

Project: **TARONGA ZOO - UPPER AUSTRALIA EXHIBIT**

Prepared for: **Taronga Zoo
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Mosman 2088**

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EXECUTIVE SUMMARY

Marshall Day Acoustic has been engaged by Taronga Zoo to undertake an acoustic assessment of the proposed development of the Upper Australia Precinct exhibit. This Acoustic Assessment will form part of a State Significant Development Application. This report covers the operational noise impacts from the development as well as the construction noise and vibration impacts.

For the operational acoustic assessment, applicable noise criteria have been derived in accordance with the requirements of the EPA Noise Policy for Industry 2017, Planning Secretary's Environmental Assessment Requirements (SEAR) Section 4.12(8) of the Environmental Planning and Assessment Act 1979 and the Planning Secretary's Environmental Assessment Requirements (SEARs) Schedule 2 of the Environmental Planning and Assessment Regulation 2000.

For the construction noise and vibration impact assessment, applicable construction noise criteria have been derived in accordance with the requirements of the EPA Interim Construction Noise Guideline (ICNG) and the best practises of AS 2436-2010 - Guide to noise control on construction, maintenance and demolition sites. Construction vibration criteria applicable to the site have been determined in accordance with the requirements of the EPA document *Assessing vibration: a technical guideline*.

Construction Stage Activities

Detailed information on excavation and construction activities is not available at this stage. For the purposes of this report, noise levels from typical construction activities have been calculated in order to estimate likely noise impacts.

Noise levels from construction activities have been calculated at the nearest residential receivers for the various phases of construction. The predicted levels from all proposed phase activities indicate that "average" noise from typical activities are likely to be below both the "noise affected" levels and the "highly noise affected" levels at both residential receivers during standard ICNG hours.

"Worst case" noise levels from all site activity phases are predicted to be below the "highly affected" noise levels and marginally (1-2 dB) over the "noise affected" levels during typical site activities.

Noise control recommendations have been provided for the construction noise impacts. This includes the installation of boundary hoarding and the use of mobile noise barriers for static equipment or significant noise generating equipment where practical during the construction process.

Operational Phases

As the exhibit is currently in an early stage of development planning, specific operating installations are not yet fully developed. Estimates of noise from patron speech have been developed for the purposes of this report. Where no information is available (such as for mechanical plant and public address systems), relevant operating noise criteria are provided to establish the necessary acoustic design constraints.

Noise levels from operations on site have been calculated for patrons at the nearest residential receiver location for various number of patrons. It is concluded that noise from patron conversational speech levels is likely to be within acceptable noise limits when assessed at residential boundaries. Any events however that encourage cheering or shouting during evening hours would require management to limit possible noise impacts during evening hours.

On the basis on advice to MDA that traffic movement is likely to remain substantially unaltered, significant additional noise impacts from traffic movement is unlikely.

Noise emissions from mechanical plant and public address system will require specific acoustic design elements such that consent authority noise limits are not exceeded. The design must also allow the specific acoustic requirements expected to be required by the EPA to be incorporated.

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1.0 INTRODUCTION

Taronga Zoo are developing a new “Upper Australia” exhibit at their existing premises in Mosman, providing a representation of Australia’s flora and fauna in a natural habitat.

Marshall Day Acoustics (MDA) has been engaged by Taronga Zoo to undertake an acoustic assessment for the development of the Upper Australia Exhibit at the Taronga Zoo, Mosman NSW.

A previous Development Application (DA) has been submitted separately for demolition stage only, provided to Mosman Council.

The acoustic and vibration impacts from the proposed stages of works of construction and operations in this development have been assessed against the following criteria:

- Environment Protection Authority’s (EPA) *Interim Construction Noise Guideline (ICNG)*
- Environment Protection Authority’s (EPA) *Assessing Vibration: A Technical Guideline (AVTG)*
- Planning Secretary’s Environmental Assessment Requirements (SEAR) Section 4.12(8) of the Environmental Planning and Assessment Act 1979
- Planning Secretary’s Environmental Assessment Requirements (SEAR) Schedule 2 of the Environmental Planning and Assessment Regulation 2000
- EPA Noise Policy for Industry 2017

The assessment is based upon documentation provided to MDA by the client (Taronga Zoo) and by the Architect (lahznimmo Architects) which includes:

- State Significant Development Application Drawing Set provided in Appendix B
- Project Brief from Design Brief document
- Urbis SEARs Requirements – Upper Australia Precinct

Acoustic terminology used throughout this report is detailed in Appendix A.

