Lismore Base Hospital - Stage 3B

Noise Impact Assessment

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1 INTRODUCTION

This report details the noise impact assessment for the proposed Lismore Base Hospital Stage 3B project and the potential for noise and vibration impact to surrounding receivers.

The report presents an assessment of:

- Potential noise and vibration impacts during the construction period of the project;
- Noise emissions once the project is constructed and operating under normal conditions; and
- Helicopter noise emissions externally to the site and internally within the hospital.

2 CONSTRUCTION NOISE AND VIBRATION ASSESSMENT

This section of the Noise Impact Assessment presents a specification for the processes, which will be followed to manage noise and vibration associated with the proposed demolition and excavation activities which are required as part of the Lismore Base Hospital Stage 3B Project and the potential for noise and vibration to impact receivers within close proximity to the development.

In recognition of the requirements to minimise noise and vibration emissions from the site to adjacent uses this study has been undertaken. The principal objective of this study is to undertake an evaluation of works to be performed during the operation of the various activities during demolition and excavation and develop a management plan to ensure noise and vibration is:

1. Minimised to all surrounding receivers;

2. Does not exceed OH&S standards at surrounding receivers.

3. Is monitored when potentially high noise and vibration generating activities are being used.

This assessment will formulate/present the relevant noise and vibration criteria which construction activities are required to comply with. Additionally effective mitigation measures will be recommended where possible to ensure criteria is achieved and impacts are minimised to the surrounding areas of the existing hospital.

The principal issues, which will be addressed in this report, are:

- Identification of the noise and vibration standards which will be applicable to this project.

- Formulation of a strategy for construction activities to comply with the standards identified in the above point.

- Development at demolition and excavation methods which will minimise the impact on surrounding receivers.

2.1 PROJECT OBJECTIVES

The objective of this management plan is to set up a protocol to ensure noise and vibration emissions from the construction works associated with the Lismore Base Hospital Stage 3B Project comply with applicable standards, recommend required management controls and treatments are adopted where required and detail the required monitoring to ensure standards are met.

2.2 PROJECT DESCRIPTION AND POTENTIALLY EFFECTED PROPERTIES

The proposed Lismore Base Hospital Stage 3B Project includes the demolition of a portion of the existing building and excavation of material including infill and soft sand stone. The expected activities can be expected to include:

1. Demolition of existing buildings.

2. Removal of infill material.

3. Excavation of soft sand stone.

Based on the site location of the Lismore Base Hospital Stage 3B Project the potentially affect receivers which may be affected include:

1. Buildings within the Hospital precinct which will remain operational.

2. Surrounding residential receivers on Uralba and Little Uralba Streets.

2.3 CONSTRUCTION NOISE CRITERIA

It is proposed to utilise Australian Standard AS2436:1981 *"Guide to noise control on construction, maintenance and demolition sites"*, which is the standard commonly applied by Councils for the regulation of construction noise, the New South Wales Construction Noise Guideline developed by The NSW Environmental Protection Authority (EPA) and OH&S requirements are presented in this section of the report.

2.3.1 Australian Standard AS2436:1981 "Guide to noise control on construction, maintenance and demolition sites

The Australian Standard AS2436 states that where all reasonable and available measures have been taken to reduce construction noise, mitigation strategies may be put in place to reduce levels noise levels to within a reasonable and acceptable level.

For the control and regulation of noise from construction sites AS2436:1981 *"Guide to noise control on construction, maintenance and demolition sites"* nominates the following:

a. That reasonable suitable noise criterion is established,

b. That all practicable measures be taken on the building site to regulate noise emissions, including the siting of noisy static processes to locations of the site where they can be shielded, selecting less noisy processes, and if required regulating construction hours, and

c. The undertaking of noise monitoring where non-compliance occurs to assist in the management and control of noise emission from the demolition, excavation and construction site.

2.3.2 EPA Construction Noise Guideline

The Environmental Protection Authority (EPA) have developed a specific construction noise guideline in the aid of reducing the impact of construction associated noise.

The guideline reflects on feasible and reasonable mitigation strategies, management controls and public liaising in the effort to reach realistic comprises between construction sites and potential noise affected receivers.

2.3.2.1 EPA Construction Noise Guideline - Qualitative Assessment Method

The guideline refers to a qualitative assessment method in which construction noise is assessed on a case by case basis with regard to various activities to be conducted on site. This assessment method was developed to smaller scale projects.

Essentially this method of assessment requires that the proponent take into consideration and employ all reasonable and feasible measures to ensure that the impact on noise receivers is minimised. This is generally conducted in the following manner:

- The drafting of a noise management plan outlining all reasonable and feasible mitigation methods for the reduction of noise impact;
- The assessment of high impact equipment such as rock-hammers and piling equipment for lower noise producing methods of construction/excavation;
- The implementation of a complaints handling register and community consultation system;
- Employee (builders, contractors etc) education in effective noise reducing techniques and site etiquette; and
- The operation of plant in a quiet and efficient manner (i.e. turning off machinery when not in use).

This qualitative assessment method has been used for the basis of this report and has been used as the basis for the development of acoustic management and treatments of proposed construction activities.

In addition, the guideline specifies goals which can be used in the effort of minimising noise from construction related activities. These noise goals are presented within the table below.

Table 1 – EPA Recommended Construction Noise Goals

Governing Body	Receiver Type	External sound level Goal, $L_{eq\ 15\ min}$ dB(A)
EPA	Residential	Background + 10 dB(A)[1]
		75 dB(A)[2]
	Hospitals	45 dB(A) Internal Noise Level

1: Where the predicted or measured LAeq (15 min) is greater than the noise affected level, the proponent should apply all feasible and reasonable work practices to minimise noise. (EPA CNG, 2008).

2: Where noise is above this level, the proponent should consider very carefully if there is any other feasible and reasonable way to reduce noise to below this level. If no quieter work method is feasible and reasonable, and the works proceed, the proponent should communicate with the impacted residents by clearly explaining the duration and noise level of the works, and by describing any respite periods that will be provided. (EPA CNG, 2008).

These criteria for resultant noise from construction activities are aimed at maintaining comfort levels within the surrounding residential dwellings. Additionally, noise mitigation techniques as discussed in this report should be used if noise emissions exceed the above criteria. All work is to be carried out in accordance with AS 2436:1981 *"Guide to noise control on construction, maintenance and demolition sites"*.

2.3.3 OH&S Guidelines

Regulation 49 of the Occupational Health and Safety Regulation specifies maximum levels of noise which a 'worker' may be exposed to. Acoustic treatment to the work environment or hearing protection is recommended for workers exposed to higher noise levels. These maximum OH&S noise levels are presented in the table below.

Table 2 – OH&S Maximum Noise Level Exposure

	Energy Averaged Over 8 Hour Day	**Maximum Noise Level During Day**
OH&S maximum noise level exposure	85 dB(A) L_{eq}	140 dB(C)$_{Peak}$

2.4 CONSTRUCTION VIBRATION CRITERIA

Construction vibration criteria associated with works on the Lismore Base Hospital Stage 3 Project when measured at the potentially affected receivers should not exceed the following sets of vibration criteria to ensure no architectural or structural damage to surrounding buildings and human comfort is maintained. These standards have been selected as they are widely used in the assessment of vibration associated with construction activities within Australia, namely:

- German Standard DIN 4150-3 (1999-02): *"Structural Vibration – Effects of Vibration on Structures"*; and
- British Standard BS 6472:1992 *"Guide to Evaluation of Human Exposure to Vibration in Buildings (1Hz to 80Hz)*.

The criteria and the application of these Standards are discussed in separate sections below.

