Construction and Operational Noise and Vibration Assessment

Moree Hospital Redevelopment
Moree, NSW

Prepared for: OzArk Environment and Heritage
November 2023
MAC221546-02RP1V4

Muller Acoustic Consulting

Document Information

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Moree Hospital Redevelopment

Moree, NSW

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1 Introduction

Muller Acoustic Consulting Pty Ltd (MAC) has been commissioned by OzArk Environment and Heritage (OzArk), on behalf of Health Infrastructure (HI) and Hunter New England Local Health District (HNELHD) to complete a Construction and Operational Noise and Vibration Assessment (CONVA) for the Moree Hospital Redevelopment Project at Moree, NSW (the proposal).

This report presents the results, findings and recommendations of the CONVA and has been prepared to support the Review of Environmental Factors (REF) being prepared for the proposal. The assessment has been completed in general accordance with the following standards and guidelines:

- NSW Environment Protection Authority's (EPA's), Noise Policy for Industry (NPI), 2017;
- NSW Department of Environment and Climate Change (DECC), Interim Construction Noise Guideline (ICNG), 2009;
- NSW Department of Planning (DPI), Development Near Rail Corridors and Busy Roads – Interim Guidelines, 2008;
- NSW Department of Environment and Conservation (DEC), Assessing Vibration: A Technical Guideline, 2006;
- Transport for NSW (Transport), Construction Noise and Vibration Guideline (Roads) (CNVG), 2023;
- Standards Australia – AS 2436-2010 (R2016) Guide to Noise Control on Construction, Maintenance and Demolition Sites;
- Standards Australia AS 2107:2016 - Acoustics - Recommended design sound levels and reverberation times for building interiors;
- Standards Australia AS 1055:2018 (AS 1055) – Description and Measurement of Environmental Noise;
- Standards Australia AS IEC 61672.1-2019 Electroacoustics – Sound level meters – Specifications;
- British Standard BS 7385: Part 2-1993 "Evaluation and measurement for vibration in buildings Part 2"; and
- German Institute for Standardisation – DIN 4150 (1999-02) Part 3 (DIN4150-3) – Structural Vibration - Effects of Vibration on Structures.

A glossary of terms, definitions and abbreviations used in this report is provided in **Appendix A**.

1.1 Assessment Objectives

The CONVA quantifies potential construction noise and vibration impacts and operational noise intrusion to residential receivers adjacent to the proposal site.

Primary considerations in this assessment report include:

- provide a technical document that can support the REF for the proposal;
- identification of sensitive receivers;
- quantifying construction noise and vibration impacts from the proposal based on the proposal brief information;
- quantifying potential operational noise, including consideration of public address systems, alarms, mechanical services and maintenance activities;
- review of external transportation noise sources, including road, rail and aviation sources, and assessment of potential noise intrusion to adjacent receivers; and
- review reasonable and feasible control measures to mitigate noise and vibration emissions with the aim of meeting Noise Management Levels and relevant vibration criteria.

2 Project Description

2.1 Site Description

The Moree District Hospital (MDH) is an existing C2 District acute hospital located at 58 Victoria Terrace, Moree, on the Moree Plains of northern NSW.

The MDH is located immediately to the south of the Mehi River and is bounded by parkland to the north, residential and primary production land to the west, residential properties to the south and commercial premises to the east.

The existing hospital campus comprises several buildings and provides the following services:

- non-inpatient services via an emergency department, a renal dialysis unit, day surgery, oncology, chemotherapy and community health centre;
- acute inpatient services including general medicine, general surgery, obstetrics, paediatrics and palliative care;
- a range of specialist services provided via visiting surgeons including orthopaedics, ophthalmology, ear, nose and throat surgery; and
- clinical support services including general radiology unit, a private imaging service and a private pathology service.

The study area for the proposal is illustrated in **Figure 1**.

2.2 Proposal Background

The Moree Hospital Redevelopment (MHR) is dedicated to replacing existing aging infrastructure with new and repurposed buildings. The new building works will predominantly consist of the two-storey Acute Services Building (ASB) located on the southeastern area of the site.

Access to the ASB is provided by a dedicated undercover drop-off bay to accommodate two ambulances at the eastern end of the building, while building services and loading dock are situated at the western end of the building. Staff and visitor access to the building will be through the main entry along the northern façade opposite the carpark. The new ASB will be connected to buildings B4 and B1 via covered walkways. The projected use of the new facility will not increase parking needs.

The new ASB will generally be serviced with new dedicated plant enabling it to be functionally 'stand-alone', meaning that the remainder of the campus will remain as functional. A new services area will be located at the western end of building B3.

Disruption to existing buildings and infrastructure on the site will be limited to the demolition of the building B2, while carparking at the front of building B4 will be relocated to be adjacent to the existing main carpark.

A helicopter landing pad B36, decommissioned previously, will be demolished. Building B5, while not within the new ASB building footprint, will also be demolished due to its poor state of repair, its impact on future expansion, and to improve safety and security around the adjacent buildings.

To enable the construction of the new ASB and vehicular access, several trees will be removed, with the surrounding areas of the ASB landscaped as part of the development.

The MHR demolition plan and site plan for the proposal are presented in **Appendix B**.

2.3 Identification of Sensitive Receivers

The noise environment surrounding the proposal site is typical of a suburban environment, with dominant noise sources including local and highway traffic noise, and environmental noise (bird calls).

A review of aerial photography identifies that the study area comprises predominantly residential properties from the southeast to the west of the proposal site, active recreation areas from the northwest to the northeast of the proposal site, and commercial receivers from the east to southeast of the proposal site. The nearest residential receiver is located on Alice Street, approximately 30m from the proposal site. The closest non-residential receivers are the Moree District Ambulance Station approximately 70m southeast of the proposal site and the Moree Visitor Information Centre approximately 120m to the east of the proposal site.

The level of affectation for each receiver is influenced by the activity that is being undertaken and the distance and exposure of each receiver to the proposal site. It is noted that the area of affectation is the distance from the proposal where receivers may experience noise levels above the relevant Noise Management Levels. The locality plan identifying the position of the potentially affected receivers is provided in **Figure 2**.

FIGURE 1

Locality Map

MAC221546-02

Moree Hospital Redevelopment

KEY

Project Site

0 40 80 120 160 m

N

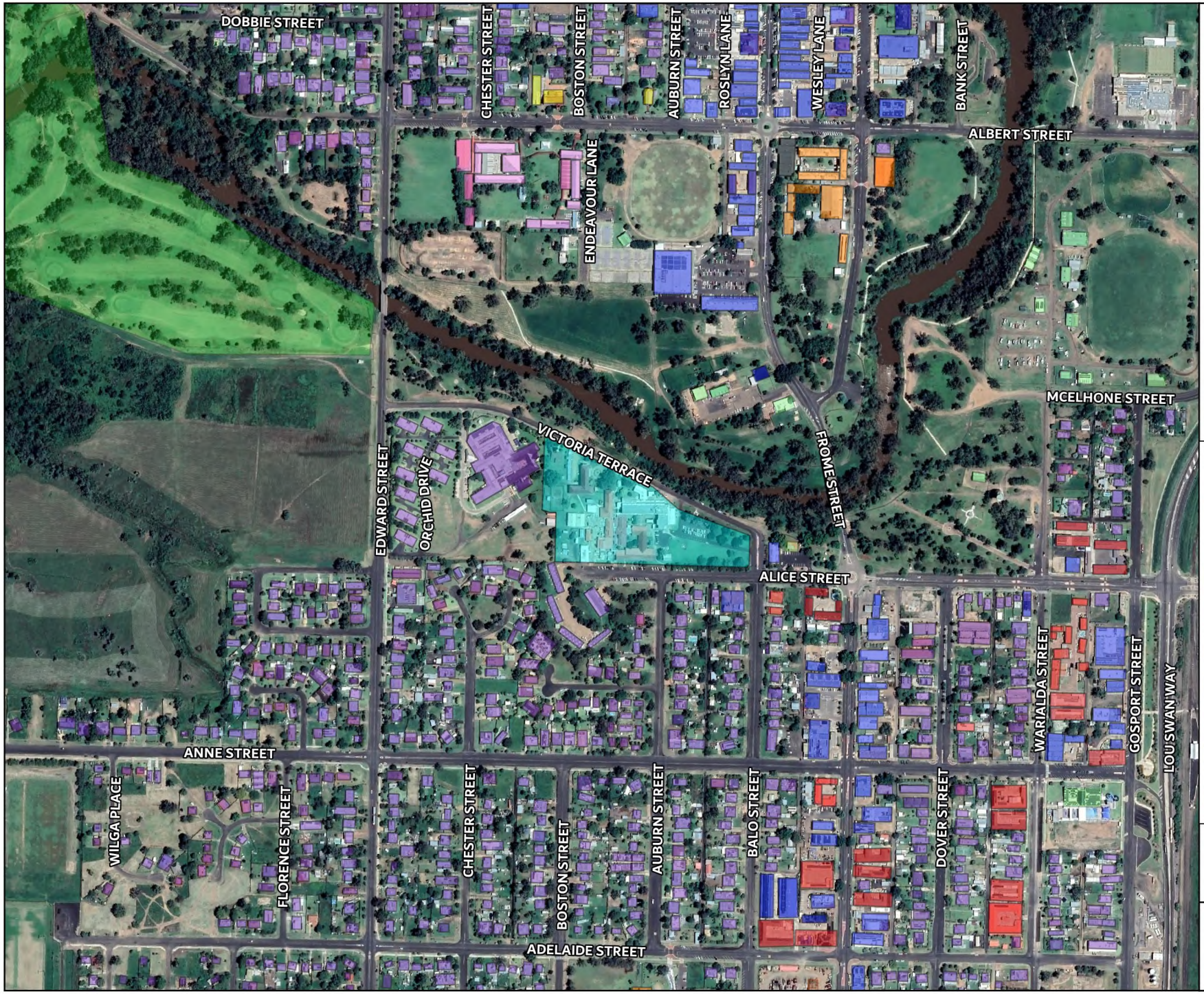

FIGURE 2

Receiver Map

MAC221546-02

Moree Hospital Redevelopment

KEY

- Project Site

Sensitive Receivers

- Residential
- Accommodation
- Commercial Receiver
- Education Institute
- Active Recreation
- Place of Worship
- Community Centre

0 70 140 210 280 m

N

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3 Existing Environment

The community's reaction to noise from construction may be influenced by the time of day that work is carried out. Residents are potentially more affected by work that occurs during OOH periods (ie evening or night periods). Therefore, it is important to understand the existing noise environment surrounding the proposal to manage and minimise potential noise impact on the environment and local community.