In the absence of specific construction methodologies Marshall Day have made generalised assumptions for the construction equipment schedule used for assessment as part of this report.

It will be necessary to verify or develop these assumptions as part of specific construction Noise and Vibration Management Plans.

2.0 PROJECT DESCRIPTION

A detailed description of the project is provided within an Architectural and Landscape Design Statement, prepared by lahznimmo Architects and spackman mossop michaelis. The exhibit will comprise a path through various landscapes, through tree canopies and koala habitats, rock escarpments and through to the nocturnal house.

It is understood the project will include the following key elements:

- complete refurbishment of the existing nocturnal house;
- construction of a new koala encounter and canopy walk;
- new / extended macropod walkthrough;
- creation of a new eastern plaza and western pavilion;
- upgrades to back of house facilities for animal care;
- new toilets and amenities for staff and visitors;
- other supporting infrastructure and walkways; and
- modifications to the existing ropes course including a new entrance.

3.0 SITE LOCATION AND BOUNDARIES

The Upper Australia Exhibit is located at Taronga Zoo, Bradleys Head Road, Mosman, NSW, and is bounded by the Taronga Zoo site on the North South and West and by Bradleys Head Road on the East.

The nearest residential premises are located along Bradleys Head Road, with the nearest residence approximately 200m from the site. A site map showing the location of the Upper Australia Exhibit site and nearby receivers is provided in Figure 1 overleaf. Only receivers outside the Taronga Zoo grounds have been considered. It will be necessary for Taronga Zoo management to manage noise impacts from the re-development of the site as part of day-to-day operational expectations. These requirements are likely to supercede the requirements for control at residential boundaries.

Noise sensitive receivers are detailed in Table 1 and have been selected to be representative for the purpose of our assessments and calculations. The land use for each receiver has been described in accordance with the sensitive land uses detailed in the ICNG and NPfI.

With regards to the construction noise requirements of the ICNG, distances to the receivers have been provided for "Average" and "Worst Case" equipment positions with "Average" typically relating to a plant position to the centre of the site and "Worst-Case" at a position within the site closest to the receiver.

Table 1: Nearby noise sensitive receivers and land uses

Receiver No.	Location	Land Use	Distance to development (Average), m	Distance to development (Worst Case), m
1	1 Bradleys Head Road	Residential	230	180
2	2 Whiting Beach Road	Residential	240	190

Figure 1: Subject site and nearby noise sensitive receivers



It is assumed that demolition and construction activities on-site will comply with the recommended standard hours for construction work on-site, as described in the ICNG:

- Monday to Friday 0700hrs to 1800hrs
- Saturday 0800hrs to 1300hrs
- No work on Sundays or public holidays

4.0 BACKGROUND NOISE LEVELS

In order to assess background noise levels at the site, MDA has deployed an unattended noise logger within the work site location from 20 May 2020 to 02 June 2020. Calibrations of the equipment were performed before and after the deployment and no significant drifts were observed. The noise logger data was processed according to the Noise Policy for Industry (NPfI) for weather corrections. Due to the extensive flora present on the site, the weather elements such as wind are categorised as being a feature of the site. Therefore, we have elevated the wind speed limit to which noise data is usually corrected from 5 m/s to 6 m/s. This corresponds to the guidance in the NPfI regarding weather exposed sites.

Background noise levels measured are presented in Table 2 and are presented in graphs in Appendix G

Table 2: Measured background noise level

Time	Noise level L_{A90} dB	Noise level L_{Aeq} dB
Day: 0700-1800 hrs	43	55
Evening: 1800-2200 hrs	41	48
Night: 2200-0700 hrs	40	46

We note that due to COVID-19 restrictions, including reduced vehicle movements and closure of the zoo, that ambient noise levels are likely to be lower than typical. For the purposes of this assessment we have used the 43dB L_{A90} measured, which may result in a slightly conservative (i.e. lower) criteria.

5.0 NOISE POLICY FOR INDUSTRY (NPFI) OPERATIONAL NOISE CRITERIA

Compliance with the NPFI would require total noise from the site to not exceed the following limits at the adjacent boundaries 1.5 m from ground level. For the purposes of this assessment, we have taken any elevated assessments at the property façades. The full derivation of the NPFI noise criteria can be found in Appendix F. It is assumed that the site would generally operate during the daytime hours (0700-1800), with some exceptions for special activities. We have included an evening period (1800-2200) in our assessment should it be required.