2.4.1 German Standard DIN 4150-3 (1999-02)

German Standard DIN 4150-3 (1999-02) provides vibration velocity guideline levels for use in evaluating the effects of vibration on structures. The criteria presented in DIN 4150-3 (1999-02) are presented in the Table below.

It is noted that the peak velocity is the absolute value of the maximum of any of the three orthogonal component particle velocities as measured at the foundation, and the maximum levels measured in the x- and y-horizontal directions in the plane of the floor of the uppermost storey.

Table 3 – DIN 4150-3 (1999-02) Safe Limits for Building Vibration

TYPE OF STRUCTURE		PEAK PARTICLE VELOCITY (mms^{-1})			
		At Foundation at a Frequency of			**Plane of Floor of Uppermost Storey**
		< 10Hz	**10Hz to 50Hz**	**50Hz to 100Hz**	**All Frequencies**
1	Buildings used in commercial purposes, industrial buildings and buildings of similar design	20	20 to 40	40 to 50	40
2	Dwellings and buildings of similar design and/or use	5	5 to 15	15 to 20	15
3	Structures that because of their particular sensitivity to vibration, do not correspond to those listed in Lines 1 or 2 and have intrinsic value (eg buildings that are under a preservation order)	3	3 to 8	8 to 10	8

2.4.2 British Standard BS 6472:1992

British Standard BS 6472:1992 develops criteria relating to levels of building vibration that may be expected to give rise to *"adverse comment"*, in the frequency range most applicable to impacts associated with construction, which is 1 to 80Hz. These threshold values are used as criteria for assessing the loss of amenity and are presented below in Table 3.

Table 4 – BS 6472:1992 Criteria to Avoid "Adverse Comment"

Type of Occupancy	Time of Day	Peak Particle Velocity (mms^{-1}) between 1Hz to 80Hz Likely to Cause *"Adverse Comment"*			
		Continuous Vibration		Intermittent Vibration and Impulsive Vibration Excitation with Several Occurrences per day	
		Vertical	Horizontal	Vertical	Horizontal
Residential	Day	0.3 to 0.6	0.8 to 0.6	8.4 to 12.6	24 to 36
	Night	0.2	0.6	2.8	8
Offices	Day	0.6	1.6	18	51
	Night	0.6	1.6	18	51
Workshops	Day	1.2	3.2	18	51
	Night	1.2	3.2	18	51

The limits indicate that people in buildings are significantly less susceptible to horizontal vibration than to vertical vibration. Furthermore, Section 4.1 of BS 6472 notes that situations can exist where vibration magnitudes above those generally corresponding to minimal *"adverse comment"* levels can be tolerated, particularly for temporary disturbances and infrequent and intermittent events such as those associated with construction projects.

2.5 MINIMISING NOISE AND VIBRATION IMPACT

In addition to the noise and vibration standards presented in this report, demolition and excavation activities are to be selected and managed with the aim of minimising the impact on the surrounding receivers.

2.6 CONSTRUCTION HOURS

Woking hours are subject to planning approval conditions. Typically the hours of work at sites will be:

- 7:00am to 5:00pm Monday to Friday
- 8:00am to 5:00pm on Saturdays
- No work on Sundays, Public Holidays or Saturdays adjacent to a Public Holiday.

Works which are proposed to be conducted outside of these hours will be subject to special approval. The provision for quiet period during the following period will be provided for by the builder, when high noise generating equipment will not be conducted:

2.7 CONTROL OF CONSTRUCTION NOISE AND VIBRATION

As a part of the noise management of noise and vibration on each site the following process should be conducted when investigating the impact and construction activities.

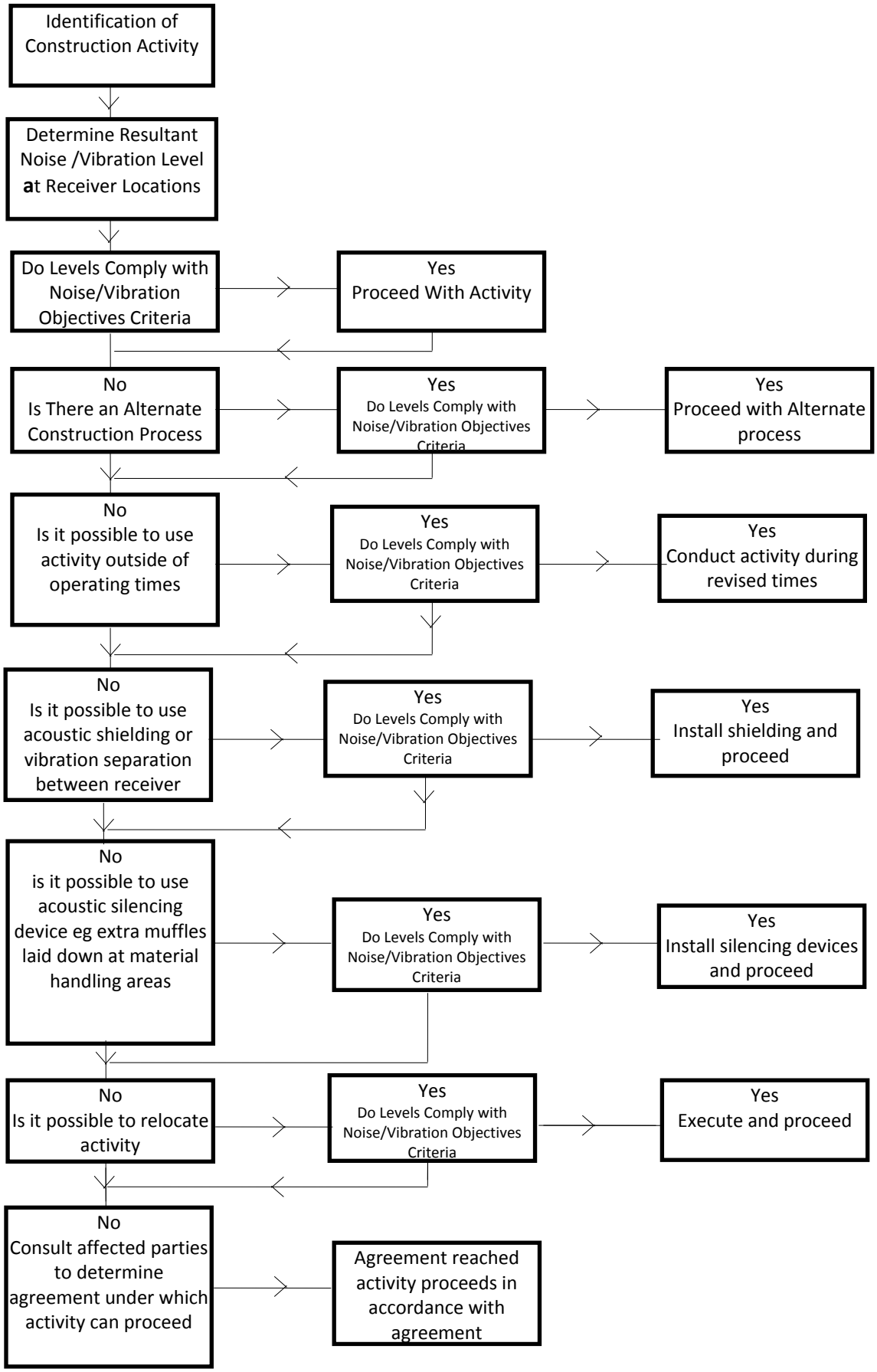


Figure 1 – Process Flowchart

2.8 NOISE AND VIBRATION CONTROL METHODS

The determination of appropriate noise control measures will be dependent on the particular activities and construction appliances. This section provides an outline of available methods.