3.1.1 Rating Background Noise Levels

As per Section 2.3 of the Noise Policy for Industry (NPI, 2017). minimum assumed Rating Noise Levels (RBLs) apply in the NPI. The minimum assumed RBLs represent the lower threshold for the derivation of assessment criteria and management levels and represents a conservative and limiting case.

Due to access and timing constraints during the assessment window for the project, background noise monitoring was not able to be undertaken at the nearest or potentially most affected residential receiver(s). Hence, minimum RBLs have been conservatively adopted in this assessment to ensure the greatest outcomes for nearby receivers in the management of potential noise impacts.

The RBLs inform the intrusiveness noise level criteria during the day, evening and night periods in accordance with the NPI, and the Noise Management Levels (NMLs) as required by the ICNG. The minimum assumed RBLs are reproduced in **Table 1**.

Table 1 Minimum Assumed RBLs

Period[1]	Adopted RBL, dB LA_{90}
Day	35
Evening	30
Night	30

Note 1: Day - the period from 7am to 6pm Monday to Saturday or 8am to 6pm on Sundays and public holidays; Evening - the period from 6pm to 10pm; Night - the remaining periods.

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4 Construction Noise Impact Assessment

4.1 Construction Noise Policy and Guidelines

The assessment and management of noise from construction work is completed with reference to the Interim Construction Noise Guideline (ICNG). The ICNG is specifically aimed at managing noise from construction work regulated by the EPA and is used to assist in setting statutory conditions in licences or other regulatory instruments.

The ICNG sets out procedures to identify and address the impact of construction noise on residences and other sensitive land uses. This section provides a summary of noise objectives that are applicable to the assessment. The ICNG provides two methodologies for the assessment of construction noise emissions:

- quantitative, which is suited to major construction proposals with typical durations of more than three weeks; and
- qualitative, which is suited to short term infrastructure maintenance (for proposals with a typical duration of less than three weeks).

The methodology for a quantitative assessment requires a more complex approach, involving noise emission predictions from construction activities to the relevant assessment locations, whilst the qualitative assessment methodology is a more simplified approach that relies primarily on noise management strategies.

This report has adopted a quantitative assessment approach. The assessment includes identification of potentially affected assessment locations, description of activities involved in the proposal, derivation of the construction noise criteria for standard and out of hours (OOH) periods, quantification of potential noise impacts at receivers and, provides management and mitigation recommendations.

4.1.1 Standard Hours for Construction

Table 2 presents the ICNG recommended standard hours for construction works.

Table 2 Recommended Standard Hours for Construction

Daytime	Construction Hours
Monday to Friday	7am to 6pm
Saturdays	8am to 1pm
Sundays or Public Holidays	No construction

These recommended hours do not apply in the event of direction from police, or other relevant authorities, for safety reasons or where required in an emergency to avoid the loss of lives, property and/or to prevent environmental harm.

Construction activities are anticipated to be undertaken primarily during standard constructions hours. It is understood that minor works to the existing hospital may be undertaken during out of hours work periods, however, these works will be internal and will not generate significant noise emissions. Hence, construction works during out of hours work periods have not been assessed further.

4.1.2 Construction Noise Management Levels

Table 3 reproduces the ICNG management levels for residential receivers. The construction Noise Management Level (NML) is the sum of the management level and relevant Rating Background Level (RBL) for each specific assessment period.

Table 3 ICNG Residential Management Levels

Time of Day	Management Level $LA_{eq(15min)}$[1]	How to Apply
Recommended standard hours: Monday to Friday 7am to 6pm Saturday 8am to 1pm No work on Sundays or public holidays.	Noise affected RBL + 10dB.	The noise affected level represents the point above which there may be some community reaction to noise. Where the predicted or measured LAeq(15min) is greater than the noise affected level, the proponent should apply all feasible and reasonable work practices to meet the noise affected level. The proponent should also inform all potentially impacted residents of the nature of works to be carried out, the expected noise levels and duration, as well as contact details.
	Highly noise affected 75dBA.	The highly noise affected level represents the point above which there may be strong community reaction to noise. Where noise is above this level, the relevant authority (consent, determining or regulatory) may require respite periods by restricting the hours that the very noisy activities can occur, taking into account: • times identified by the community when they are less sensitive to noise such as before and after school for works near schools, or mid-morning or mid-afternoon for works near residences. • if the community is prepared to accept a longer period of construction in exchange for restrictions on construction times.
Outside recommended standard hours.	Noise affected RBL + 5dB.	A strong justification would typically be required for works outside the recommended standard hours. The proponent should apply all feasible and reasonable work practices to meet the noise affected level. Where all feasible and reasonable practices have been applied and noise is more than 5dBA above the noise affected level, the proponent should negotiate with the community. For guidance on negotiating agreements see section 7.2.2.

Note 1: The Rating Background Level (RBL) is an overall single figure background level representing each assessment period over the whole monitoring period. The RBL is used to determine the construction NML for noise assessment purposes and is the median of the ABL's.

Table 4 reproduces the ICNG management levels for other receiver types.

Table 4 Noise Management Levels for Other Noise Sensitive Receivers

Land use	Where objective applies	Management Level $LA_{eq(15min)}$[1]
Classrooms at schools and other educational institutions	Internal noise level	45dB
Hospital wards and operating theatres	Internal noise level	45dB
Places of worship	Internal noise level	45dB
Active recreation areas	External noise level	65dB
Passive recreation areas	External noise level	60dB
Commercial premises	External noise level	70dB
Industrial premises	External noise level	75dB

Note 1: Noise Management Levels apply when receiver areas are in use only.

Where the predicted or measured $LA_{eq(15min)}$ noise level is greater than the NML, the proponent should apply all feasible and reasonable work practices to meet the relevant NML.

4.2 Construction Noise Management Levels (Criteria)

Construction NMLs for residential receivers are established from the prevailing background noise levels of the locality. The NMLs for standard and out of hours work periods are summarised in **Table 5** for residential receivers and **Table 6** for applicable non-residential receivers.

Table 5 Construction NMLs – Residential Receivers

Location	Assessment Period	RBL, dBA	NML dB $LA_{eq(15min)}$	Highly noise affected NML[1] dB $LA_{eq(15min)}$
All residential receivers	Day (Standard Hours)	35	45 (RBL+10dBA)	75
	Evening (OOH Period 1)	30	35 (RBL+5dBA)	75
	Night (OOH Period 2)	30	35 (RBL+5dBA)	75

Note 1: The highly noise affected NML is a hypothetical level that is adopted to ensure the avoidance of strong community reaction. Should this level be exceeded the construction methodology is to be reviewed to reduce the impact on surrounding sensitive receivers.

Table 6 Construction NMLs – Non-Residential Receivers

Location	Assessment Period	Where NML Applies	NML dB $LA_{eq(15min)}$
Education Institution	When in use	External noise level	65[1]
Active Recreation	When in use	External noise level	65
Commercial Receivers[2]	When in use	External noise level	70

Note 1: External noise criteria derived using 20dBA façade attenuation for a closed facade as per Table 4.2 of ENMM.
Note 2: Includes accommodation services during the day period.

4.3 Noise Assessment Methodology

A computer model was developed to quantify project noise emissions to neighbouring receivers using DGMR (iNoise, Version 2024) noise modelling software. iNoise is an intuitive and quality assured software for industrial noise calculations in the environment. 3D noise modelling is considered industry best practice for assessing noise emissions from projects.

The model incorporated a three-dimensional digital terrain map giving all relevant topographic information used in the modelling process. Additionally, the model uses relevant noise source data, ground type, attenuation from barrier or buildings and atmospheric information to predict noise levels at the nearest potentially affected receivers. Where relevant, modifying factors in accordance with Fact Sheet C of the NPI have been applied to calculations.

The model calculation method used to predict noise levels was in accordance with ISO 9613-1 'Acoustics - Attenuation of sound during propagation outdoors. Part 1: Calculation of the absorption of sound by the atmosphere' and ISO 9613-2 'Acoustics - Attenuation of sound during propagation outdoors. Part 2: General method of calculation' including corrections for meteorological conditions using CONCAWE[1]. The ISO 9613 standard from 1996 is the most used noise prediction method worldwide. Many countries refer to ISO 9613 in their noise legislation. However, the ISO 9613 standard does not contain guidelines for quality assured software implementation, which leads to differences between applications in calculated results. In 2015 this changed with the release of ISO/TR 17534-3. This quality standard gives clear recommendations for interpreting the ISO 9613 method. iNoise fully supports these recommendations. The models and results for the 19 test cases are included in the software.

[1] Report no. 4/18, "the propagation of noise from petroleum and petrochemical complexes to neighbouring communities", Prepared by C.J. Manning, M.Sc., M.I.O.A. Acoustic Technology Limited (Ref.AT 931), CONCAWE, Den Haag May 1981

4.4 Proposed Works and Construction Scenarios

Construction activities considered to have the greatest potential for noise impact on nearby receivers were determined in consultation with the NSW Public Works (PW). The construction scenarios included in this assessment are described in **Table 7** and the typical plant and equipment, along with the fleet Sound Power Level (SWL) and maximum noise levels (LA_{max}) for each of the construction activities are provided in **Table 8**. The fleet Sound Power Levels, and maximum noise levels were sourced from the Transport for NSW (TfNSW) Construction and Maintenance Noise Estimator tool.

The precise locations and types of equipment used for construction are not known in detail at the concept design phase of the proposal. Hence, the construction fleet for each activity was modelled across the potential extent of each work area, with all plant and equipment operating simultaneously and at maximum capacity for the duration of the assessment period. It is noted that typical construction plant and equipment are unlikely to operate simultaneously but may be used sequentially across each part of the construction area. On that basis, this assessment provides a broad assessment of the likely worst-case impacts from each stage of the construction works.