Table 3: NPFI assessment noise levels

Receiver	Period	Project Noise Trigger Level, $L_{Aeq, 15min}$, dB
Residential	Day	48
	Evening	43
	Night	38

6.0 CONSTRUCTION NOISE & VIBRATION CRITERIA

6.1 Construction noise criteria

Construction noise criteria have been derived based on the estimated average background levels presented in Table 2. The noise criteria for the permitted hours of construction are summarised in below with full derivation of the criteria set out in Appendix C. Only the day-time period is considered as no construction work is expected outside of this period.

Table 4: Construction noise management levels

Receiver	Type	Time of day	"Noise Affected" management level, dB $L_{Aeq, 15min}$	"Highly noise affected" management level, dB $L_{Aeq, 15min}$
1, 2	Residential	Mon-Fri 0700-1800hrs	53	75
		Sat 0800-1300hrs	53	75

The "noise affected" level is the point above which there may be some community reaction to noise. The "highly noise affected" level represents the point above which there may be a strong community reaction to noise. Where the "noise affected" management level is predicted to be exceeded, the ICNG requires that all feasible and reasonable work practices be employed. Where it is predicted that the "highly noise affected" management level will be exceeded, respite periods may need to be considered.

6.2 Construction vibration criteria

The ICNG refers assessment of vibration effects on people to the EPA document *Assessing Vibration: A Technical Guideline* (AV:TG). For assessment of vibration effects on structures the German standard DIN4150-3 *Structural vibration – Effects of vibration on structures -1999* is used.

6.2.1 Vibration limits – Effects on structures

DIN 4150-3 provides guidelines to use when evaluating the effects of short-term vibration on structures. The guideline vibration limits, as reproduced from the standard, are detailed in .

Table 5: Vibration limits according to DIN 4150: Peak Particle Velocity (PPV) mm/s

Line	Type of structure	Vibration at the foundation of building, at a frequency of			Vibration in horizontal plane of highest floor, at all frequencies
		1Hz to 10Hz	10Hz to 50Hz	50Hz to 100Hz and above	
I	Buildings used for commercial purposes, industrial buildings, and buildings of similar design	20	20 to 40	40 to 50	40
II	Dwellings and buildings of similar design and/or occupancy	5	5 to 15	15 to 20	15
III	Structures that, because of their particular sensitivity to vibration, cannot be classified under lines I and II and are of great intrinsic value (e.g. listed buildings under preservation order)	3	3 to 8	8 to 10	8

Experience has shown that if the guideline values of are complied with, damage which reduces the serviceability of the building will not occur.

6.2.2 Vibration limits – Effects on people

As the DIN standard is commonly accepted by industry, the criterion of 5mm/s PPV for dwellings is considered appropriate for this assessment.

The EPA document *Assessing vibration: A technical guideline*, provides a vibration dose value (VDV) criterion to assess the severity of intermittent vibration, such as that experienced from construction activities. The VDV criteria for residential receivers as detailed in the guideline are provided in below.

Table 6: Acceptable vibration dose values for intermittent vibration

Receiver type	Day-time ¹	
	Preferred value	Maximum value
Residences	0.20	0.40
Offices	0.40	0.80

¹ 16 hour day period 0600-2200hrs.

The preferred values indicate a low probability of adverse comment, and the maximum values indicate that adverse comments may be expected.

7.0 CRITICAL STATE SIGNIFICANT INFRASTRUCTURE STANDARD SECRETARY'S ENVIRONMENTAL ACOUSTIC ASSESSMENT REQUIREMENTS (SEARS)

The Taronga Zoo Upper Australia development is will be subject to the following assessment requirements, dictated by the SEARs. These are as follows:

"5. Noise

- *Identify and provide a quantitative assessment of the noise generating sources and activities during operation together with designs for feasible and reasonable noise impact avoidance and mitigation.*
- *Outline measures to minimise and mitigate the potential noise impacts on surrounding occupiers of land, including the scheduling of intra-day 'respite periods' from noise-generating construction activities that may impact on adjoining properties.*
- *Construction impacts should include an assessment of on-site and off-site traffic noise impacts and vibration impacts.*
- *Noise and vibration impacts must be assessed in accordance with the relevant guidelines identified in Attachment A "*

As the exhibit is currently in an early stage of development planning, specific construction methodologies and operating installations are not yet fully developed. Estimates of noise producing activities have been developed for the purposes of this report. Where no information is available (such as for mechanical plant and public address systems), relevant operating noise criteria are provided to establish the necessary acoustic design constraints.