2.8.1 Selection of Alternative Appliance or Process

Where a particular activity or construction appliance is found to generate excessive noise levels, it may be possible to select an alternative approach or appliance. For example; the use of a hydraulic hammer on certain areas of the site may potentially generate high levels of noise. By carrying this activity by use of pneumatic hammers, bulldozers ripping and/or milling machines lower levels of noise will result.

2.8.2 Acoustic Barrier

Barriers or screens can be an effective means of reducing noise. Barriers can be located either at the source or receiver.

The placement of barriers at the source is generally only effective for static plant (tower cranes). Equipment which is on the move or working in rough or undulating terrain cannot be effectively attenuated by placing barriers at the source.

Barriers can also be placed between the source and the receiver.

The degree of noise reduction provided by barriers is dependent on the amount by which line of sight can be blocked by the barrier. If the receiver is totally shielded from the noise source reductions of up to 15dB(A) can be effected. Where only partial obstruction of line of sight occurs, noise reductions of 5 to 8dB(A) may be achieved. Where no line of sight is obstructed by the barrier, generally no noise reduction will occur.

As barriers are used to provide shielding and do not act as an enclosure, the material they are constructed from should have a noise reduction performance that is approximately 10dB(A) greater than the maximum reduction provided by the barrier. In this case the use of a material such as 10mm or 15mm thick plywood (radiata plywood) would be acceptable for the barriers.

2.8.3 Silencing Devices

Where construction process or appliances are noisy, the use of silencing devices may be possible. These may take the form of engine shrouding, or special industrial silencers fitted to exhausts.

2.8.4 Material Handling

The installation of rubber matting over material handling areas can reduce the sound of impacts due to material being dropped by up to 20dB(A).

2.8.5 Treatment of Specific Equipment

In certain cases it may be possible to specially treat a piece of equipment to dramatically reduce the sound levels emitted.

2.8.6 Establishment of Site Practices

This involves the formulation of work practices to reduce noise generation. A noise plan will be developed for this project outlining work procedures and methods for minimising noise.

2.8.7 Regular noise Checks of Equipment

To determine the requirement for silencing devices on machinery it is proposed to undertake fortnightly noise check. Noise levels of all machines on site will be measured and if they are found to be higher than nominated for that equipment type, items such as mufflers and engine shrouds will be examined to ensure they are in good working order.

A record of these measurements will be kept on a form similar to that shown in Appendix 1. This measure is expected to maintain noise at constant levels, and prevent any increases.

2.8.8 Treatment of Existing Equipment

An effective method of mitigating vibration on existing equipment would be to vibration isolated mounts to existing equipment and installations. Vibration isolation would be required to be investigated on a case by case basis and consist of neoprene mounts as specified (such as waffle pads, supershear flex or the like).

Based on investigations conducted at the site the areas which may be suitable for treatment include tables with sensitive equipment such as microscopes and the like.

2.8.9 Noise and Vibration Monitoring

Noise and vibration monitoring will be undertaken to determine the effectiveness of measures which are been implemented. The results of monitoring can be used to devise further control measures.

2.8.10 Combination of Methods

In some cases it may be necessary that two or more control measures be implemented to minimise noise.

2.8.11 Saw Cutting

Introduction of a saw cut to manage vibration impacting on surrounding receivers from construction activities.

2.9 NOISE AND VIBRATION ASSESSMENT

An assessment of the principal sources of noise and vibration emission has been undertaken to identify the activities that may produce noise and/or vibration impacts so that appropriate ameliorative measures can be formulated. Typical acoustic/vibration controls for specific equipment are discussed in this section of the report.

2.9.1 Determination of Construction Noise Impact

Using the noise levels presented in the Table below, the resultant noise potentially impacting surrounding receivers can be determined.

Based on the source of the site the expected noise levels at surrounding receivers can be predicted based on distance, barrier and working conditions (i.e. period which the activity is continuously being conducted).

2.9.2 Sound Power Levels

Noise impact will be determined from all processes and equipment, which are involved in the activities outlined below by defining the levels of sound, which they generate.

The A-weighted sound power levels for all the component parts of the above-described activities are outlined in the tables below.

Table 5 - Sound Power Levels and Potential Vibration

EQUIPMENT /PROCESS	SOUND POWER LEVEL - dB(A)	POTENTIAL VIBRATION LEVELS
Hydraulic Hammers	115	Up to 8mm/s @ 10m
Concrete Saw Cutting	114	Up to 2mm/s @ 5m
Excavator (without hammer)	98	Up to 3mm/s @ 10m
Drill Pilling equipment	105	Up to 2mm/s @ 5m
Truck	96	Minimal vibration impact
Bobcat	89	Minimal vibration impact
Angle Grinders	114	Minimal vibration impact
Electric Saw	111	Minimal vibration impact
Drilling	94	Minimal vibration impact
Hammering	110	Minimal vibration impact
Concrete Vibrator	100	Minimal vibration impact
Cement Mixing Truck	105	Minimal vibration impact

The noise levels presented in the above table are derived from the following sources, namely:

1. On-site measurements
2. Table D2 of Australian Standard 2436-1981
3. Data held by this office from other similar studies.

2.9.3 Noise Management

This section of the report presents the required noise strategies to ensure noise levels when measured at a receiver within close proximity to surrounding receivers with the nosier level criteria presented in this report.

The table below presents the construction activities and discussed the required management/treatments required to be conducted.

Table 6 - Recommended Noise and vibration Controls

EQUIPMENT /PROCESS	Receiver	Discussion
Hydraulic Hammering	All surrounding receivers	Ripping of material should be maximised where possible. No additional acoustic controls to other surrounding receivers
Drill pilling equipment	All surrounding receivers	No additional acoustic controls to other surrounding receivers
Concrete Saw Cutting	All surrounding receivers	No additional acoustic controls to other surrounding receivers
Excavators – Including all excavators up to and including 35 tons	All surrounding receivers	No additional acoustic controls to other surrounding receivers
Truck (including the loading of materials into trucks)	All Receivers	No acoustic controls required
Bobcat	All Receivers	No acoustic controls required
General Construction including - Angle Grinders, Electric Saw, Drilling, Hammering etc	All surrounding receivers	No additional acoustic controls to other surrounding receivers
Concrete Pumps	All Receivers	No acoustic controls required

2.10 COMMUNITY INTERACTION AND COMPLAINTS HANDLING

2.10.1 Establishment of Direct Communication with Affected Parties

In order for any construction noise management programme to work effectively, continuous communication is required between all parties, which may be potentially impacted upon including the builder, neighbours and other areas of the Lismore Hospital. This establishes a dynamic response process which allows for the adjustment of control methods and criteria for the benefit of all parties.

The objective in undertaking a consultation processes is to:

- Inform and educate the groups about the project and the noise controls being implemented;
- Increase understanding of all acoustic issues related to the project and options available;
- Identify group concerns generated by the project, so that they can be addressed; and
- Ensure that concerned individuals or groups are aware of and have access to the Contractor Complaints Register which will be used to address any construction noise related problems should they arise.

To ensure that this process is effective, regular information regarding the proposed works and period when they will be required to be conducted should be provide to neighbouring receivers (including residence and other areas of the Lismore Hospital), until all issues have been addressed and the evidence of successful implementation is embraced by all parties.

2.10.2 Dealing with Complaints

Should ongoing complaints of excessive noise or vibration criteria occur measures shall be undertaken to investigate the complaint, the cause of the exceedances and identify the required changes to work practices. In the case of exceedances of the vibration limits all work potentially producing vibration shall cease until the exceedance is investigated.