Table 7 Proposed Construction Scenarios

Scenarios	Description
S1 – Demolition of existing structures	■ Demolition of existing structures ■ Breaking up rubble including existing footings
S2 – Bulk earthworks	■ Excavation and relocation of fill across the site ■ Removal of excess fill using truck and dog type arrangements
S3 – Site Preparation and footings	■ Construction of footings / foundations ■ Installation of services
S4 – Construction of buildings	■ Erection of structures ■ Building facades ■ Internal fit out ■ Landscaping

Table 8 Construction Scenarios & Fleet Sound Power Levels dB $LA_{eq(15min)}$ – Construction Phase					
Item	SWLs	Construction Scenarios			
		S1 Demolition	S2 Earthworks	S3 Site Preparation	S4 Construction
Excavator (20t)	105	✓	✓		
Excavator Hammer (10t)	118	✓			
Loader – Front End / Telehandler	112	✓			
Tipper Truck	108	✓	✓		
Genset	98	✓			✓
Grinder / Impact Wrench	109	✓			✓
Dozer (D6)	110		✓		
Roller	109		✓		
Backhoe / Trencher	104			✓	
Concrete Truck	109			✓	
Concrete Pump	109			✓	
Truck (10t)	103			✓	✓
EWP	95				✓
Franna	98				✓
Mobile Crane	105				✓
Hand Tools (Powered)	102				✓
Welding Equipment	110				✓
Total Fleet SWL		**120**	**113**	**113**	**114**

4.5 Construction Noise Levels

Construction noise levels have been predicted for sensitive receiver locations for each of the construction scenarios described in **Section 4.4**. A summary of the predicted $LA_{eq(15min)}$ noise emissions is presented for the most affected receiver location for each receiver type in **Table 9**. Predicted levels exceeding the NMLs are displayed **BOLD** text.

Table 9 Summary of Noise Assessment Results – Most Affected Receivers

Receiver Type	Period	NML (dB LA_{eq})	Highest Predicted dB LA_{eq} Per Scenario[1]			
			Demolition	Earthworks	Site Prep	Construction
Residential	Standard	45	**68**	**63**	**65**	**64**
Education Institution	When in use	65[2]	48	43	43	42
Active Recreation	When in use	65	64	59	60	59
Commercial[3]	When in use	70	66	61	62	62

Note 1: Exceedance of relevant NMLs highlighted and shown in **BOLD**.

Note 2: External noise criteria derived using 20dBA façade attenuation for a closed facade as per Table 4.2 of ENMM.

Note 3: Includes accommodation services during the day period.

The results of the assessment demonstrate that $LA_{eq(15min)}$ noise emissions would be above the relevant NMLs for residential receivers for all construction scenarios during standard construction hours. The highest $LA_{eq(15min)}$ noise levels are predicted at up to 68dB at 74 and 76 Alice Street, Moree, NSW during demolition of existing structures (S1). Construction noise levels are predicted to remain below the highly affected NML of 75dB $LA_{eq(15min)}$ at all residential receivers.

The construction noise emissions are predicted to remain below the relevant NMLs for all non-residential receivers during each construction scenario.

Further analysis was undertaken to determine the potentially affected distance from the project site, and the number of residential receivers within the affected area for each of the construction scenarios. The results of the analysis are provided in **Table 10**. For detailed mapping of the affected areas, noise contours for each modelled scenario are presented in **Appendix C**.

Table 10 Affected Distances – Construction Activities				
Receiver Type	Construction Scenario	NML dB $LA_{eq(15min)}$	Affected Distance (m)	Number of Receivers Affected
Residential	S1 – Demolition	45	~560	~200
	S2 – Earthworks		~315	~45
	S3 – Site Preparation		~420	~55
	S4 – General Construction		~330	~50

The results of the assessment demonstrate that during demolition works, residential receivers located within approximately 560m of the project site may experience noise levels above the relevant NML for standard construction hours, with up to 200 houses potentially affected. During earthworks, up to 45 residential receivers within approximately 315m of the project site are predicted to experience noise levels above the standard hours NML, while up to 55 receivers within 420m and 50 receivers within 330m of the project site are predicted to experience noise levels above the standard hours NML during site preparation works and general construction works respectively.

Potential mitigation measures to minimise the impacts of construction noise on nearby sensitive receivers are discussed in **Section 4.6**.

4.6 Construction Noise Mitigation Measures

Noise modelling identifies that relevant NMLs for the project may be exceeded during each of the proposed construction activities. The ICNG and Standards Australia AS 2436-2010 “Guide to Noise Control on Construction, Maintenance and Demolition Sites” outline noise management and mitigation initiatives to minimise the impact and improve the acoustic amenity of receivers potentially affected by construction projects.

Recommendations provided in the ICNG and AS2436 include combinations of operational strategies, source noise control strategies, noise barrier controls, and community consultation. Adopting strategies contained in this standard may result in the following noise attenuation:

- up to 10dBA where space requirements place limitations on the attenuation options available; and
- up to 20dBA in situations where noise source noise mitigation measures (silencers, mufflers, etc) can be combined with noise barriers and other management techniques.

The potential mitigation measures are provided in Table 11.

Table 11 Standard Mitigation Measures

Action Required	Management Measures
Universal Work Practices	
Pre-Construction / Site Inductions	All employees, contractors and subcontractors are to receive an environmental induction. The induction must at least include: • relevant noise and vibration mitigation measures • licence and approval conditions • permissible hours of work • limitations on high noise generating activities • location of nearest sensitive receivers • construction employee parking areas • designated loading/unloading areas and procedures • site opening/closing times • environmental incident procedures.
	Implement a noise monitoring program to quantify noise emissions from construction activities and guide practical reasonable and feasible noise control measures.
Plan Worksites	Locate compounds away from sensitive receivers and discourage access from local roads.
	Plan traffic flow, parking and loading/unloading areas to minimise reversing movements within the site.
Site Practices / Behavioural Practices	Conduct toolbox talks pre-shift to communicate awareness regarding the importance of noise emission management.
	Ensure site managers periodically check the site and nearby residences and other sensitive land uses for noise problems so that solutions can be quickly applied.
	Include in tenders, employment contracts, subcontractor agreements and work method statements clauses that require minimisation of noise and compliance with directions from management to minimise noise
	Avoid shouting and minimise talking loudly. Avoid dropping materials from height, throwing of metal items and slamming of doors.
	Keep truck drivers informed of designated vehicle routes, parking locations, acceptable delivery hours or other relevant practices
	Encourage workers to operate equipment in a conservative manner.

Table 11 Standard Mitigation Measures	
Action Required	**Management Measures**
Notification	Provide information to neighbours detailing work activities, dates and hours, impacts and mitigation measures, work schedule over the night period, any operational noise benefits from the works (where applicable) and contact telephone number.
	Notifications should be a minimum of 7 calendar days prior to the start of the works.
	Use site information board at the front of the site with relevant details about site contacts, hours of operation and regular information updates.
Complaints Handling	Have a documented complaints handling procedure with an escalation procedure so that if a complaint is not satisfied, there is a clear path to follow.
	Implement all feasible and reasonable measures to address the source of the complaint.
	Keep a register of any complaints including all relevant details and provide a quick response to all complaints.
Construction Method	Use quieter and less vibration emitting construction methods where feasible and reasonable (eg bore piles rather than impact driven piles).
Equipment / Maintenance	Select the quietest plant to perform a specific function and consider the noise levels of plant and equipment in rental or purchasing decisions.
	Regularly inspect and maintain equipment to ensure that it is in good working order.
	Equipment must not be operated until it is maintained or repaired, where maintenance or repair would address an annoying character of noise identified.
	Return any hired equipment that is causing noise that is not typical for the equipment – the increased noise may indicate the need for repair.
Site Practices	The offset distance between noisy plant and adjacent sensitive receivers should be maximised and restrict areas that mobile plant can be operated during sensitive times.
	Maximise shielding between plant and adjacent sensitive receivers by making use of natural landforms, temporary structures and stockpiles, and barriers.
	Operate plant in a quiet and efficient manner. Reduce throttle settings and turn off equipment when not being used.
	Where practicable, avoid the coincidence of noisy plant/machinery working simultaneously in close proximity to sensitive receivers.
	Minimise disturbance arising from delivery of goods to construction sites by: • avoid queuing of vehicles where practicable or ensure engines are switched off to reduce their overall noise impacts on receivers • minimise the use of engine brakes • fit delivery vehicles with straps rather than chains • select site access points and roads as far away as possible from sensitive receivers and provide shielding where practicable.

Table 11 Standard Mitigation Measures	
Action Required	**Management Measures**
Work Scheduling	Where feasible and reasonable, construction should be carried out during standard construction hours (daytime period). Work generating high noise and/or vibration should be scheduled during less sensitive time periods.
	Where additional activities or plant may only result in a marginal noise increase and speed up works, consider limiting duration of impacts by concentrating noisy activities at one location and move to another as quickly as possible.
	Schedule delivery of materials to occur during the day or early evening periods only.
	Organise deliveries and access to optimise the number of vehicle trips to and from the site – movements can be organised to amalgamate loads rather than using a number of vehicles with smaller loads.
Physical Methods	Reduce the line-of-sight transmission from noise emissions sources to residences or other sensitive land uses using temporary barriers or mobile screens.
	Erect temporary noise barriers before work commences to ensure noise is minimised during the entire shift.
	Consider the height of mobile screens and barriers to ensure adequate shielding to multistorey dwellings.

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5 Construction Vibration Impact Assessment

5.1 Construction Vibration Criteria

British Standard BS 7385:Part 2-1993 “Evaluation and measurement for vibration in buildings Part 2”, gives guidance on the levels of vibration which building structures could be damaged. BS7385 also takes into consideration the frequency of the vibration which is critical when assessing the likelihood of building damage.

Guide values are set for building vibration based on the lowest vibration levels above which damage has been credibly demonstrated. These levels are judged to result in a minimum risk of vibration-induced damage, where minimal risk for a named effect is usually taken as a 95% probability of no effect.

The recommended limits (guide values) for transient vibration to ensure minimal risk of cosmetic damage to residential and heavy commercial/industrial buildings are presented in **Table 12**. Where sources of continuous vibration may give rise to dynamic magnification due to resonance, the values provided in **Table 12** should be reduced by 50%, this is especially the case with respect to Peak Particle Velocity (PPV) at lower frequencies.

