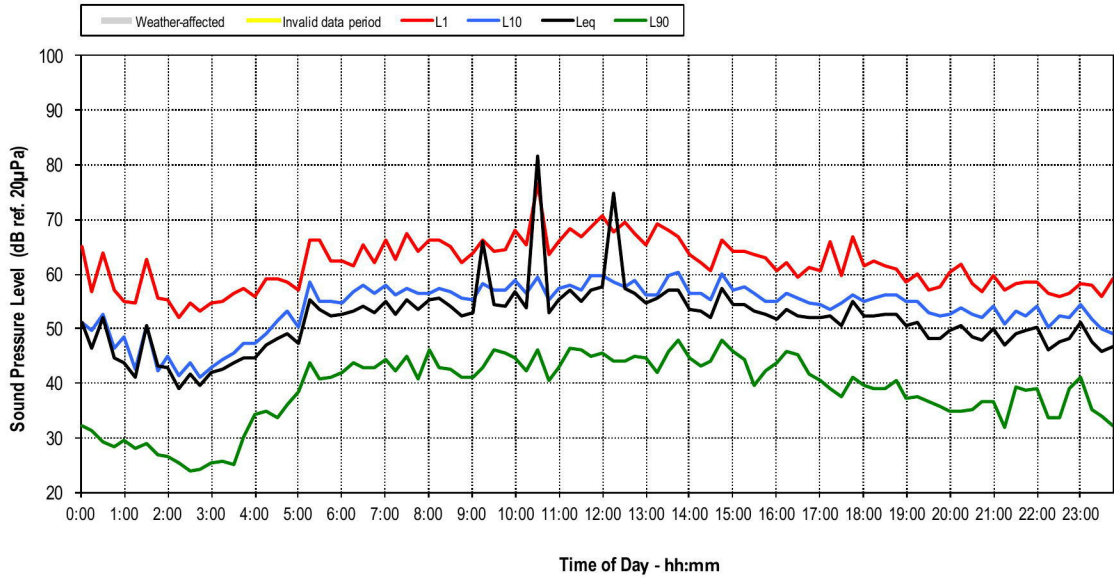
Wallacia Panthers Golf Course Redevelopment - Logger 2 - Thursday 28 September 2017



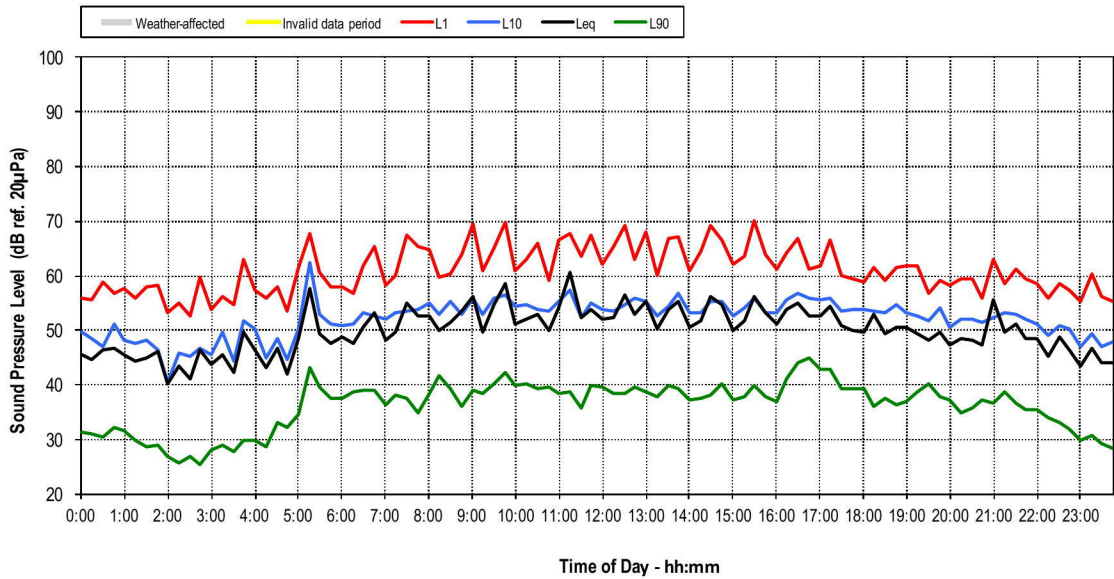
Wallacia Panthers Golf Course Redevelopment - Logger 2 - Friday 29 September 2017



Wallacia Panthers Golf Course Redevelopment - Logger 2 - Saturday 30 September 2017