The effectiveness of any changes shall be verified before continuing. Documentation and training of site staff shall occur to ensure the practices that produced the exceedances are not repeated.

If a noise complaint is received the complaint should be recorded on a Noise Complaint Form. The complaint form should list:

- The name and location of the complainant (if provided);
- The time and date the complaint was received;
- The nature of the complaint and the time and date the noise was heard;
- The name of the employee who received the complaint;
- Actions taken to investigate the complaint, and a summary of the results of the investigation;

- Required remedial action, if required;
- Validation of the remedial action by a consultant or as detailed in this report; and
- Summary of feedback to the complainant.

A permanent register of complaints should be held.

All complaints received should be fully investigated and reported to management. The complainant should also be notified of the results and actions arising from the investigation.

The investigation of a complaint shall involve where applicable;

- noise measurements at the affected receiver;
- an investigation of the activities occurring at the time of the incident;
- inspection of the activity to determine whether any undue noise is being emitted by equipment; and
- Whether work practices were being carried out either within established guidelines or outside these guidelines.

Where an item of plant is found to be emitting excessive noise or vibration, the cause is to be rectified as soon as possible. Where work practices within established guidelines are found to result in excessive noise being generated then the guidelines should be modified so as to reduce noise emissions to acceptable levels. Where guidelines are not being followed, the additional training and counselling of employees should be carried out.

Measurement or other methods shall validate the results of any corrective actions arising from a complaint where applicable.

2.11 CONTINGENCY PLANS

Where non-compliances or noise complaints are raised the following methodology will be implemented.

1. Determine the offending plant/equipment/process
2. Locate the plant/equipment/process further away from the affected receiver(s) if possible.
3. Implement additional acoustic treatment in the form of localised barriers, silencers, vibration separation etc where practical.
4. Selecting alternative equipment/processes where possible

Complaints associated with noise and vibration generated by site activities shall be recorded on a Noise Complaint Form. The person(s) responsible for complaint handling and contact details for receiving of complaints shall be established on site prior to construction works commencing. A sign shall be displayed at the site indicating the Site Manager to the general public and their contact telephone number.

If a noise complaint is received the complaint should be recorded on a Noise Complaint Form as discussed in Section 2.11.2 of this report.

3 NOISE EMISSION LIMITS – NOISE GENERATED ON THE SITE (OPERATIONAL NOISE)

The Lismore Base Stage 3B will be designed such that all operation noise during the normal operation of the completed project will comply with the relevant EPA and Council noise level criterion.

This section of the report detailed the suitable noise level criterion, which operational noise from the project will be assessed. It is noted that the Stage 3B development includes both temporary plant and permanent plant associated with the development. All plant noise levels, including permanent and temporary plant, will be designed to comply with the relevant noise level criteria detailed in this section of the report.

3.1 BACKGROUND NOISE MONITORING

Unattended noise monitoring was conducted between 29 September and 12 October 2011 using an Acoustic Research Laboratories monitor set on A-weighted fast response mode.

Unattended noise monitoring was conducted using Acoustic Research Laboratories monitors set on A-weighted fast response mode. The monitors were calibrated before and after the measurements using a Rion Type NC-73 calibrator. No significant drift was recorded.

Background noise levels are presented below.

Table 7 – Measured Background Noise Levels

Location	Background noise level dB(A)L_{90}		
Lismore Base Hospital	Daytime (7am-6pm)	Evening (6pm-10pm)	Night time (10pm-7am)
	39	39	34

3.2 NOISE EMISSION OBJECTIVES

The Environmental Protection Authority (EPA) Industrial Noise Policy provides guidelines for assessing noise impacts from development sites. The recommended assessment objectives vary depending on the potentially affected receivers, the time of day, and the type of noise source. The EPA's Industrial Noise Policy has two requirements which both have to be complied with, namely an amenity criterion and an intrusiveness criterion. In addition, the EPA in its Environmental Noise Control Manual states that noise controls should be applied with the general intent to protect residences from sleep arousal.

3.3 EPA INTRUSIVENESS CRITERION

The EPA guideline is intended to limit the audibility of noise emissions at residential receivers and requires that noise emissions measured using the L_{eq} descriptor not exceed the background noise level by more than 5 dB(A). Where applicable, the intrusive noise level should be penalised (increased) to account for any annoying characteristics such as tonality.

Table 8 – EPA Intrusiveness Criteria

Location	Time of Day	Background noise level dB(A)L_{90}	Noise Emission Criteria dB(A)L_{eq} (Background + 5dB)
Residential Properties on Northern Boundary of the Site	Day Time (7am – 6pm)	39	44
	Evening (6pm – 10pm)	39	44
	Night (10pm-7am)	34	39

3.4 EPA AMENITY CRITERION

The EPA guideline is intended to limit the absolute noise level from all industrial noise sources to a level that is consistent with the general environment.

The EPA's Industrial noise policy sets out acceptable noise levels for various localities. Table 2.1 on page 16 of the policy indicates 4 categories to distinguish different residential areas. They are rural, suburban, urban and urban/industrial interface.

Table 6 of the INP provides the recommended ambient noise levels for the suburban residential receivers for the day, evening and night periods. For the purposes of this condition:

- Day is defined as the period from 7am to 6pm Monday to Saturday and 8am to 6pm Sundays and Public Holidays;
- Evening is defined as the period from 6pm to 10pm; and
- Night is defined as the period from 10pm to 7am Monday to Saturday and 10pm to 8am Sundays and Public Holidays.

Table 9 – Recommended Amenity Industrial Noise Levels

Type of Receiver	Time of day	Recommended Acceptable Noise Level dB(A) L_{eq}
Residential	Day	55
	Evening	45
	Night	40

3.5 SLEEP AROUSAL

To minimise the potential for sleep arousal the $L_{1\ (1\ minute)}$ noise level of any specific noise source does not exceed the background noise level (L_{90}) by more than 15 dB(A) outside a resident's bedroom window between the hours of 10pm and 7am. The L_1 noise level is the level exceeded for 1 per cent of the time and approximates the typical maximum noise level from a particular source. Where the typical repeatable existing L_1 levels exceed the above requirement then the existing L_1 levels form the basis for, sleep disturbance criteria.

3.6 MECHANICAL PLANT TREATMENTS

As detailed plant selections have not been conducted at this time a detailed acoustic assessment of noise impact cannot be conducted.

A detailed mechanical noise assessment will be conducted once plant selections and services drawings have been finalised as part of the construction documentation to ensure noise levels comply with the criteria detailed in this report.

Based on experience with similar development acoustic treatments are both possible and practical using acoustic treatments such as lining of ductwork, acoustic silences, variable speed controllers, time switches, acoustic screens etc. General requirements for a number of potential plant items on the site are expanded on below.

3.6.1 Chillers / Air Handling Units

Units can be located on roof tops with an acoustic screen or in basement areas, with acoustic treatment to intake and exhaust as necessary.

These units would predominantly operate during the day, with the potential to operate with extended hours. Acoustic treatment to these units may be required to ameliorate noise impact to the surrounding residents and to comply with the criteria specified in this report and verified at CC stage.

3.6.2 Supply / Exhaust fans

Supply and exhaust fans may be located within the underground plant rooms or in rooftop plant areas. These units typically emit high noise levels and require acoustic treatment such as silencers and internal lined ductwork. Silencer requirements would be determined once fan selections have been completed at CC stage.

3.6.3 Condenser Units

Condensing units typically emit relatively low noise levels and with careful selection, it is possible that no further acoustic treatment would be necessary.