Table 12 Transient Vibration Guide Values - Minimal Risk of Cosmetic Damage

Line	Type of Building	Peak Component Particle Velocity in Frequency Range of Predominant Pulse	
		4 Hz to 15 Hz	15 Hz and above
1	Reinforced or framed structures Industrial and heavy commercial buildings	50 mm/s at 4 Hz and above	
2	Unreinforced or light framed structures Residential or light commercial type buildings	15 mm/s at 4 Hz increasing to 20 mm/s at 15 Hz	20 mm/s at 15 Hz increasing to 50 mm/s at 40 Hz and above

5.2 Heritage Items

It is noted that the Roads and Maritime CNVG and BS7385 do not specify recommended vibration limits or minimum working distances for heritage items or other sensitive structures. BS7385 indicates that heritage buildings and structures should not be assumed to be more sensitive to vibration unless they are found to be structurally unsound. If a heritage building or structure is structurally unsound (following inspection) a more conservative cosmetic damage objective as per DIN 4150 would be applicable.

German Standard DIN 4150 - Part 3: 1999 provides guideline values for vibration velocity to be used with evaluating the effects of short-term vibration on structures, including for sensitive structures such as heritage items. The DIN 4150 values are summarised in **Table 13.**

Table 13 Structural Damage Guideline – DIN4150

Type of Structure	Vibration Velocity in mm/s			
	Less than 10Hz	10Hz to 50 Hz	50Hz to 100Hz	… at horizontal plane of highest floor (all frequencies)
Buildings used for commercial purposes, industrial buildings and buildings of similar design	20	20 to 40	40 to 50	40
Dwellings and buildings of similar design and/or use	5	5 to 15	15 to 20	15
Structures that because of their particular sensitivity to vibration do not correspond to those above and have intrinsic value (e.g. heritage buildings)	3	3 to 8	8 to 10	8

Table 13 demonstrates that for sensitive buildings such as heritage structures, the guideline vibration values for effects on structures are typically half of those for dwellings. Therefore, based on the DIN 4150 structural damage guidelines, the minimum working distance for heritage structures that are found to be structurally unsound would be approximately equal to twice the minimum working distance for other building types. Human Comfort – Assessing Vibration a Technical Guideline.

5.3 Human Comfort – Assessing Vibration a Technical Guideline

Humans are far more sensitive to vibration than is commonly realised and may detect vibration levels which are well below levels that may cause damage to buildings or structures. Assessing vibration: a technical guideline was published in February of 2006 by the DECC and is based on guidelines contained in BS 6472 – 1992, Evaluation of human exposure to vibration in buildings (1-80 Hz) and provides guidance on assessing vibration against human comfort.

The guideline presents preferred and maximum vibration values for use in assessing human responses to vibration and provides recommendations for measurement and evaluation techniques. At vibration values below the preferred values, there is a low probability of adverse comment or disturbance to building occupants. Where all feasible and reasonable mitigation measures have been applied and vibration values are still beyond the maximum value, it is recommended the operator negotiate directly with the affected community.

The guideline defines three vibration types and provides direction for assessing and evaluating the applicable criteria. Table 2.1 of the guideline provides examples of the three vibration types and has been reproduced in **Table 14**.

Table 14 Examples of types of vibration (from Table 2.1 of the guideline)		
Continuous Vibration	Impulsive Vibration	Intermittent Vibration
Machinery, steady road traffic, continuous construction activity (such as tunnel boring machinery)	Infrequent: Activities that create up to three distinct vibration events in an assessment period, e.g. occasional dropping of heavy equipment, occasional loading and unloading. Blasting is assessed using ANZECC (1990)	Trains, intermittent nearby construction activity, passing heavy vehicles, forging machines, impact pile driving, jack hammers. Where the number of vibration events in an assessment period is three or fewer these would be assessed against impulsive vibration criteria.

5.3.1 Continuous Vibration

Appendix C of the guideline outlines acceptable criteria for human exposure to continuous vibration (1-80 Hz), the criteria are dependent on both the time of activity (usually daytime or night-time) and the occupied place being assessed. **Table 15** reproduces the preferred and maximum criteria relating to measured peak velocity.

Table 15 Criteria for Exposure to Continuous Vibration			
Place	Time[1]	Peak Velocity (mm/s)	
		Preferred	Maximum
Critical working Areas (e.g. hospital operating theatres, precision laboratories)	Day or Night	0.14	0.28
Residences	Day	0.28	0.56
	Night	0.20	0.40
Offices	Day or Night	0.56	1.1
Workshops	Day or Night	1.1	2.2

Note: rms velocity (mm/s) and vibration velocity value (dB re 10^{-9} mm/s) values given for most critical frequency >8Hz assuming sinusoidal motion.

Note 1: Daytime is 7am to 10pm and Night-time is 10pm to 7am.

5.3.2 Impulsive Vibration

Appendix C of the guideline outlines acceptable criteria for human exposure to impulsive vibration (1-80 Hz), these criteria are dependent on both the time of activity (usually daytime or night-time) and the occupied place being assessed. Impulsive vibration (as defined in Section 2.1 of the guideline) is generally associated with infrequent activities that create up to three (3) distinct vibration events in an assessment period e.g. occasional dropping of heavy equipment, occasional loading and unloading. **Table 16** reproduces the preferred and maximum criteria relating to measured peak velocity.

Table 16 Criteria for Exposure to Impulsive Vibration

Place	Time[1]	Assessment Criteria	
		Peak Velocity (mm/s)	
		Preferred	Maximum
Critical working Areas (e.g. hospital operating theatres, precision laboratories)	Day or Night-time	0.14	0.28
Residences	Daytime	8.6	17.0
	Night-time	2.8	5.6
Offices	Day or Night-time	18.0	36.0
Workshops	Day or Night-time	18.0	36.0

Note 1: Daytime is 7am to 10pm and Night-time is 10pm to 7am.

5.3.3 Intermittent Vibration

Intermittent vibration (as defined in Section 2.1 of the guideline) is assessed using the vibration dose concept which relates to vibration magnitude and exposure time.

Intermittent vibration is representative of activities such as impact hammering, rolling or general excavation work (such as an excavator tracking).

Section 2.4 of the Guideline provides acceptable values for intermittent vibration in terms of vibration dose values (VDV) which requires the measurement of the overall weighted RMS (root mean square) acceleration levels over the frequency range 1-80 Hz. To calculate VDV the following formula (refer section 2.4.1 of the guideline) was used:

$$VDV = \left[\int_0^T a^4(t)dt \right]^{0.25}$$

Where VDV is the vibration dose value in $m/s^{1.75}$, a (t) is the frequency-weighted RMS of acceleration in m/s^2 and T is the total period of the day (in seconds) during which vibration may occur.

The Acceptable Vibration Dose Values (VDV) for Intermittent Vibration is reproduced in **Table 17**.

Table 17 Acceptable Vibration Dose Values (VDV) for Intermittent Vibration

Location	Daytime		Night-time	
	Preferred Value $m/s^{1.75}$	Maximum Value $m/s^{1.75}$	Preferred Value $m/s^{1.75}$	Maximum Value $m/s^{1.75}$
Critical Areas	0.10	0.20	0.10	0.20
Residences	0.20	0.40	0.13	0.26
Offices, schools, educational institutions and places of worship	0.40	0.80	0.40	0.80
Workshops	0.80	1.60	0.80	1.60

Note: Daytime is 7am to 10pm and Night-time is 10pm to 7am.

Note: These criteria are indicative only, and there may be a need to assess intermittent values against continuous or impulsive criteria for critical areas.

There is a low probability of adverse comment or disturbance to building occupants at vibration values below the preferred values. Adverse comment or complaints may be expected if vibration values approach the maximum values. The guideline states that activities should be designed to meet the preferred values where an area is not already exposed to vibration.

5.4 Vibration Assessment

The items of plant with the greatest potential for vibration during construction include hydraulic hammers during the demolition of existing structures, or vibratory rollers during earthworks. Peak levels of vibration from rolling typically occurs as the roller stops to change direction and a resonance is created as the roller (and vibrator) is stationary.

Table 18 provides the minimum working distances for the use of various vibration intensive sources to nearby receivers to meet cosmetic damage and human response criteria. It is important to note that the minimum working distances are indicative and will vary depending on the particular item of plant and local geotechnical conditions.

Table 18 Minimum Working Distances or Vibratory Plant (m)

Plant item	Rating / Description	Minimum working distance		
		Cosmetic damage (BS 7385)	Sensitive Items (DIN 4150)	Human response (OH&E)
Vibratory Roller	< 50 kN (Typically 1-2 tonnes)	5m	10m	15m to 20m
	< 100 kN (Typically 2-4 tonnes)	6m	12m	20m
	< 200 kN (Typically 4-6 tonnes)	12m	24m	40m
	< 300 kN (Typically 7-13 tonnes)	15m	30m	100m
	> 300 kN (Typically 13-18 tonnes)	20m	40m	100m
	> 300 kN (> 18 tonnes)	25m	50m	100m
Small Hydraulic Hammer	(300 kg - 5 to 12t excavator)	2m	4m	7m
Medium Hydraulic Hammer	(900 kg – 12 to 18t excavator)	7m	14m	23m
Large Hydraulic Hammer	(1600 kg – 18 to 34t excavator)	22m	44m	73m

Note: Source, CNVG (Roads and Maritime, 2016).

A review of aerial photography identifies that the nearest residential receivers are located approximately 30m from the project site, while the nearest non-residential receiver is located approximately 70m of the project site. A review of the State Heritage Inventory identifies that the closest heritage item is the Kirby Park Bandstand approximately 300m to the northeast of the proposal site.

Based on the minimum working distances provided in **Table 18**, it is anticipated that vibration levels would remain below the cosmetic damage criteria for all residential and non-residential receivers. Where a vibratory roller in excess of 7 tonnes or a large hydraulic hammer is utilised, vibration levels are likely to exceed the human response criteria at nearby residential receiver locations. Once the final vibratory plant has been selected a review of minimum offset distances should be conducted.

Vibration levels are not predicted to exceed the cosmetic damage criteria for any non-residential receivers or heritage items in the vicinity of the proposal site.

5.5 Noise and Vibration Impacts to Existing Hospital Buildings

Assessment of noise and vibration is typically undertaken for noise sensitive receivers surrounding the project site. Although not specially required under the ICNG, assessment of noise and vibration is undertaken at the existing hospital buildings to enable proactive and pragmatic management of potential impacts.

The assessment considered noise levels at the most exposed façades of each of the existing hospital buildings to the proposed construction works. The results were assessed against the ICNG criteria for "hospital wards and operation theatres", with a conservative external to internal attenuation of 20dB for a closed building.