8.0 DEPARTMENT OF PLANNING AND ENVIRONMENT (EPA) ACOUSTIC ASSESSMENT REQUIREMENTS

As well as the SEARs requirement, the EPA have, previously identified key areas were required to be addressed during the application stages of the Savannah Project. In anticipation of these requirements being replicated, they are reproduced in this section. We note that the roar and snore activities that were part of the Savannah project are not part of the proposed exhibit.

"The EPA emphasises the importance of properly managing noise and vibration impacts during demolition, site preparation, bulk earthworks, construction and construction-related activities, especially in regard to high noise impact activities, such as grinding, jack hammering, pile driving, rock breaking and hammering, rock drilling, saw cutting and vibratory rolling.

General Construction

The EPA emphasises that in general demolition, site preparation, bulk earthworks, construction and construction-related activities should be undertaken during the recommended standard construction hours. Any change from standard hours should include strong justification

Ongoing noise impacts

(a) Provide a quantitative assessment of predicted operational noise impacts on surrounding noise sensitive receivers, especially those residences which are likely to be the most affected by noise from:

(i) Mechanical plant and equipment, and

(ii) 'Roar and snore' and any other patron activities undertaken after the general zoo opening hours (Wildlife Retreat);

(b) ensure plant and equipment does not generate noise that exceeds 55 dB LAeq (15minute) measured at the nearest part of the open walkway or outdoor spaces associated with the precinct

(c) ensure plant and equipment does not generate noise that exhibits tonal, low frequency or other annoying characteristics; and

(d) any public address system is designed, installed and operated to minimise noise impacts on nearby residences, including –

- (i) more lower power speaker horns in preference to a few higher power speaker horns,*
- (ii) zones to limit noise to only those zones essential to the particular announcement,*
- (iii) speaker horns located only in essential control areas rather than throughout the zoo,*
- (iv) speaker horns pointed in the appropriate direction within the zoo, and*
- (v) speaker horns inclined downwards at an angle of 45 degrees. “*

These requirements will require further acoustic input during the design stage and have been addressed in a preliminary manner in Section 9 below .

9.0 OPERATIONAL NOISE ASSESSMENT

The operational noise from the development will be driven by the following noise sources:

- Patron Noise
- Mechanical and Services Noise
- Public Address System Noise
- Traffic Noise

These sources have been assessed within the guideline of the SEARs and EPA requirements above.

9.1 Patron Noise

Taronga Zoo has indicated that the number of patrons at any one time in the development area will be similar to the number of patrons previously noted on site. As such we would not expect a significant difference in noise generation, compared to that generated by the existing use.

While detailed site population densities are not available at this stage, Marshall Day have however provided indicative calculations in order to consider likely noise transmission from patrons in the course of normal speech. The estimates are based on patrons using normal conversation levels, with differing patron numbers as shown, allowing for 33 % simultaneous conversation. The location is based on position averaged on the site as described in Table 7.

Noise emissions from conversational voice levels from patrons on site are expected to be within satisfactory levels. It is possible that the recommended noise criteria may be exceeded particularly during evening hours during any sustained any exhibits supporting high level exclamation or cheering. While, given the nature of the exhibit, this is unlikely, management of any such events during the evening would be required.

Table 7: Patron noise assessment

Receiver Type	Number of Patrons	Distance to receiver (m)	Period	Noise level criteria (RBL dB)	Noise level from patron noise at the receiver (L _p dB)	Compliance?
Residential	50	230	Day	48	30	✓
			Evening	43	30	✓
Residential	100	230	Day	48	33	✓
			Evening	43	33	✓
Residential	150	230	Day	48	35	✓
			Evening	43	35	✓
Residential	200	230	Day	48	36	✓
			Evening	43	36	✓

9.2 Mechanical and Services Noise

Details of the proposed mechanical plant and equipment are not yet available. It will be necessary during detailed design to ensure that the noise from plant and equipment:

- Complies cumulatively with other noise sources with the NPfI criteria set out in section 5 of this report
- does not generate noise that exceeds 55 dB LAeq (15minute) measured at the nearest part of the open walkway or outdoor spaces associated with the precinct
- does not generate noise that exhibits tonal, low frequency or other annoying characteristics

9.3 Public Address System Noise

Details of the proposed public address system and equipment are not yet available. It will be necessary during detailed design to ensure that the equipment is designed to meet the expected specific EPA requirements as follows:

any public address system is designed, installed and operated to minimise noise impacts on nearby residences, including –

- more lower power speaker horns in preference to a few higher power speaker horns,
- zones to limit noise to only those zones essential to the particular announcement,
- speaker horns located only in essential control areas rather than throughout the zoo,
- speaker horns pointed in the appropriate direction within the zoo, and
- speaker horns inclined downwards at an angle of 45 degrees.