3.6.4 Minor Plant

Other minor plant items, such as bathroom or kitchen exhaust fans, will be required. These items typically emit relatively low noise levels and may require minimal acoustic treatment of a standard nature, such as internally lining of ductwork.

3.7 LOADING DOCK

3.7.1 Operation

At this stage, it is anticipated that the loading dock will operate between 6am and 2:30pm, 7 days a week. The loading dock will accommodate for vehicles up to 12.5m trucks. It is noted that only small delivery vehicles and vans will operate within the loading dock before the 7am period.

Development in the vicinity of the loading dock includes residential premises on Little Uralba Street.

3.7.2 Noise Emission Assessment

The primary noise sources as a result of the proposed works are as follows:

- Noise from the loading docks.
- Noise associated with vehicle circulation and the ramps.
- Noise as a result of increased traffic generation created by the site.

These noise sources will be discussed below.

3.7.2.1 Loading Dock Noise

The primary noise emissions from loading docks is from trucks moving into and out of the loading dock.

The nearest noise sensitive receiver is the single storey receivers on Little Uralba Street to the north east of the loading dock.

Noise emissions will be predicted assuming:

- Typical operating noise levels are as follows:
    - Truck (articulated truck) sound power level of 100-105dB(A)L_{eq} when manoeuvring.

    These noise levels have been derived based on previous measurements of loading dock and vehicle noise conducted by this office.
- There is never more than 1 large truck (semi-trailer) movement in any fifteen minute period.
- The manoeuvring period takes approximately 1 minute.
- No trucks will use the loading dock before 7am; only vans will be used during this time.
- That the acoustic treatments recommended in section 3.8 are adopted.

Predicted noise levels are assessed below. Noise emissions will be assessed with reference to the “evening time” acoustic criteria as this represents the most stringent time period for loading dock operation.

Table 10 –Loading Dock Noise Impacts

Receiver Location	Predicted Level	Noise Emission Objectives	Comment
Little Uralba Street	43dB(A)$L_{eq(15min)}$	44dB(A) – Daytime 44dB(A) - Evening	Complies Day and Evening

Noise emissions are capable of being compliant, provided the recommendations in section 3.8 are adopted.

3.7.3 Increased Traffic on Public Streets

Vehicular access to and from the site will be via the existing Uralba Street. Additional noise as a result of increased traffic generation on public streets will not be significant. There will be no significant increase in vehicle noise on public streets in residential areas as a result of the proposed loading dock.

3.8 RECOMMENDATIONS

The following treatments are recommended:

- Loading Docks:
    - Operating times limited as to between 7am and 2:30pm for 12.5m trucks.
    - Install acoustic lining to underside of the loading dock roof/slab over. Noise absorptive lining to consist of 50mm thick Echosoft or Bradford Ultraphon Lining or other material with minimum NRC 0.7. If required, lining can have a perforated metal facing – minimum perforation open area 25%.
    - Trucks to switch off engine when stopped in loading dock.
- Polished concrete finish is not recommended as the loading dock slab. Broom finish or similar is recommended to prevent tyre squeal.
- Entry ramps / turning path:
    - Noise screen is required to the outside edge of the entry ramp and turning path. Screen size must be minimum 2.5m from the finished floor level of the ramp and turning path. Screen to consist of lapped and capped timber, Colorbond or masonry.

4 HELICOPTER NOISE ASSESSMENT

This section of the report presents our assessment of potential acoustic impacts associated with the operation of a helicopter pad proposed to be constructed on the roof of the proposed Stage 3B of Lismore Hospital.

This section will:

- Review the proposed location and expected level of usage of the proposed helipad.
- Identify appropriate acoustic guidelines.
- Identify potentially affected noise receivers both within the development and external to the development.
- Determine acoustic treatments or planning controls for noise emissions from the helipad to be in compliance with formulated acoustic objectives.

4.1 HELIPAD LOACTION

The location for the Helipad is proposed to be located centrally on the podium roof slab of the Stage 3B development. The proposed Stage 3B development is bounded to the north and west by existing Lismore Hospital buildings. To the south of the Helipad are residential properties, the proposed Stage 1 and 2 Lismore Hospital car parking, and commercial allied health properties. To the east of Stage 3B are existing residential properties. Figure 1 and 2 detail the proposed location of the helipad and surrounding potentially affected receivers both internally and externally to the development.

It is anticipated that the helipad will typically accommodate Bell 412 and AW139 rescue and emergency helicopters (which are currently the potentially worst case typical emergency helicopter servicing Australian hospitals). The noise level for these helicopters is presented in the following Table.

Table 11 - Helicopter Noise Levels

Service	Helicopter	Noise Level dB(A) L_{max}
Emergency	Bell 412 / AW139	101dB(A) at 15m (helicopter approaching)*

- *Noise levels obtained from previously obtained measurements at Liverpool Hospital.

- The noise levels presented above present the typical “worst case scenario” for noise emissions. It should be noted that the noise emission assessment has been based on the noise levels generated by the Bell helicopter, as it anticipated to be the loudest helicopter to regularly use the helipad.

The proposed helipad is to be used for emergency flights only.

Figure 1 – Site Map (Sourced from SixMaps)

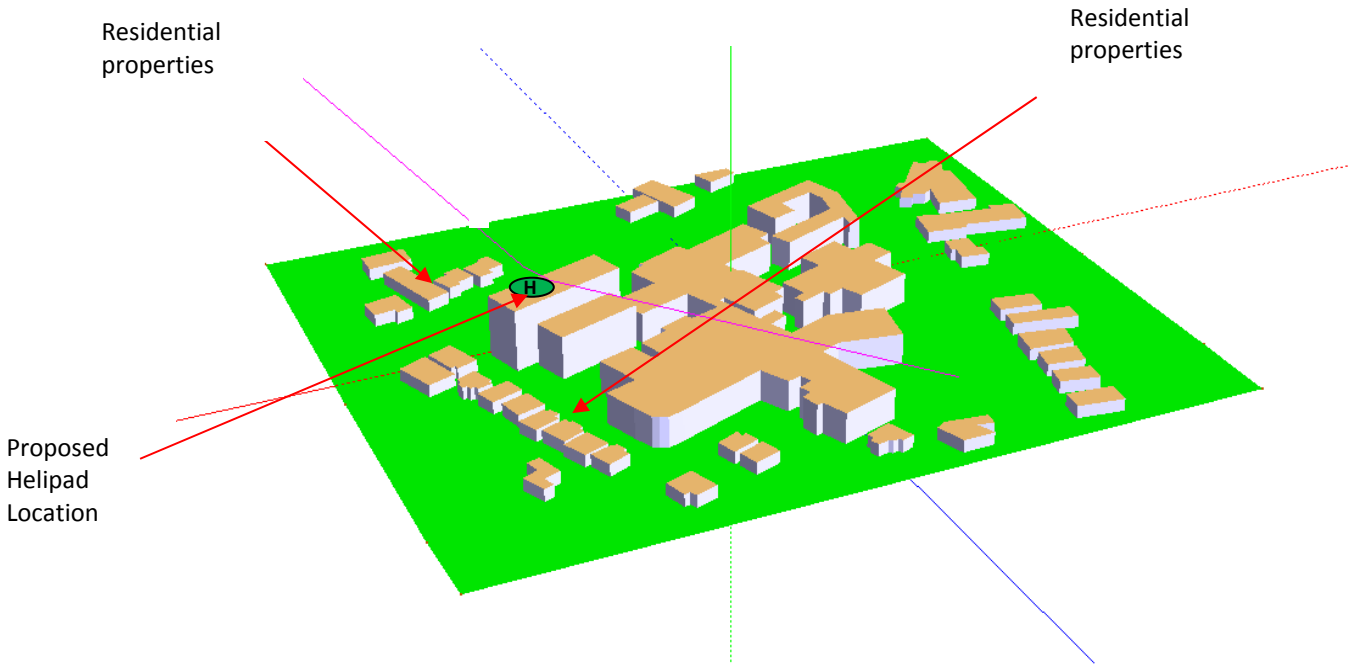


Figure 2 – 3D Site Map

4.2 ACOUSTIC CRITERIA / CONTROLS

4.2.1 Noise Impacts on Nearby Development - External

There are no mandatory acoustic criteria with respect to noise from emergency vehicles.