A summary of the predicted $LA_{eq(15min)}$ noise emissions is presented for the existing hospital buildings in **Table 9**. Predicted levels exceeding the NMLs are displayed **BOLD** text.

Table 19 Summary of Noise Assessment Results – Existing Hospital Buildings

Hospital Building	Period	NML	Highest Predicted dB LA_{eq} Per Scenario[1]			
		(dB LA_{eq})	Demolition	Earthworks	Site Prep	Construction
Bld1 – Hospital Bld	When in use	65[2]	**80**	**72**	**72**	**75**
Bld3 – Picone Bld	When in use	65[2]	**75**	**90**	**92**	**93**
Bld4 – Mental Health	When in use	65[2]	**80**	**73**	**75**	**77**
Bld6 – Hollingworth Blk	When in use	65[2]	**96**	**68**	**70**	**91**

Note 1: Exceedance of relevant NMLs highlighted and shown in **BOLD**.

Note 2: External noise criteria derived using 20dBA façade attenuation for a closed facade as per Table 4.2 of ENMM.

The results of the analysis indicate that due to the close proximity of works to the existing hospital buildings, the construction noise levels would potentially exceed the internal design sound levels for the existing hospital buildings during each of the construction activities. Where construction works may impact on sensitive spaces, including operating theatres and hospital wards, consultation should be undertaken with the administrators of the hospital to schedule construction works around critical activities.

A review of offset distances identifies that the proposed construction works would occur within very close proximity (<5m) of the existing hospital buildings to be retained. Where vibration intensive plant, such as vibratory rollers and hydraulic hammers are used, vibration levels may exceed the cosmetic damage criteria for sensitive items. Once the final vibratory plant has been selected a review of minimum offset distances should be conducted. Where the works are to be undertaken close to sensitive processes, different construction method with lower source vibration levels should be used where feasible and reasonable.

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6 Assessment of Operational Noise Impacts

6.1 Operational Noise Policy and Guidelines

The Noise Policy for Industry (NPI) sets out the NSW EPAs requirements for the assessment and management of noise from industrial facilities. The policy provides a procedure for establishing noise criteria and operational requirements for development consents.

The objectives of the NPI are to:

- provide noise criteria that is used to assess the change in both short term and long-term noise levels;
- provide a clear and consistent framework for assessing environmental noise impacts from industrial premises and industrial development proposals;
- promote the use of best-practice noise mitigation measures that are feasible and reasonable where potential impacts have been identified; and
- support a process to guide the determination of achievable noise limits for planning approvals and/or licences, considering the matters that must be considered under the relevant legislation (such as the economic and social benefits and impacts of industrial development).

The policy sets out a process for industrial noise management involving the following key steps:

1. Determine the Project Noise Trigger Levels (PNTLs) (ie criteria) for a development. These are the levels (criteria), above which noise management measures are required to be considered. They are derived by considering two factors: shorter-term intrusiveness due to changes in the noise environment; and maintaining the noise amenity of an area.
2. Predict or measure the noise levels produced by the development with regard to the presence of annoying noise characteristics and meteorological effects such as temperature inversions and wind.
3. Compare the predicted or measured noise level with the PNTL, assessing impacts and the need for noise mitigation and management measures.
4. Consider residual noise impacts - that is, where noise levels exceed the PNTLs after the application of feasible and reasonable noise mitigation measures. This may involve balancing economic, social and environmental costs and benefits from the proposed development against the noise impacts, including consultation with the affected community where impacts are expected to be significant.

5. Set statutory compliance levels that reflect the best achievable and agreed noise limits for the development.

6. Monitor and report environmental noise levels from the development.

6.1.1 Project Noise Trigger Levels (PNTL)

The policy sets out the procedure to determine the PNTLs relevant to an industrial development. The PNTL is the lower (ie, the more stringent) of the **Project Intrusiveness Noise Level** (PINL) and **Project Amenity Noise Level** (PANL) determined in accordance with Section 2.3 and Section 2.4 of the NPI.

6.1.2 Rating Background Level (RBL)

The Rating Background Level (RBL) is a determined parameter from noise monitoring and is used for assessment purposes. As per the NPI, the RBL is an overall single figure background level representing each assessment period (day, evening and night) over the noise monitoring period. The measured RBLs relevant to the project are contained in **Section 3.1.1**.

6.1.3 Project Intrusiveness Noise Level (PINL)

The PINL ($LA_{eq(15min)}$) is the RBL + 5dB and seeks to limit the degree of change a new noise source introduces to an existing environment. Hence, when assessing intrusiveness, background noise levels need to be measured.

6.1.4 Project Amenity Noise Level (PANL)

The PANL is relevant to a specific land use or locality. To limit continuing increases in intrusiveness levels, the ambient noise level within an area from all combined industrial sources should remain below the recommended Amenity Noise Levels specified in Table 2.2 (of the NPI). The NPI defines two categories of Amenity Noise Levels:

- **Amenity Noise Levels (ANL)** – are determined considering all current and future industrial noise within a receiver area; and
- **Project Amenity Noise Level (PANL)** – is the recommended level for a receiver area, specifically focusing the project being assessed.

Additionally, Section 2.4 of the NPI states: "to ensure that industrial noise levels (existing plus new) remain within the recommended Amenity Noise Levels for an area, a Project Amenity Noise Level applies for each new source of industrial noise as follows":

PANL for new industrial developments = recommended **ANL** minus 5dBA.

The following exceptions apply when deriving the PANL:

- areas with high traffic noise levels;
- proposed developments in major industrial clusters;
- existing industrial noise and cumulative industrial noise effects; and
- greenfield sites.

There are no significant sources of industrial noise in the vicinity of the project site, hence, no correction to the Amenity Noise Level has been applied;

The recommended Amenity Noise Levels as per Table 2.2 of the NPI are reproduced in **Table 20**.

Table 20 Amenity Noise Levels

Receiver Type	Noise Amenity Area	Time of day	Recommended Amenity Noise Levels dB LAeq(period)
Residential	Suburban	Day	55
		Evening	45
		Night	40
Hotels, motels, caretakers' quarters, holiday accommodation, permanent resident caravan parks.	See column 4	See column 4	5dB above the recommended Amenity Noise Level for a residence for the relevant noise amenity area and time of day
School Classroom	All	Noisiest 1-hour period when in use	35 (internal) 45 (external)
Hospital ward	All	Noisiest 1-hour	35 (internal)
	All	Noisiest 1-hour	50 (external)
Place of worship	All	When in use	40 (internal)
Passive Recreation	All	When in use	50
Active Recreation	All	When in use	55
Commercial premises	All	When in use	65
Industrial	All	When in use	70

Notes: The recommended Amenity Noise Levels refer only to noise from industrial noise sources. However, they refer to noise from all such sources at the receiver location, and not only noise due to a specific project under consideration. The levels represent outdoor levels except where otherwise stated.

Types of receivers are defined as rural residential; suburban residential; urban residential; industrial interface; commercial; industrial – see Table 2.3 and Section 2.7 of the NPI.

Note 1: Day - the period from 7am to 6pm Monday to Saturday or 8am to 6pm on Sundays and public holidays; Evening - the period from 6pm to 10pm; Night - the remaining periods.

6.1.5 Maximum Noise Assessment Trigger Levels

The potential for sleep disturbance from maximum noise level events from a project during the night-time period needs to be considered. The NPI considers sleep disturbance to be both awakenings and disturbance to sleep stages.

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

- $L_{Aeq(15min)}$ 40dB or the prevailing RBL plus 5dBA, whichever is the greater, and/or
- L_{Amax} 52dB or the prevailing RBL plus 15dBA, whichever is the greater.

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

Other factors that may be important in assessing the impacts on sleep disturbance include:

- how often the events would occur;
- the distribution of likely events across the night-time period and the existing ambient maximum events in the absence of the development;
- whether there are times of day when there is a clear change in the noise environment (such as during early morning shoulder periods); and
- current understanding of effects of maximum noise level events at night.

6.1.6 Road Traffic Noise

The road traffic noise criteria are provided in the Road Noise Policy (RNP), 2011. The policy sets out noise criteria applicable to different road classifications for the purpose of quantifying traffic noise impacts. Road noise criteria relevant to this assessment are presented in detail in Section 6.2.5.

6.2 Operational Assessment Criteria

6.2.1 Intrusiveness Noise Levels

The PINL for the project are presented in **Table 21** and have been determined based on the RBL +5dBA and only apply to residential receivers.

Table 21 Project Intrusiveness Noise Levels

Receiver Type	Period[1]	Measured RBL dB LA_{90}	Adopted RBL dB LA_{90}	PINL dB $LA_{eq(15min)}$
All residential	Day	44	35	40
	Evening	42	30	35
	Night	36	30	35

Note 1: Day - the period from 7am to 6pm Monday to Saturday or 8am to 6pm on Sundays and public holidays; Evening - the period from 6pm to 10pm; Night - the remaining periods.

6.2.2 Amenity Noise Levels and Project Amenity Noise Levels

The PANL for residential receivers and other receiver types (ie non-residential) potentially affected by the project are presented in **Table 22.**

Table 22 Amenity Noise Levels and Project Amenity Noise Levels

Receiver Type	Noise Amenity Area	Assessment Period[1]	NPI Recommended ANL dB $LA_{eq(period)}$	Adopted ANL dB $LA_{eq(period)}$	PANL dB $LA_{eq(15min)}$[2]
Residential	Suburban	Day	55	55	58
		Evening	45	45	48
		Night	40	40	43
Accommodation	Suburban	Day	60	60	63
		Evening	50	50	53
		Night	45	45	48
Education Institution	All	When in use	35 (internal)	35 (internal)	38 (internal) 58 (external)[3]
Active Recreation	All	When in use	55	55	58
Commercial	All	When in use	65	65	68

Note 1: Day - the period from 7am to 6pm Monday to Saturday or 8am to 6pm on Sundays and public holidays; Evening - the period from 6pm to 10pm; Night - the remaining periods.

Note 2: Includes a +3dB adjustment to the amenity period level to convert to a 15-minute assessment period as per Section 2.2 of the NPI.

Note 3: External level based on 20dB loss through a closed façade.

6.2.3 Project Noise Trigger Levels

The PNTL are the lower of either the PINL or the PANL. **Table 23** presents the derivation of the PNTLs in accordance with the methodologies outlined in the NPI.