9.4 Traffic Generated Noise

Information on vehicle movements associated with the development is not available at this stage.

Taronga Zoo have however advised Marshall Day that the development is at the location of existing Zoo facilities and further, that traffic volumes at the existing carpark and adjacent roadway not expected to vary significantly.

Provided the hours of operation of the site together with car and bus parking location locations remain as existing, noise emissions to residential boundaries from vehicle movements are expect to remain similar to that existing.

9.5 Roar and Snore Experience

The previous EPA assessment requirements referenced noise from Roar and Snore activities. These activities do not however form part of the Upper Australia Exhibit, and consideration of noise from these activities is therefore not relevant.

It would however be necessary to manage any events that encourage cheering or elevated vocal levels from patrons during the evening hours.

10.0 CONSTRUCTION NOISE & VIBRATION IMPACT ASSESSMENT

There are several noise sources associated with the difference phases of construction that have the potential to increase noise at the nearest noise sensitive receivers. A schedule of anticipated activities and a list of assumed equipment for each construction phase is below in .

Table 8: Anticipated activities and equipment schedule

Phase	Activities	Equipment
Demolition & site preparation	Concrete removal	1 x 12t excavator
		1 x 22t excavator
		Jack hammer & breaker
		Concrete saw/ring saw
	Removal of waste material from site	Bogie truck, no trailer
	General	Generator
		Air compressor & lines
Piling & shoring	Piling activities	Concrete truck & pump
		1 x 12t excavator
		1 x 40 tonne hydraulic rotary piling rig with auger
		Jack hammer & breaker
		Concrete saw/ring saw
	Delivery of materials & removal of waste materials	Bogie truck
	General	Generator
		Air compressor & lines
		De-watering plant

Excavation	Bulk & detailed excavation works	3 x excavators (12 tonne, 22 tonne, 27 tonne) with hydraulic hammer, eccentric rock ripper, buckets, rock grinder, demolition grab, rock-saw Compacting plate Jack hammer & breaker Concrete saw / ring saw (hand operated) Concrete saw - road
	Delivery of materials & removal of waste materials	Flatbed truck Bogie truck
	General	Generator Air compressor & lines De-watering plant
Construction – Structure	Concreting	Concrete pump 1 x tower crane Exhaust fans Brick saw Concrete vibrator Concrete floats Concrete saw/ring saw Diamond core drill Nail guns Hydraulic bar cutter
	Delivery of materials	Concrete truck Bogie truck
	General	Generator Air compressor & lines De-watering plant Pressure cleaner Electric winch & materials hoist
Construction – Finishes	Construction activities	1 x tower crane Exhaust fans Diamond core drill Brick saw Scissor lift Nail guns Hydraulic bar cutter
	Delivery of materials	Flatbed truck

General

Generator

Air compressor & lines

De-watering plant

Pressure cleaner

Electric winch & materials hoist

10.1 Noise control recommendations

MDA recommends the noise control recommendations detailed in overleaf are implemented on-site. Our calculations include the effect of these recommendations.

Table 9: Noise control recommendations for site

Phase	Equipment/Location	Recommendation
Demolition	Jack hammer & breaker	<ul style="list-style-type: none"> - Localised noise barriers should be utilised when this equipment is in use. - Barriers should be mobile and extend to a height 1m above noise source. - Barrier should envelope the work location to ensure no direct line of site to nearby receivers. - Practical and feasible measures should be taken to allow the noise barrier to be located within 4m of the noise source.
Piling/shoring	Jack hammer & breaker	<ul style="list-style-type: none"> - Localised noise barriers should be utilised when this equipment is in use. - Barriers should be mobile and extend to a height 1m above noise source. - Barrier should envelope the work location to ensure no direct line of site to nearby receivers. - Practical and feasible measures should be taken to allow the noise barrier to be located within 4m of the noise source.
Excavation	Compacting Plate	- Localised noise barriers should be utilised when this equipment is in use.
	Jack hammer & breaker	- Barriers should be mobile and extend to a height 1m above noise source.
	Concrete saw/ring saw	- Barrier should envelope the work location to ensure no direct line of site to nearby receivers.
	Concrete saw - road	- Practical and feasible measures should be taken to allow the noise barrier to be located within 4m of the noise source.
Construction (structure)	Core drill	- Localised noise barriers should be utilised when this equipment is in use.
	Concrete saw/ring saw	

Phase	Equipment/Location	Recommendation
		<ul style="list-style-type: none"> - Barriers should be mobile and extend to a height 1m above noise source. - Barrier should envelope the work location to ensure no direct line of site to nearby receivers. - Practical and feasible measures should be taken to allow the noise barrier to be located within 4m of the noise source.
Construction (finishes)	Core drill	<ul style="list-style-type: none"> - Localised noise barriers should be utilised when this equipment is used. - Barriers should be mobile and extend to a height 1m above noise source. - Barrier should envelope the work location to ensure no direct line of site to nearby receivers. - Practical and feasible measures should be taken to allow the noise barrier to be located within 4m of the noise source.