Acoustic guidelines such as the EPA *Industrial Noise Policy* and Australian Standard 2021:2000 are commonly adopted guidelines for noise emissions and for aircraft noise respectively. However, neither are appropriate for use in assessment of emergency helicopter noise, which is much more infrequent than industrial noise or noise from commercial aircraft.

Other relevant (although not mandatory) guidelines are:

- The EPA Noise Control Manual. Although no longer used by the EPA, the Noise Control Manual provides some guidance for helicopter noise. The Noise Control Manual recommends:

  - Peak noise events – noise not exceed 82dB(A)L_{max} at residential properties and 85dB(A)L_{max} at commercial properties.

  - Average noise levels (ie – the noise level averaged over the entire day) should not exceed 55dB(A) at residential properties and 65dB(A) at commercial properties.

  The Noise Control Manual, however, does not apply to emergency vehicles.

- Air Services Australia *Environmental Principles and Procedures for Minimising the Impact of Aircraft Noise*. Principle 7 states – *There should be a current agreed aircraft noise exposure level above which no person should be exposed, and agreement that this level should be progressively reduced. The goal should be 95dB(A).* (This performance goal was adopted at Royal North Shore, where there are typically 3-4 helicopter movements per week).

We note, however, that the above guidelines are not intended to be applied to emergency vehicles.

4.2.2 Noise Impacts Within the Hospital Campus

There are no mandatory Health Facilities Guidelines or similar documents which dictate required internal noise levels within hospitals during the operation of emergency transport vehicles.

Australian Standard 2021:2000 *"Aircraft Noise Intrusion - Building Siting and Construction"* is typically adopted in the assessment of general aircraft noise impacts on internal areas. However, a strict application of this standard is not recommended in façade design of the hospital, as:

- It is anticipated that there would be, on average, generally fewer than two flights per week serving the hospital.

- On any given day in which there is a flight, the noise impact is likely to occur for a short duration (approximately one minute on arrival, one minute on departure).

Design of the building shell of building will be undertaken with a view to achieving the internal noise levels set out in Table 9 below.

Table 12 - Recommended Internal Noise Level – Helicopter Noise

SPACE TYPE	NOISE LEVEL OBJECTIVE dB(A)L_{max}
Operating Theatres	65
Wards, Treatment Rooms, Consulting Rooms. Private Offices, Conference Rooms.	70
Offices – general, Laboratories	75
Service Areas	85
Mental Health Unit Wards	70

In our experience this is an acceptable noise level for noise generated as a result of emergency vehicles, bearing in mind the infrequency of these events. These target noise levels have been adopted on a range of NSW hospital development, including Royal North Shore, Westmead, Liverpool, Blacktown and Bega Hospitals.

4.3 SOUNDPLAN ANALYSIS

Although noise from emergency vehicles is exempted from acoustic controls, a review of potential noise impacts will be conducted to compare projected noise levels with the *Principles and Procedures for Minimising the Impact of Aircraft Noise* Principle 7. In order to determine the potential acoustic impact of the helipad on the Hospitals and surrounding properties, noise modelling of helicopter movements has been conducted within SoundPLAN®. SoundPLAN® is a software suite created by professionals in noise engineering for professionals working with noise and air pollution scenarios.

SoundPlan™ modelling software implements the ISO 9613-2:1996 “Acoustics – Attenuation of Sound During Propagation Outdoors – Part 2: General Method of Calculation” noise propagation Standard. This Standard predicts noise levels through directivity and spherical spreading effects and includes variables for atmospheric absorption, ground attenuation and screening.

The noise levels of the helicopters adopted in this analysis are as follows:

- Sound level generated by the design helicopter (Bell 412 / AW139) is 101B(A) at 15m (approach).
- A take-off/ approach gradient of 12.5^{o} as is typical of emergency helicopters.

- The above-mentioned data was input into SoundPLAN® to develop a noise contour level model taking into account the orientation of surrounding residences, building heights, air-absorption and potential screening effects where applicable. This SoundPLAN® permits accurate assessment of noise levels impinging on the façade of the proposed Hospitals and surrounding residences enabling the determination of acoustic ameliorative measures required.

Based on the typical approach gradient, the likely distance between the helicopter and the residential premises can be determined, and a resultant noise level determined.

Figures 4 to 7 details the results of the helicopter noise modelling.

Table 10 details the resultant predicted noise levels for the aforementioned configurations when a Bell 412 is used in proposed helipad locations.

It is noted that as these are emergency approaches, the helicopter could potentially approach from any direction.