Table 23 Project Noise Trigger Levels

Receiver Type	Noise Amenity Area	Assessment Period[1]	PINL dB $L_{Aeq(15min)}$	PANL dB $L_{Aeq(15min)}$	PNTL dB $L_{Aeq(15min)}$
Residential	Suburban	Day	49	58	40
		Evening	47	48	35
		Night	41	43	35
Accommodation	Suburban	Day	N/A	63	63
		Evening	N/A	53	53
		Night	N/A	48	48
Education Institute	All	When in Use	N/A	38 (internal 1 hr) 58 (external 1 hr)[2]	38 (internal 1 hr) 58 (external 1 hr)[2]
Active Recreation	All	When in Use	N/A	58	58
Commercial	All	When in Use	N/A	68	68

Note 1: Day - the period from 7am to 6pm Monday to Saturday or 8am to 6pm on Sundays and public holidays; Evening - the period from 6pm to 10pm; Night - the remaining periods.

Note 2: External level based on 20dB loss through a closed façade.

6.2.4 Maximum Noise Assessment Trigger Levels

The maximum noise trigger levels shown in **Table 24** are based on night-time RBLs and trigger levels as per Section 2.5 of the NPI. The trigger levels will be applied to transient noise events that have the potential to cause sleep disturbance.

Table 24 Maximum Noise Trigger Level (Night / Morning Shoulder / Evening Shoulder)

Residential Receivers

$L_{Aeq(15min)}$		L_{Amax}	
40dB $L_{Aeq(15min)}$ or RBL + 5dB		52dB L_{Amax} or RBL + 15dB	
Trigger	40	Trigger	52
RBL +5dB	35	RBL +15dB	45
Highest	**40**	**Highest**	**52**

Note: Monday to Saturday; Night 10pm to 7am. On Sundays and Public Holidays Night 10pm to 8am. Morning Shoulder 5am to 7am; Evening Shoulder 10pm to 12am.

Note: NPI identifies that maximum of the two values is to be adopted which is shown in bold font.

6.2.5 Road Traffic Noise Criteria

Table 25 presents the road traffic noise assessment criteria reproduced from the RNP relevant to this assessment.

Table 25 Road Traffic Noise Assessment Criteria

Road category	Type of project/development	Assessment Criteria – dBA	
		Day (7am to 10pm)	Night (10pm to 7am)
Freeways/arterial/ sub-arterial Roads	Existing residences affected by additional traffic on freeways/arterial/sub-arterial roads generated by land use developments	60dB LAeq(15hr)	55dB LAeq(9hr)
Local Roads	Existing residences affected by additional traffic on existing local roads generated by land use developments	55dB LAeq(1hr)	50dB LAeq(1hr)

Additionally, the RNP states where existing road traffic noise criteria are already exceeded, any additional increase in total traffic noise level should be limited to 2dBA, which is generally accepted as the threshold of perceptibility to a change in noise level.

6.3 Operational Noise Assessment Methodology

An operational noise model was developed to quantify project noise emissions to neighbouring receivers, consistent with the methodology described in Section 4.3.

Noise generated by the project will typically be associated with the following sources:

- vehicle movements within the new/upgraded carpark; and
- mechanical plant operation.

It is understood that the Out Plant would include the following acoustically significant items of plant:

- chiller units; and
- pump room.

Assessment of noise emissions from vehicles in the upgraded car park has assumed up to 20 vehicles traversing the car park during any 15-minute period during the day period, representing approximately 25% of the potential car spaces. During the evening and night periods, it has been assumed that up to 10 vehicles would traverse the car park during any 15-minute period.

It is noted that the hospital will not utilise public address systems, and equipment alarms will involve notifications to devices only.

6.3.1 Sound Power Levels

Table 26 presents the Sound Power Level for each noise source modelled in this assessment. It is noted that Sound Power Levels were sourced from manufacturer's specifications or from in-field measurements at similar project sites.

Table 26 Acoustically Significant Sources - Sound Power Levels dBA (re 10^{-12} Watts)

Item and quantity (per 15 minutes)	Individual Sound Power Level dB LAeq	Modelled Sound Power Level dB LAeq(15min)	Source Height[1]
Operation			
Roof Plant (Inlets/Outlets)	70 - 91	94	0.5m
Generator	93	93	1m
Chiller Unit (x2)	89	92	1m
22kW Pump (x3)	82	87	1m
Truck at Loading Bay	92	92	1m
Car idle, start up and drive off (x20)[2]	81	87	0.5m
Sleep disturbance assessment (L_{Amax}), Night-time periods (10pm to 7am)			
Car Door Slam	92		1m
Delivery Impact Noise	104		1m

Note 1: Height above the relative ground or building below source.

Note 2: Includes a duration adjustment assuming vehicles operate for three (3) minutes continuously within a period of 15-minutes.

6.4 Operational Noise Levels

This assessment has quantified operational noise levels at the nearest sensitive receivers. Noise predictions from all sources have been quantified at sensitive receivers surrounding the project site, with the highest predicted noise levels for each receiver type presented in Table 27.

Table 27 Operational Noise Predictions – All Receivers

Residential Receivers							
Receiver	Predicted Noise Level dB $LA_{eq(15min)}$			PNTL dB $LA_{eq(15min)}$			Compliant
	Day	Evening	Night	Day	Evening	Night	
Residential	36	35	35	40	35	35	✓
Accommodation	<30	<30	<30	63	53	48	✓
Education Institute	<30	N/A	N/A		58[1]		✓
Active Recreation	35	<30	N/A		58		✓
Commercial	35	32	30		68		✓

Note: Day – the period from 7am to 6pm Monday to Saturday or 8am to 6pm on Sundays and public holidays; Evening – the period from 6pm to 10pm; Night – the remaining periods.

Note 1: External noise level with internal to external correction for 20dB for closed building.

The results of the operational noise predictions indicate that noise emissions from vehicles in the upgraded car park, and mechanical plant would satisfy the PNTLs at all receiver locations. It is noted that the assessment has included indicative mechanical plant as per the preliminary mechanical services plan.

It is recommended that a review of mechanical plant should be undertaken as part of the detailed design of the project, including prediction of noise emissions and identification of feasible and reasonable mitigation measures to ameliorate potential noise impacts. It is also recommended that prior to the completion of the detailed design operational noise assessment, to inform the final selection of plant and identification of mitigation measures, a detailed background noise assessment should be undertaken to quantify existing noise levels in the surrounding catchment, to establish area specific criteria for the project.

The assessment of operational noise levels has considered the following assumptions and mitigation measures:

- pumps would be located within a dedicated pump room with no penetrations towards the nearby sensitive receivers;
- acoustic enclosures should be constructed of an acoustic louvre to an approximately blade depth of 300mm (eg NAP Silentflo 300 CH-Line chevron louvre or similar);
- acoustic louvre would be constructed around roof plant area to a height of 600mm above mechanical plant;
- new services area at western end of building B3 would be covered; and
- where possible, the sliding gate to the external loading zone / services zone should be constructed of an acoustic louvre (eg Slimshield Acoustic Louvre or similar).

6.4.1 Maximum Noise Level Assessment

In assessing maximum noise events, typical L_{Amax} noise levels from transient events were assessed at the nearest residential receivers. For the sleep disturbance assessment, a Sound Power Level of 92dBA for a door slam in the new car park area is adopted for this assessment.

Predicted noise levels from $L_{Aeq(15min)}$ and L_{Amax} events for the most affected residential receiver are presented in **Table 28.** Results identify that the maximum noise trigger levels will be satisfied for all residential receivers.

Table 28 Maximum Noise Trigger Level Assessment (Night)[1]

Night Period					
Receiver	Predicted Noise Level		Trigger Level		Compliant
	dB $L_{Aeq(15min)}$	dB L_{Amax}	dB $L_{Aeq(15min)}$	dB L_{Amax}	
Residential	35	46	48	52	✓

Note 1: Day - the period from 7am to 6pm Monday to Saturday or 8am to 6pm on Sundays and public holidays; Evening - the period from 6pm to 10pm; Night - the remaining periods.

6.4.2 Road Traffic Noise Assessment

Access to the MDH is via the Gwydir Highway, Alice Street and Victoria Terrace to the east, and Edward Street and Victoria Terrace to the west. Currently, vehicles enter the existing hospital carpark via a one-way internal road from Victoria Terrace to the east of the hospital and exit the hospital carpark to Victoria Terrace to the north. The existing hospital carpark (patient / visitor parking) has a capacity of approximately 51 car spaces. Additionally, staff parking is available off Alice Street (approximately 19 car spaces) and on-street parking is available along Alice Street for up to approximately 130 car spaces.

Under the proposed redevelopment of MDH, the total number of available on-campus car spaces is anticipated to remain consistent with the existing number of car spaces, with changes to on-campus parking confined to entry/exit arrangements to/from Victoria Terrace to the north only, and minor reconfigurations of the carparking areas. Furthermore, it is anticipated that on-street parking along Alice Street would be reduced as a result of the redevelopment. Hence, it is anticipated that road traffic noise levels would remain materially the same or slightly lower than existing road traffic noise levels as a result of the proposed development.

7 External Noise Intrusion

The assessment of noise intrusion from external sources is undertaken in accordance with the State Environmental Planning Policy (SEPP) (Transport and Infrastructure) 2021, which states:

2.120 Impact of road noise or vibration on non-road development:

This section applies to development for any of the following purposes that is on land in or adjacent to the road corridor for a freeway, a tollway or a transitway or any other road with an annual average daily traffic volume of more than 20,000 vehicles (based on the traffic volume data published on the website of TfNSW) and that the consent authority considers is likely to be adversely affected by road noise or vibration—

(a) residential accommodation,

(b) a place of public worship,

(c) a hospital,

(d) an educational establishment or centre-based childcare facility.

A review of AADT volumes from the TfNSW Traffic Volume Viewer identifies that the Gwydir Highway to the east of the MDH carries up to 18,800 vehicles per day, while a review of aerial imagery identifies that the separation distance from the Gwydir Highway to the nearest exposed façade is approximately 150m.

As the Gwydir Highway does not carry more than 20,000 vehicles per day, and the MDH is not located immediately adjacent to the Highway, further acoustic assessment is not required to address the requirements of the SEPP Transport and Infrastructure.

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8 Discussion and Conclusion

Muller Acoustic Consulting Pty Ltd (MAC) has prepared a Construction and Operational Noise and Vibration Assessment for the Moree District Hospital Redevelopment Project at Moree, NSW. The assessment was completed in accordance with the relevant guidelines to accompany the review of environmental factors for the project.