10.2 Summary of findings

Our assessment of noise levels from the construction is summarised below. Refer to Appendix D for our detailed assessment. Noise levels associated with each noise source are detailed in Appendix E.

The predicted L_{Aeq} levels from the proposed construction equipment indicate that average noise from typical excavation and construction (structures) activities may marginally exceed the “noise affected” goals from the EPA criteria at the nominated receivers.

Within standard ICNG hours (Monday – Friday: 0700-1700hrs, Saturday 0800-1300hrs) the average noise levels from typical operations would be;

- Demolition activities are calculated to be:
 - o up to 1 dB above “noise affected” goals at both receivers for a “worst case” plant position, but below “noise affected” goals for “average” plant position
- Piling activities are calculated to be:
 - o Below “noise affected” goals at both receivers
- Excavation activities are calculated to be:
 - o up to 2 dB above “noise affected” goals at both receivers for a “worst case” plant position, but below “noise affected” goals for “average” plant position
- Construction (structure) activities are calculated to be:
 - o Below “noise affected” goals at both receivers
- Construction (finishes) activities are calculated to be:
 - o Below “noise affected” goals at both receivers

These marginal exceedances are typical of construction sites in suburban areas. Further, since all construction work is restricted to take place only during the daytime, noise impacts will not be experienced during the most sensitive time period i.e. evening and night-time.

It is not expected that the “highly noise affected” levels will be exceeded at any receivers during typical operations.

The dominant noise sources for each phase of construction are indicated in table 10 overleaf.

Table 10: Dominant noise generating equipment

Phase	Dominant noise generating equipment
Demolition	Jack hammer, bogie truck, concrete saw/ring saw
Piling and shoring	Jack hammer, bogie truck, auger piling rig
Excavation	Jack hammer, 27t excavator, bogie trucks
Construction (structure)	Tower crane, concrete truck, bogie truck, concrete saw/ring saw, electric winch
Construction (finishes)	Tower crane, flatbed truck, hydraulic bar cutter

During “average” operation within guidance hours, the “noise affected” management goals are not predicted to be exceeded at either receiver. For “worst case” operations, the “noise affected” management goals may be exceed by up to 1dB for short periods of time.

Whilst the predicted exceedances are typically minor in nature, due diligence by the site operator requires community consultation and negotiation. Notification should be provided of the proposed construction activities to nearby residents and non-residential receivers.

Vibration generating activity will need to be minimised through the construction methodologies and selection of appropriate construction equipment. Care needs to be taken to ensure that vibration events do not adversely affect the nearby underground train station and associated activities. Final selections should be checked by MDA when available. Management practices relating to community consultation and construction noise and vibration control measures have been detailed in Section 6 below.

11.0 CONSTRUCTION NOISE AND VIBRATION MANAGEMENT

11.1 Community consultation and negotiation

It is recommended that the following practices relating to community consultation be adopted:

- All potentially impacted residents should be informed, reasonably ahead of time, of the nature of works to be carried out, the expected noise levels from noisier activities and their duration, and the measures being taken to minimise noise from the construction
- Effective channels of communication must be established between the contractor/developer, Local Authority and affected receivers.
- A site representative responsible for all matters relating to noise should be appointed and contact details of this representative should be readily available. A site information board should be installed in front of the construction site with the name and contact details for the site representative.

11.2 Scheduling of activities and providing respite periods

- Scheduling high noise-generating activities to be undertaken when background noise, including local road traffic, is high to provide masking to construction noise.
- All building, demolition and site work, including site deliveries are restricted to Monday to Friday (7.00am to 5.00pm), Saturday (8.00am to 1.00pm) and not any time on Sunday & public holidays as per the recommended standard hours detailed in the ICNG.

- Excavating of rock, and the use of jack-hammers, pile-drivers, vibration rollers/compactors or the like represent dominant noise sources on site, and their use during the weekend period may give rise to adverse noise impacts. In order to mitigate noise from these sources, the scheduling of site work to concentrate these activities during the weekday periods is advisable, where practical and feasible.
- Ensuring that periods of respite are provided when noisier activities such as excavation take place. Respite periods may be provided by restricting the hours in which the noisiest activities can take place.
- Respite periods may also need to be provided in response to complaints from affected receivers.