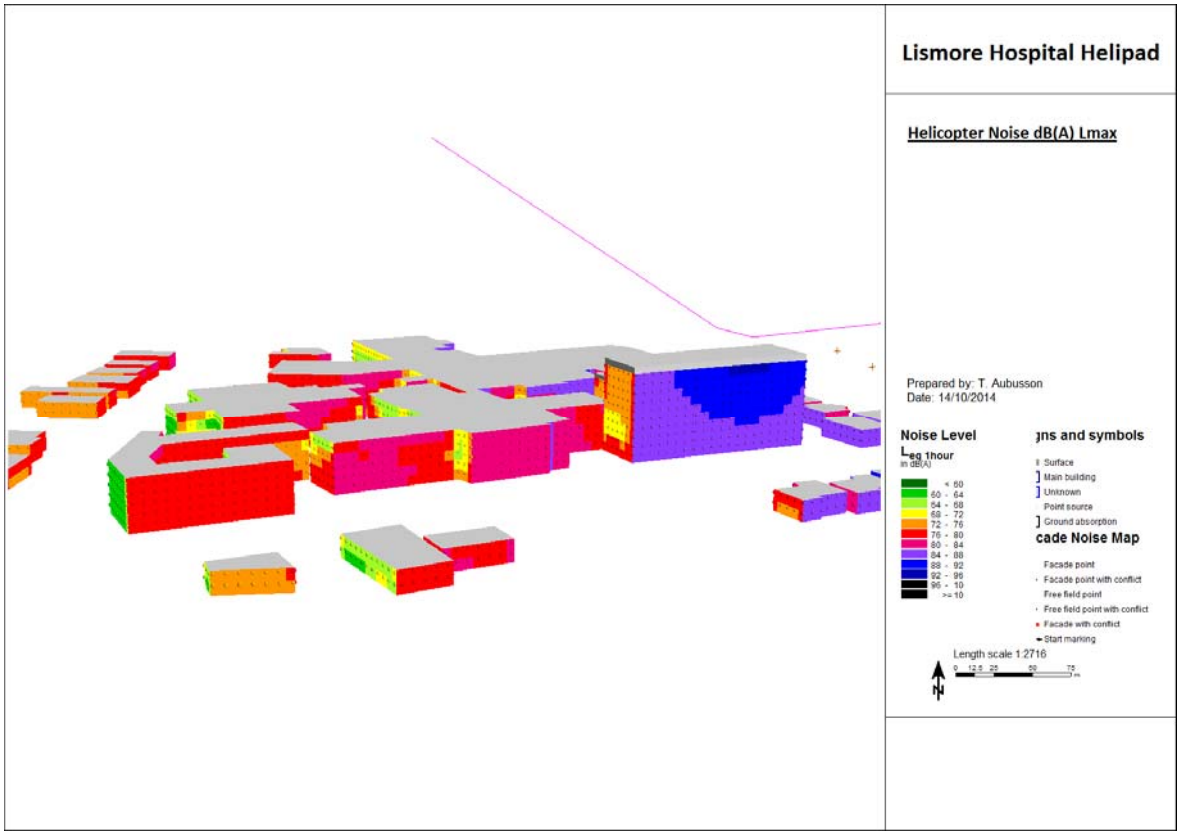


Figure 4 – Helicopter Noise – Southern View

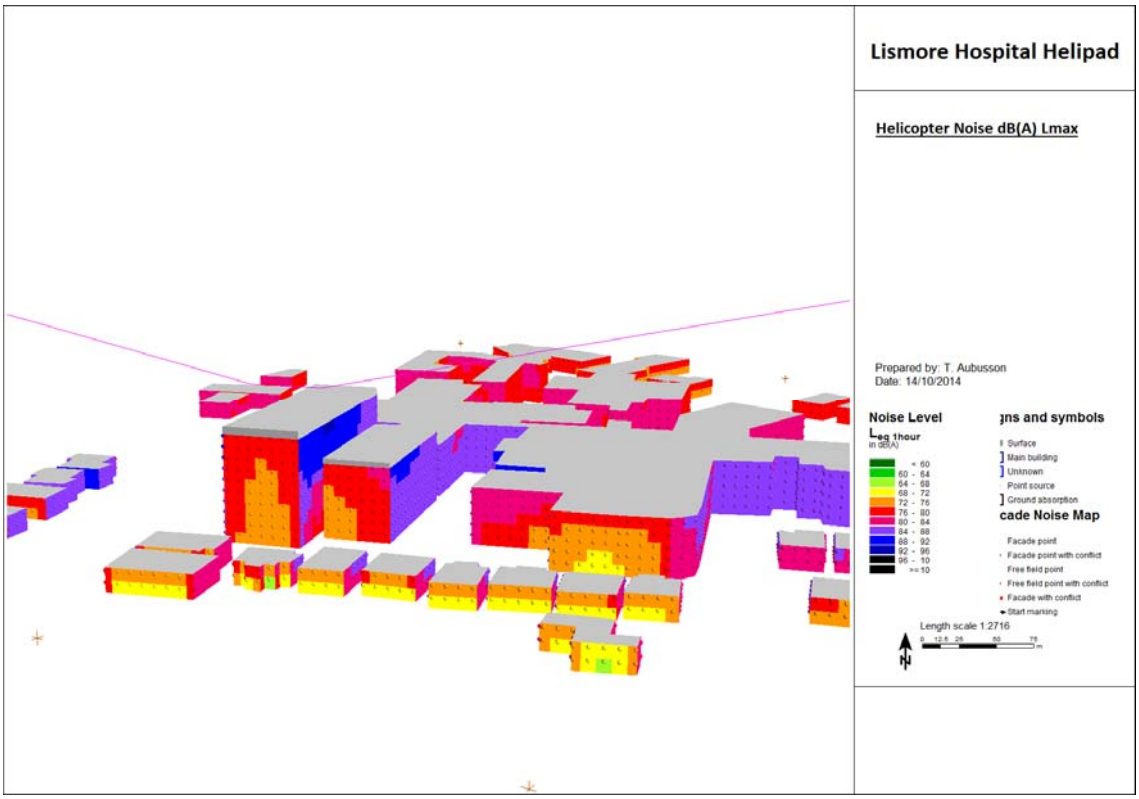


Figure 5 – Helicopter Noise – Eastern View

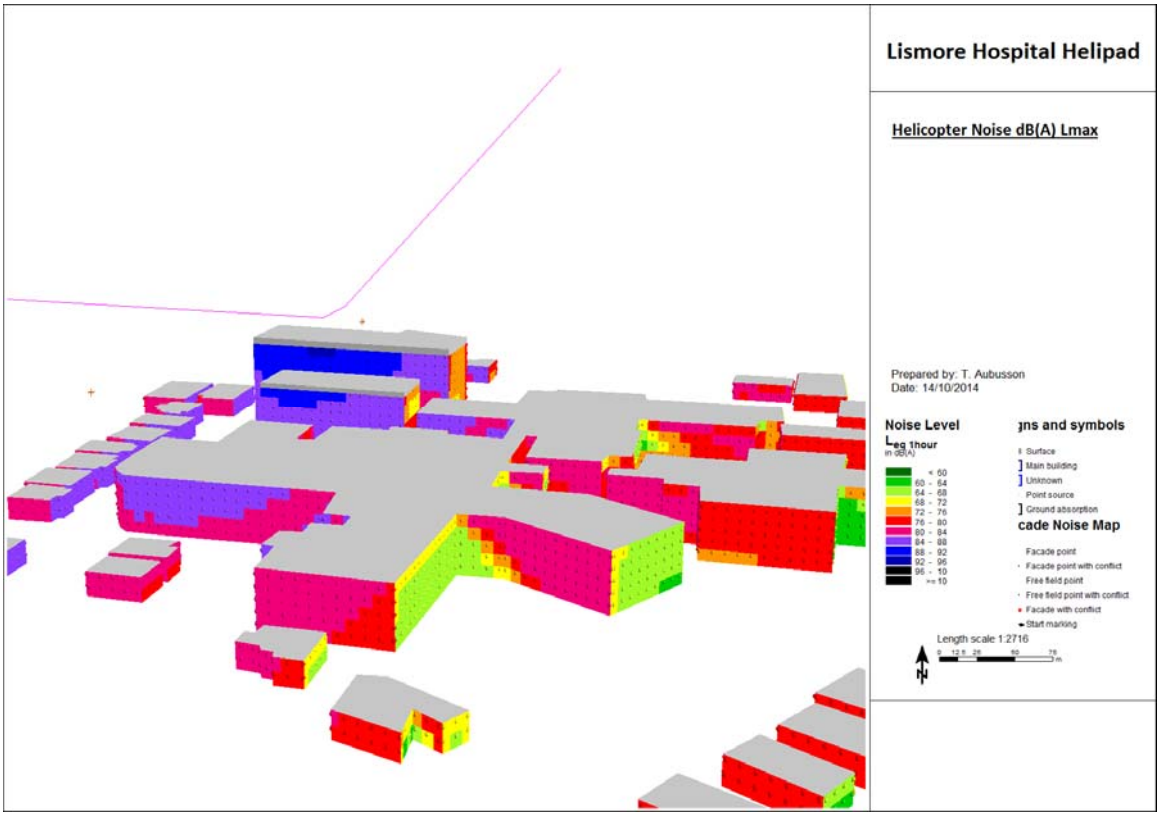


Figure 6 – Helicopter Noise – Northern View

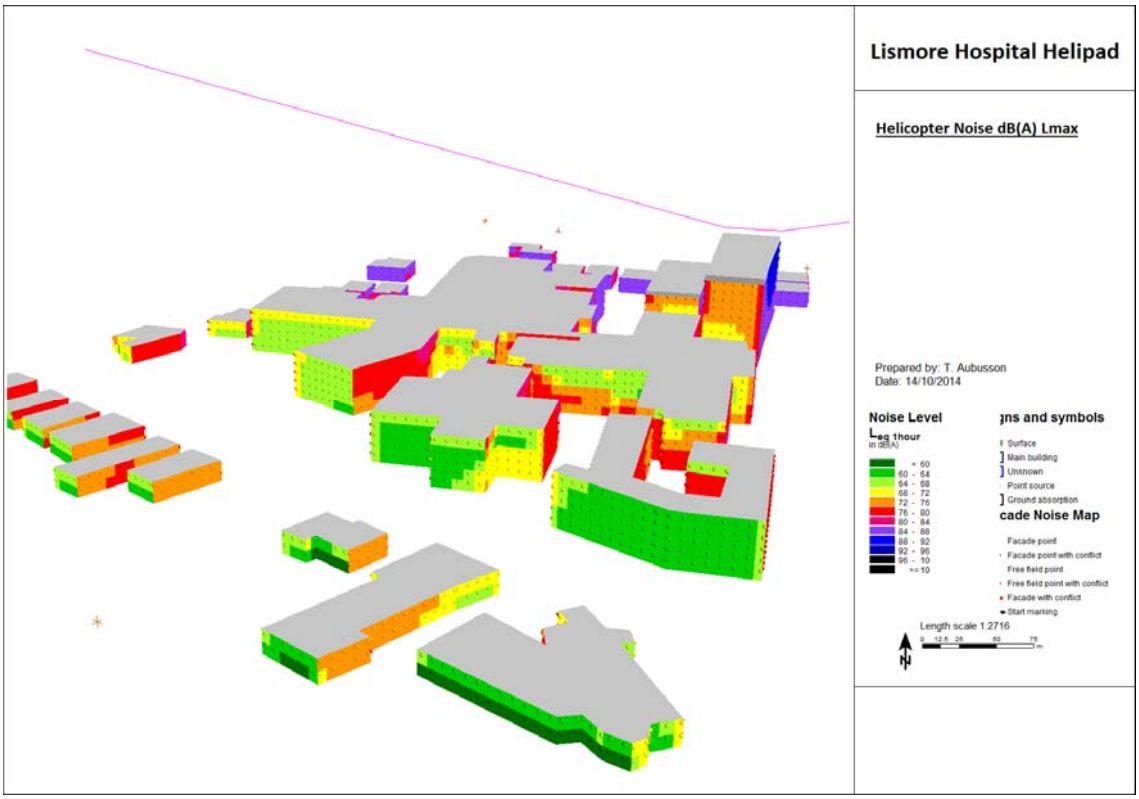


Figure 7 – Helicopter Noise – Western View

4.4 PROPOSED HELIPAD LOCATION RESULTS

Table 13 - Helicopter Noise – Worst Affected Residences – Bell 412

Receiver Location	Predicted Maximum Noise Level	Air Services Australia Guidelines External Noise	Complies
Residences Surrounding the site	70-90dB(A)L_{max}	95dB(A) L_{Max}	Yes

Table 14 - Helicopter Noise – Worst Affected Façade (Internal Development) – Bell 412

Location	Predicted Maximum Noise Level
Stage 3 Façade	96dB(A) L_{Max}

4.5 NOISE IMPACTS EXTERNALLY TO THE DEVELOPMENT – RESIDENTIAL RECEIVERS

- It is predicted that the 95dB(A) noise goal of Air Services Australia will be achieved at all times.

- The proposed helipad location is on the roof of the Stage 3B development, which increases the distance between the helicopters and residences, and subsequently significantly decreases the noise impact on surrounding residences than if it were located at ground level.

- The Bell 412 / AW139 requires that pilots approach to a landing decision point which is typically around 100 – 120 feet vertical of the helipad. This results in the helicopter staying elevated for longer on the approach, increasing the distance between the helicopter and affected residences. The benefit of this approach angle is that it will result in lower noise levels than approach gradients of other helicopters.

- In the proposed helipad position, the predicted worst case scenario noise level of approximately 90dB(A) at the residences is slightly less than what may be expected in the event of a police car/fire truck with siren (or other emergency vehicle) passing by a residential property at a distance of approximately 10m at ground level.

4.6 IMPACTS WITHIN THE HOSPITAL PRECICNT

Acoustic design of the building shell is to be undertaken so as to ensure noise levels compliant with table 9 are achieved. This will require, in principle:

- Any new Stage 3A or 3B roof within 50m of the helicopter flight path is recommended to be concrete.

- Any light weight roof element over an occupied space within 50m of the flight path should have 2x13mm plasterboard ceiling with 100mm thick insulation to ceiling cavity. We note, however, the light weight roofing within this 50m distance is likely to audibly vibrate as a result of the air-turbulence created by the helicopter. This system does not need to be applied to plant rooms.

- 10.38mm laminated glass is recommended for all ward rooms, offices, meeting rooms and treatment rooms within Stage 3B. Details of selected glazing will be provided as part of the CC submission.