The construction noise assessment demonstrates that noise from the project is anticipated to exceed the Noise Management Levels at residential receivers adjacent to the proposal site during each of the construction scenarios during standard construction hours. It is anticipated that construction noise levels would remain below the relevant NMLs for non-residential receivers during each of the construction activities.

Further analysis of potential noise impacts demonstrates that during demolition works, up to 200 residential receivers within approximately 560m of the project site may experience noise levels above the relevant NML for standard construction hours. Similarly, during earthworks, up to 45 residential receivers within approximately 315m of the project site are predicted to experience noise levels above the standard hours NML, while up to 55 receivers within 420m of the project site and 50 receivers within 330m of the project site are predicted to experience noise levels above the standard hours NML during site preparation works and general construction works respectively.

A review of safe working distances for vibration intensive equipment indicates that construction vibration levels would potentially exceed the criteria for human comfort for receivers immediately adjacent to the project site. It is not anticipated however, that vibration levels would exceed the cosmetic damage criteria for any non-project related sensitive receivers, including heritage structures.

Operational noise levels associated with vehicle movements in the upgraded hospital carparks and mechanical plant are predicted to achieve the relevant NPI criteria. It is recommended that the mechanical plant be reviewed following development of a detailed mechanical services plan. Furthermore, a detailed background noise assessment should be completed to inform the detailed design operational noise assessment.

Analysis of potential sleep disturbance impacts from transient events such as car door slams within the hospital carpark and loading activities within the external loading bay, demonstrates that L_{Amax} noise levels at the nearest residential receivers are predicted to remain below the maximum noise trigger level. Hence sleep disturbance impacts are unlikely to occur.

A review of carparking and access arrangements identified that the number of on-street and on-campus car spaces would remain materially the same as existing car spaces. Hence, it is anticipated that there would be no material change to road traffic noise levels from the proposed development.

A review of potential external noise intrusion, undertaken in accordance with the SEPP Transport and Infrastructure, identified that traffic volumes on the nearby Gwydir Highway are below the threshold for assessment. Hence, noise levels are expected to comply with the internal design sound levels.

Appendix A – Glossary of Terms

A number of technical terms have been used in this report and are explained in **Table A1**.

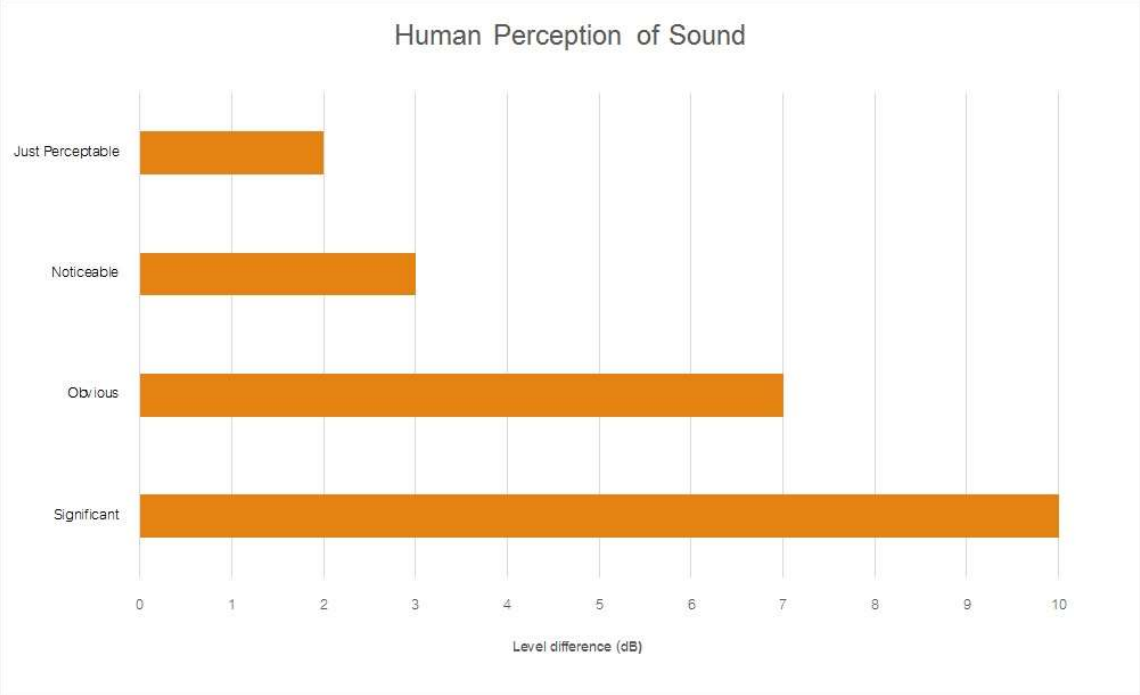
Table A1 Glossary of Acoustical Terms

Term	Description
1/3 Octave	Single octave bands divided into three parts
Octave	A division of the frequency range into bands, the upper frequency limit of each band being twice the lower frequency limit.
ABL	Assessment Background Level (ABL) is defined in the NPI as a single figure background level for each assessment period (day, evening and night). It is the tenth percentile of the measured L90 statistical noise levels.
Ambient Noise	The total noise associated with a given environment. Typically, a composite of sounds from all sources located both near and far where no particular sound is dominant.
A Weighting	A standard weighting of the audible frequencies designed to reflect the response of the human ear to sound.
Background Noise	The underlying level of noise present in the ambient noise, excluding the noise source under investigation, when extraneous noise is removed. This is usually represented by the LA90 descriptor
dBA	Noise is measured in units called decibels (dB). There are several scales for describing noise, the most common being the 'A-weighted' scale. This attempts to closely approximate the frequency response of the human ear.
dB(Z), dB(L)	Decibels Z-weighted or decibels Linear (unweighted).
Extraneous Noise	Sound resulting from activities that are not typical of the area.
Hertz (Hz)	The measure of frequency of sound wave oscillations per second - 1 oscillation per second equals 1 hertz.
LA10	A sound level which is exceeded 10% of the time.
LA90	Commonly referred to as the background noise, this is the level exceeded 90% of the time.
LAeq	Represents the average noise energy or equivalent sound pressure level over a given period.
LAmax	The maximum sound pressure level received at the microphone during a measuring interval.
Masking	The phenomenon of one sound interfering with the perception of another sound. For example, the interference of traffic noise with use of a public telephone on a busy street.
RBL	The Rating Background Level (RBL) as defined in the NPI, is an overall single figure representing the background level for each assessment period over the whole monitoring period. The RBL, as defined is the median of ABL values over the whole monitoring period.
Sound Power Level (Lw or SWL)	This is a measure of the total power radiated by a source in the form of sound and is given by 10.log10 (W/Wo). Where W is the sound power in watts to the reference level of 10^{-12} watts.
Sound pressure level (Lp or SPL)	the level of sound pressure; as measured at a distance by a standard sound level meter. This differs from Lw in that it is the sound level at a receiver position as opposed to the sound 'intensity' of the source.

Table A2 provides a list of common noise sources and their typical sound level.

Table A2 Common Noise Sources and Their Typical Sound Pressure Levels (SPL), dBA	
Source	Typical Sound Pressure Level
Threshold of pain	140
Jet engine	130
Hydraulic hammer	120
Chainsaw	110
Industrial workshop	100
Lawn-mower (operator position)	90
Heavy traffic (footpath)	80
Elevated speech	70
Typical conversation	60
Ambient suburban environment	40
Ambient rural environment	30
Bedroom (night with windows closed)	20
Threshold of hearing	0

Figure A1 – Human Perception of Sound



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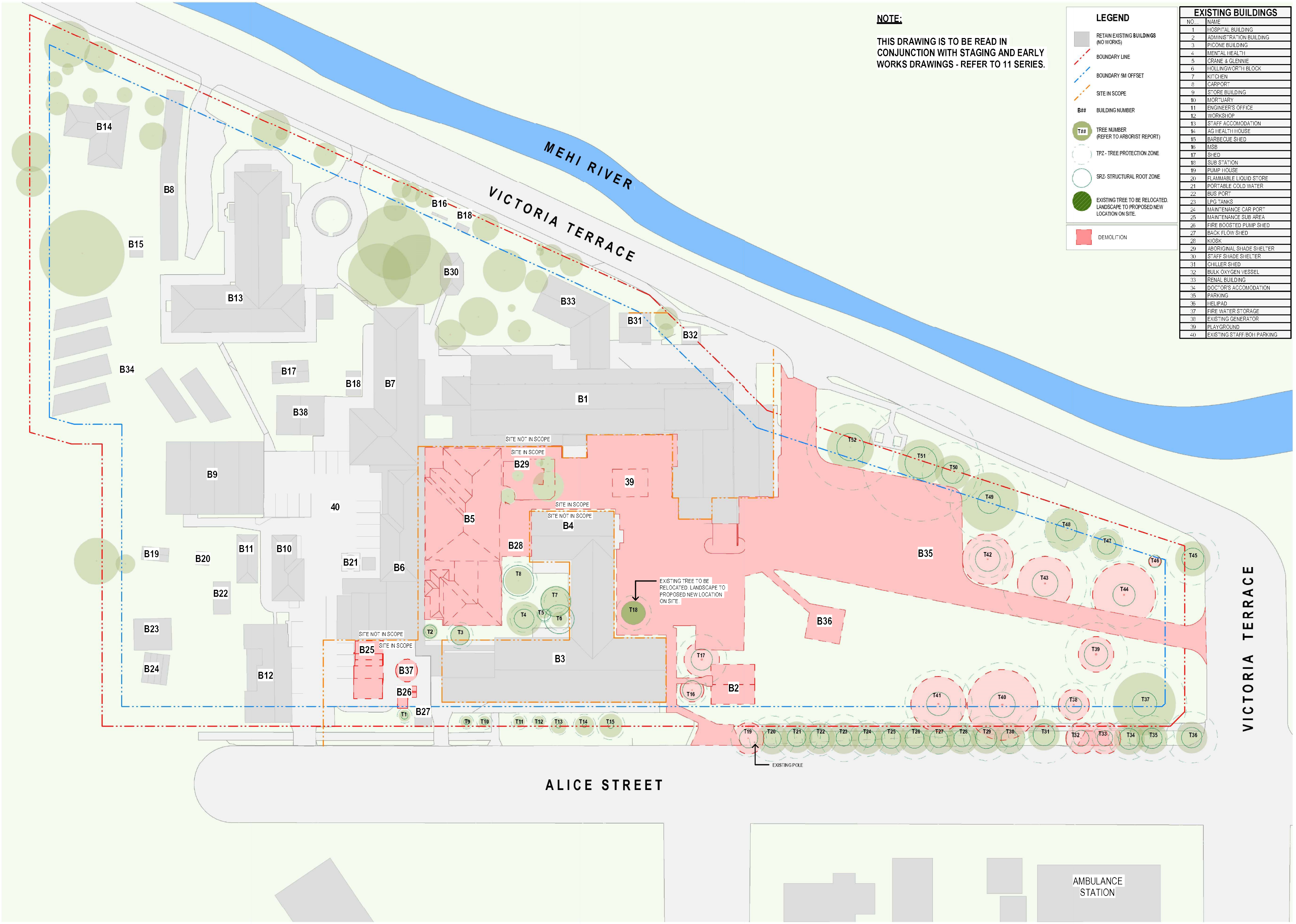
Appendix B – Masterplan Design

NOTE:

THIS DRAWING IS TO BE READ IN CONJUNCTION WITH STAGING AND EARLY WORKS DRAWINGS - REFER TO 11 SERIES.