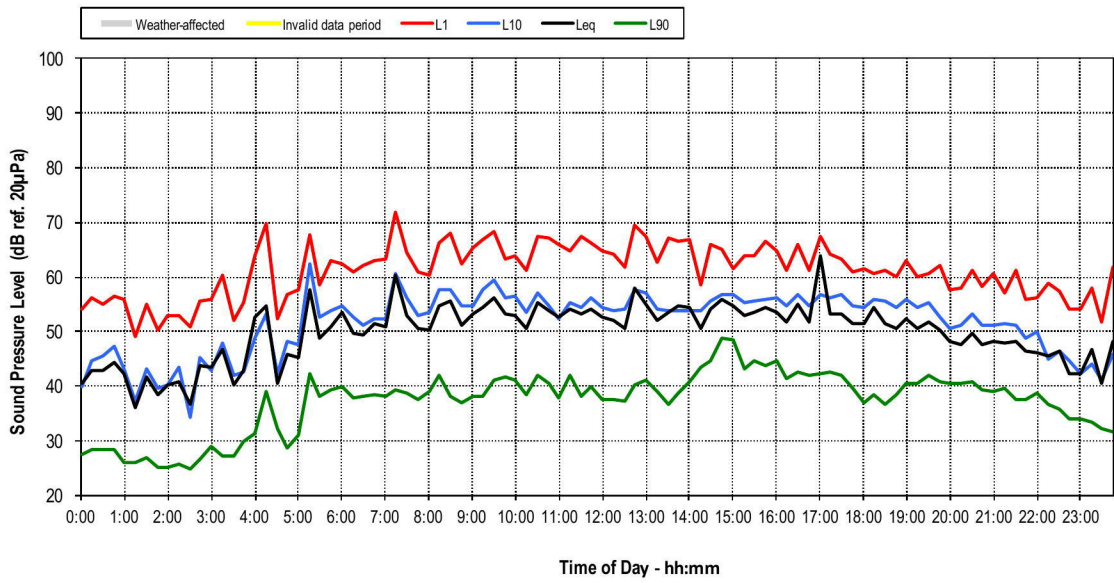


Wallacia Panthers Golf Course Redevelopment - Logger 2 - Sunday 01 October 2017

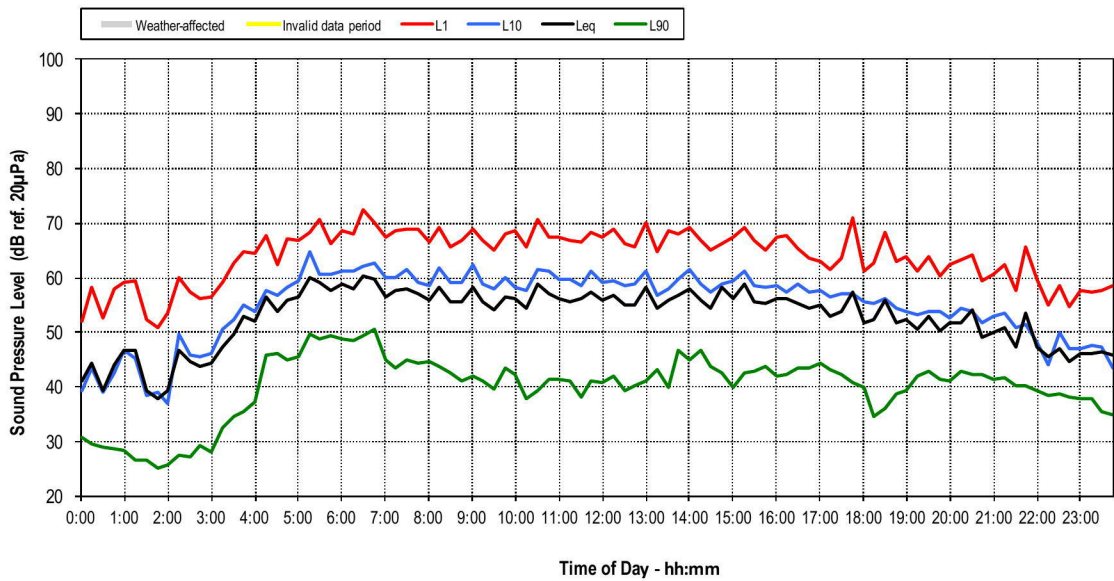


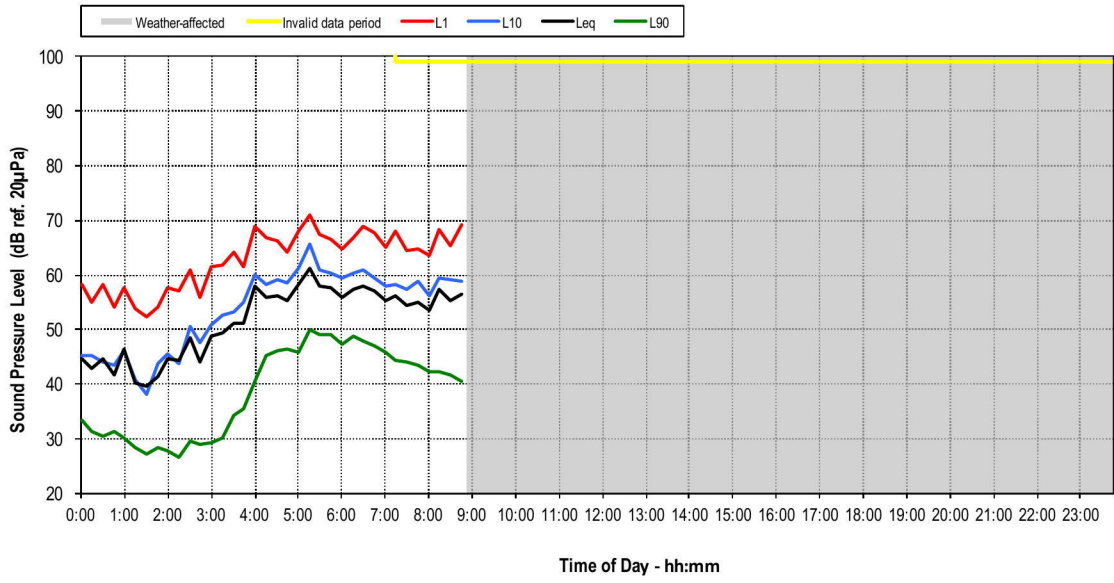


Wallacia Panthers Golf Course Redevelopment - Logger 2 - Monday 02 October 2017



Wallacia Panthers Golf Course Redevelopment - Logger 2 - Tuesday 03 October 2017





# 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	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	39	35	29	51	48	48

**Table B1:** Long-term background and ambient noise levels measured around the MMP 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  $51 + 5 = 56 \text{ dB(A)}$
- Evening Intrusiveness criterion of  $48 + 5 = 53 \text{ dB(A)}$
- Night Intrusiveness criterion of  $48 + 5 = 53 \text{ dB(A)}$

## 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 Rural.

Indicative Noise Amenity Area	Period	Recommended L <sub>Aeq, period</sub> Noise Level (ANL)	
		Acceptable	Recommended Maximum
Residential (Rural)	Day	50	55
	Evening	45	50
	Night	40	45
School Classroom - Internal	Noisiest 1 hour period	35	40
Places of Worship – Internal	When in use	50	45
Commercial	When in use	65	70

**Table B2:** Recommended LAeq 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.

The NSW Industrial Noise Policy states:

“Where internal noise levels are specified, they refer to the noise level at the centre of the habitable room that is most exposed to the noise and are to apply with the windows opened sufficiently to provide adequate ventilation. In cases where the gathering of internal access for monitoring is difficult, then external noise levels 10 dB above internal levels apply”.

### Amenity criterion

The amenity criterion is determined from the relationship of the existing LAeq 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.

Indicative Noise Amenity Area	Period	Existing L <sub>Aeq</sub>	ANL	Adjustment	Amenity Criterion
Residential	Day	51	50	ANL minus 8	42
	Evening	48	45	Existing L <sub>Aeq</sub> minus 10	38
	Night	48	40	Existing L <sub>Aeq</sub> minus 10	38
Places of Worship	When in use	51	50	ANL minus 8	42
Educational	Noisiest 1-hour period When in Use	51	45	Existing L <sub>Aeq</sub> minus 10	41
Commercial	When in use	51	65	ANL	65

**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 mechanical noise emissions associated with the site are shown in Table B5 below (PNLs shown shaded in grey).

Receiver Type	Period	INP Criteria			INP Project Specific
		Acceptable Noise Level	Amenity L <sub>eq</sub> (period), dBA	Intrusiveness L <sub>eq</sub> (15-minute), dBA	
Residential	Day (7am-6pm)	50	42	44	42
	Evening (6pm-10pm)	45	38	40	38
	Night (10pm to 6am)	40	38	34	34
Place of Worship	When in use	50	42	-	42
Educational	Noisiest 1-hour period When In Use	45	41	-	41
Commercial	When in use	65	65	-	65

**Table B5:** Determination of project specific noise levels for the project