- 10.38mm laminated glass / 100mm cavity / 6mm jockey sash is recommended for all operating theatres located on the façade from level 3 and above. Details of selected glazing will be provided as part of the CC submission.

- Any lightweight elements of the façade will be required to be upgraded in order to control noise to levels compliant with Table 1. Indicatively, depending on the location and area of the lightweight façade, the following would be required:

    - **Operating Theatre on L12 or L11** - 0.5mm steel external sheet with 9mm fc sheet backing/180mm insulated cavity with 2x16mm plasterboard internal lining.
    - **Wards / Offices or Treatment Rooms on L12 or L11 -** 0.5mm steel external sheet /180mm insulated cavity with 2x16mm plasterboard internal lining.
    - **Operating Theatre on L10 and below** - 0.5mm steel external sheet /180mm insulated cavity with 2x16mm plasterboard internal lining.
    - **Wards / Offices or Treatment Rooms on L10 and below -** 0.5mm steel external sheet /180mm insulated cavity with 2x13mm plasterboard internal lining.

Based on measurements of helicopter landing movements at similar helipads, no vibration attenuation treatments are necessary to prevent excessive vibration transmission from the helipad in to the hospital building.

It should be noted that this advice indicates that acoustic treatment of helicopter noise is both possible and practical and all glazing types / façade types should be further reviewed at Construction Certificate stage.

5 CONCLUSION

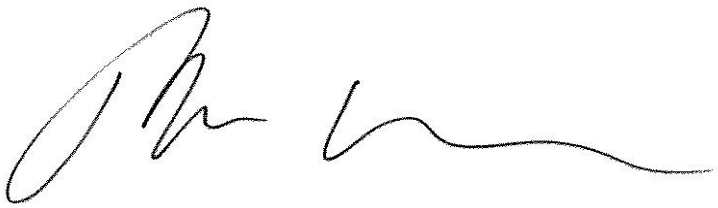
This document presents an assessment of demolition, excavation and construction noise impacts associated with the Lismore Base Hospital Stage 3B project. Measures to ensure adjoining receivers and existing hospital users are not adversely impacted are presented within this report.

The report also establishes noise emission goals for the operation of the Stage 3B project to ensure ongoing compliance once the development is complete.

Additionally an assessment of potential helicopter noise impact has been presented within this report. Building shell constructions to ensure helicopter noise complies with noise intrusion criteria has been detailed within this report.

We trust this information is satisfactory. Please contact us should you have any further queries.

Yours faithfully,



Acoustic Logic Consultancy Pty Ltd
Thomas Aubusson

APPENDIX ONE

CONSTRUCTION APPLIANCE COMPLIANCE CERTIFICATE

Lismore Base Stage 3B Project

Construction Appliance Compliance Certificate

Month .....

Year .....

Plant Item .....

Allowable Noise Level .....

Measured Noise Level .....

Complies Yes ☐ No ☐

Issuing Engineer .....

Sub-Contractor .....

Project Manager .....