LEGEND

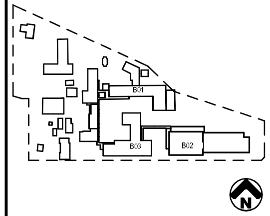
- RETAIN EXISTING BUILDINGS (NO WORKS)
- BOUNDARY LINE
- BOUNDARY 5M OFFSET
- SITE IN SCOPE
- B## BUILDING NUMBER
- T## TREE NUMBER (REFER TO ARBORIST REPORT)
- TPZ - TREE PROTECTION ZONE
- SRZ- STRUCTURAL ROOT ZONE
- EXISTING TREE TO BE RELOCATED. LANDSCAPE TO PROPOSED NEW LOCATION ON SITE.
- DEMOLITION

EXISTING BUILDINGS

NO....	NAME
1	HOSPITAL BUILDING
2	ADMINISTRATION BUILDING
3	PICONE BUILDING
4	MENTAL HEALTH
5	CRANE & GLENNIE
6	HOLLINGWORTH BLOCK
7	KITCHEN
8	CARPORT
9	STORE BUILDING
10	MORTUARY
11	ENGINEER'S OFFICE
12	WORKSHOP
13	STAFF ACCOMODATION
14	AG HEALTH HOUSE
15	BARBECUE SHED
16	MSB
17	SHED
18	SUB STATION
19	PUMP HOUSE
20	FLAMMABLE LIQUID STORE
21	PORTABLE COLD WATER
22	BUS PORT
23	LPG TANKS
24	MAINTENANCE CAR PORT
25	MAINTENANCE SUB AREA
26	FIRE BOOSTED PUMP SHED
27	BACK FLOW SHED
28	KIOSK
29	ABORIGINAL SHADE SHELTER
30	STAFF SHADE SHELTER
31	CHILLER SHED
32	BULK OXYGEN VESSEL
33	RENAL BUILDING
34	DOCTOR'S ACCOMODATION
35	PARKING
36	HELIPAD
37	FIRE WATER STORAGE
38	EXISTING GENERATOR
39	PLAYGROUND
40	EXISTING STAFF/BOH PARKING

WORK IN PROGRESS

KEY PLAN



REV	DESCRIPTION	DRN	DATE
A	ISSUED FOR TENDER	NM	13/10/2023

GENERAL NOTES

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FIXTURES, FITTINGS & EQUIPMENT SPECIFICATIONS

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PRINCIPAL

NSW GOVERNMENT | Health Infrastructure

ISSUED FOR INFORMATION

PROJECT

MOREE HOSPITAL REDEVELOPMENT

35 Alice St, Moree NSW 2400

DRAWING TITLE

MANDATORY OPTION - DEMO PLAN

SCALE	DRAWN BY	CHECKED
1 : 500 @ A1	Author	Checker

DOCUMENT NUMBER	REVISION
MHR-STH-AR-DR-SW-13XX01	A

INTERNAL REFERENCE ONLY: STH PROJECT NO: 10649 | STH SHT NO: 13XX01

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38	EXISTING GENERATOR
39	PLAYGROUND
40	EXISTING STAFF/BOH PARKING

NEW BUILDING

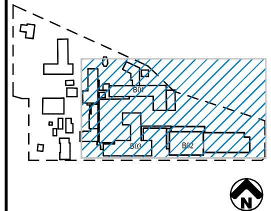
NO.	NAME
2	ACUTE SERVICES BUILDING

NEW EXTERNAL SERVICES

N.	NAME
LD1	FIRE PUMP ROOM
LD2	HYD PUMP ROOM
LD3	MECH ANCILLARY PLANT
A	GENERATOR
B	COLD WATER TANK
C	FIRE WATER TANK
D	COMBINED BOOSTER
E	TEMPORARY GENERATOR STAND
F	SUBSTATION
G	CHILLER

WORK IN PROGRESS

KEY PLAN



REV	DESCRIPTION	DRN	DATE
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DOCUMENT NUMBER	REVISION
MHR-STH-AR-DR-SW-13XX02	A

INTERNAL REFERENCE ONLY: STH PROJECT NO: 10649 | STH SHT NO: 13XX02

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Appendix C – Construction Noise Contours

FIGURE C1

Noise Affected Area -

Demolition Works

MAC221546-02

Moree Hospital Redevelopment

KEY

Project Site

Noise Affected Area

Standard Construction Hours

Highly Noise Affected

0 80 160 240 320 m

N

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FIGURE C2

Noise Affected Area -

Bulk Earthworks

MAC221546-02

Moree Hospital Redevelopment

KEY

Project Site

Noise Affected Area

Standard Construction Hours

Highly Noise Affected

0 60 120 180 240 m

N

MAC
Muller Acoustic Consulting

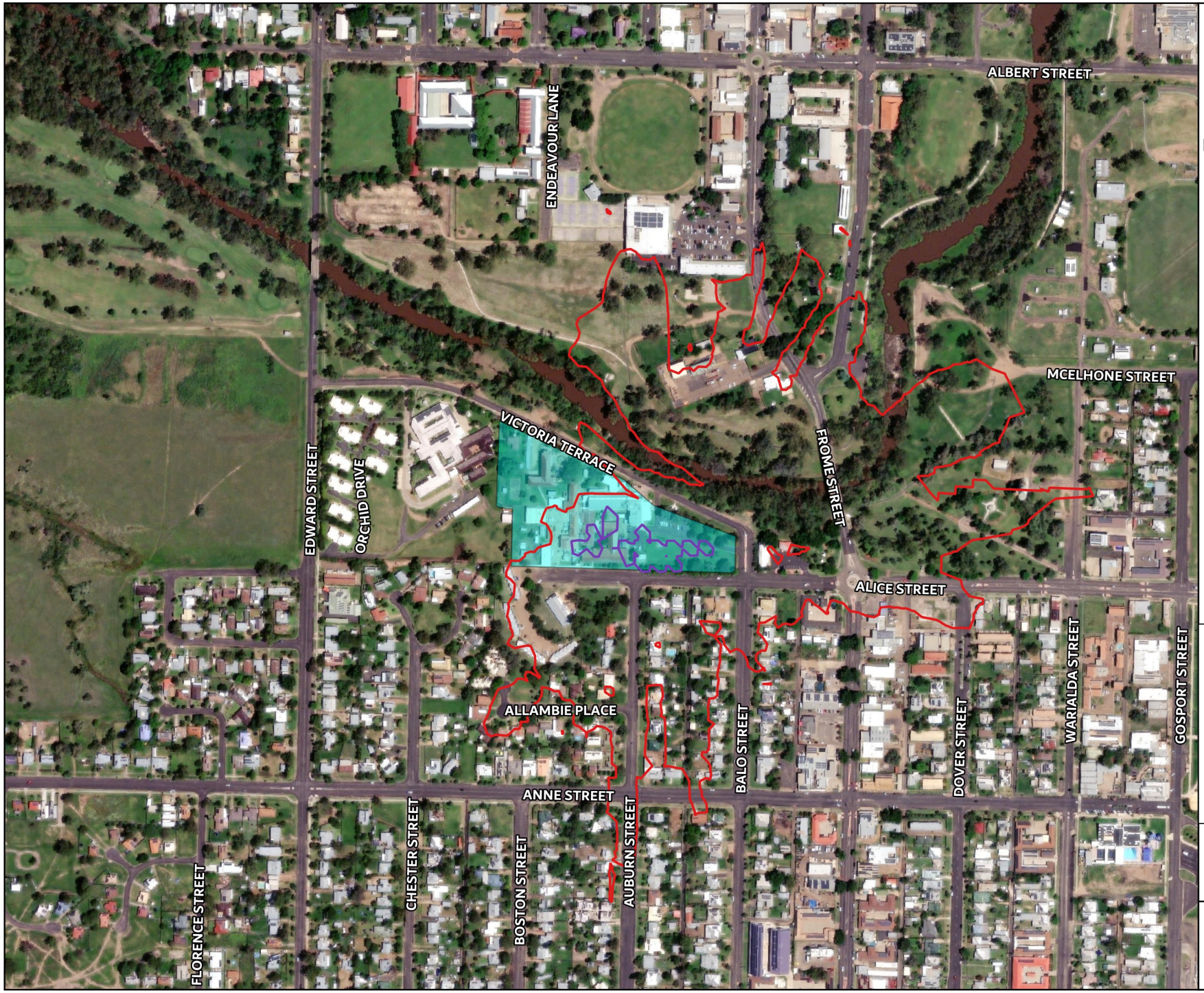

FIGURE C3

Noise Affected Area -

Site Preparation

MAC221546-02

Moree Hospital Redevelopment

KEY

Project Site

Noise Affected Area

Standard Construction Hours

Highly Noise Affected

0 65 130 195 260 m

N

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Muller Acoustic Consulting

FIGURE C4

Noise Affected Area -

Building Construction

MAC221546-02

Moree Hospital Redevelopment

KEY

Project Site

Noise Affected Area

Standard Construction Hours

Highly Noise Affected

0 75 150 225 300 m

N

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