11.3 Management work practices

- Planning deliveries and access to the site to occur quietly and efficiently. Truck drivers must be kept informed of designated entry and egress points, parking locations and acceptable delivery hours. Vehicle movements outside standard construction hours should be avoided where possible.
- Scheduling vehicle deliveries so that there are no trucks waiting in side streets and ensuring that all delivery vehicles are switched off during loading and unloading activities where close to residences.

11.4 Construction noise control measures

Predicted noise levels take into account the proposed boundary hoarding and mobile noise barriers detailed in Section 9.1.

It is envisaged that a variety of additional practicable noise control measures may be employed:

- Using existing structures and temporary site structures and material stockpiles as noise barriers
- Reducing the line-of sight from noise source to receiver through erection of barriers as necessary around static, high noise items such as compressors and preferentially locating on-site to use the retained building (if applicable) as shielding
- Where practicable, installing broadband noise reversing alarms as an alternative to common 'beeper' alarms for on-site vehicles and vehicles that regularly visit the construction site
- Siting of noisy plant as far away from sensitive properties as permitted by site constraints

11.5 Complaint handling procedure

- The site representative responsible for matters relating to noise will be responsible for handling complaints and will need to be readily accessible to give complaints a fair hearing should they arise.
- All feasible and reasonable measures will need to be applied to address the source of complaint.
- A register of all complaints will need to be maintained documenting the nature of complaints and the procedures applied to resolve the complaint. All complaints should be responded to and a record kept of actions taken to address the issues. All complaints should be followed up after the implementation of any controls to identify whether the complaint has been adequately resolved.

11.6 EPA Construction Noise and Vibration Recommendations

The EPA has previously issued a set of recommendations for the Savannah project at Taronga Zoo. These will need to be adhered to for best practise and EPA compliance. These are as follows:

The EPA emphasises the importance of properly managing noise and vibration impacts during demolition, site preparation, bulk earthworks, construction and construction-related activities,

especially in regard to high noise impact activities, such as grinding, jack hammering, pile driving, rock breaking and hammering, rock drilling, saw cutting and vibratory rolling.

2.2.1 general construction hours

The EPA emphasises that in general demolition, site preparation, bulk earthworks, construction and construction-related activities should be undertaken during the recommended standard construction hours.

Section 8.2 to EIS Appendix J proposes construction hours inconsistent with the recommended standard construction hours and omits strong justification for departing from those standard hours. In particular the proponent proposes –

- proposes extending Saturday construction hours by starting an hour earlier than the standard hours of 8.00 am to 1.00pm, and*
- appears to propose allowing construction vehicles to enter the site an hour earlier on weekdays (i.e. 6.00 am) and Saturdays (i.e. 7.00 am).*

The proponent has provided no justification for starting construction-related activities (i.e. entry of construction vehicles) early on weekdays and Saturdays. The EPA anticipates that early arrival of construction vehicles including tradesman vehicles with trailers, tip trucks, concrete agitators and other construction vehicles, plant and equipment are likely to emit noise audible at surrounding residences. And, are likely to cause sleep disturbance during the night period which includes 6.00 am to 7.00 am.

Recommendation

The proponent be required to ensure that as far as practicable all demolition, site preparation, bulk excavation, construction and construction-related work likely to be audible at any noise sensitive receivers, including residences, is undertaken only during the standard construction hours, being -

- (a) 7.00 am to 6.00 pm Monday to Friday,*
- (b) 8.00 am to 1.00 pm Saturday, and*
- (c) no work on Sundays or gazetted public holiday.*

2.2.2 intra-day respite periods

The EPA anticipates that those demolition, site preparation, bulk earthworks, construction and construction-related activities generating noise with particularly annoying or intrusive characteristics (such as those identified as particularly annoying in section 4.5 of the Interim Construction Noise Guideline) would be subject to a regime of intra-day respite periods where those activities are only undertaken –

- (a) after 8.00 am, and*
- (b) over continuous periods not exceeding 3 hours with at least a 1 hour respite every three hours (where ‘continuous’ means any period during which there is less than an uninterrupted 60-minute respite between temporarily halting and recommencing any of the intrusive and annoying work referred to in Interim Construction Noise Guideline section 4.5)*

The EPA emphasises that intra-day respite periods are not proposed to apply to those demolition, site preparation, construction and construction-related activities that do not generate noise with particularly annoying or intrusive characteristics.

Recommendation

The proponent be required to schedule intra-day ‘respite periods’ for those demolition, site preparation, bulk earthworks, construction and construction-related activities identified in section 4.5

of the Interim Construction Noise Guideline as being particularly annoying to noise sensitive receivers (i.e. surrounding residences).

2.2.3 idling and queuing construction vehicles

The EPA is aware from previous major infrastructure projects that community concerns are likely to arise from noise impacts associated with the early arrival and idling of construction vehicles (including concrete agitator trucks) at the development site and in the residential precincts surrounding that site.

Recommendation

The proponent be required to ensure construction vehicles (including concrete agitator trucks) involved in demolition, site preparation, bulk earthworks, construction and construction-related activities do not arrive at the project site or in surrounding residential precincts outside approved construction hours.

2.2.4 reversing and movement alarms

The EPA has identified the noise from ‘beeper’ type plant movement alarms to be particularly intrusive and is aware of feasible and reasonable alternatives. Transport for NSW (nee Transport Construction Authority), Barangaroo Delivery Authority/Lend Lease and Leighton Contractors (M2 Upgrade project) have undertaken safety risk assessments of alternatives to the traditional ‘beeper’ alarms. Each determined that adoption of ‘quacker’ type movement/reversing alarms instead of traditional beepers on all plant and vehicles would not only maintain a safe workplace but also deliver improved outcomes of reduced noise impacts on surrounding residents.

Interim Construction Noise Guideline Appendix C provides additional background material on this issue.

Recommendation

The proponent be required to consider undertaking a safety risk assessment of site preparation, bulk earth works, construction and construction-related activities to determine whether it is practicable to use audible movement alarms of a type that would minimise the noise impact on surrounding noise sensitive receivers, without compromising safety.

APPENDIX A GLOSSARY OF TERMINOLOGY

SWL or L_w	<p><u>Sound Power Level</u></p> <p>A logarithmic ratio of the acoustic power output of a source relative to 10^{-12} watts and expressed in decibels. Sound power level is calculated from measured sound pressure levels and represents the level of total sound power radiated by a sound source.</p>
dB	<p><u>Decibel</u></p> <p>The unit of sound level.</p> <p>Expressed as a logarithmic ratio of sound pressure P relative to a reference pressure of $P_r=20 \mu\text{Pa}$ i.e. $\text{dB} = 20 \times \log(P/P_r)$</p>
dB(A)	<p>The unit of sound level which has its frequency characteristics modified by a filter (A-weighted) so as to more closely approximate the frequency bias of the human ear.</p>
A-weighting	<p>The process by which noise levels are corrected to account for the non-linear frequency response of the human ear.</p>
$L_{Aeq}(t)$	<p>The equivalent continuous (time-averaged) A-weighted sound level. This is commonly referred to as the average noise level.</p> <p>The suffix "t" represents the time period to which the noise level relates, e.g. (8 h) would represent a period of 8 hours, (15 min) would represent a period of 15 minutes and (2200-0700) would represent a measurement time between 10 pm and 7 am.</p>
L_{A90}	<p>The A-weighted noise level equalled or exceeded for 90% of the measurement period. This is commonly referred to as the background noise level.</p>
L_{Amax}	<p>The A-weighted maximum noise level. The highest noise level which occurs during the measurement period.</p>
L_{Aavmax}	<p>The A-weighted sound pressure level obtained by arithmetically averaging the maximum levels measured during the time period considered.</p>
Vibration	<p>When an object vibrates, it moves rapidly up and down or from side to side. The magnitude of the sensation when feeling a vibrating object is related to the vibration velocity.</p> <p>Vibration can occur in any direction. When vibration velocities are described, it can be either the total vibration velocity, which includes all directions, or it can be separated into the vertical direction (up and down vibration), the horizontal transverse direction (side to side) and the horizontal longitudinal direction (front to back).</p>
PPV	<p>Peak Particle Velocity</p> <p>For Peak Particle Velocity (PPV) is the measure of the vibration aptitude, zero to maximum. Used for building structural damage assessment.</p>
VDV	<p>Vibration Dose Value</p> <p>Vibration Dose Value is based on British Standard BS 6472:1992 Guide to Evaluation of Human Exposure to Vibration in Buildings (1Hz to 80Hz) and provides guidelines for the evaluation of whole body exposure to intermittent vibration.</p> <p>VDV can be used to take into account the weighted measured RMS vibration from many vibration sources including rail vehicles, construction equipment such as jackhammers and industry. VDV takes into account the duration of each event and the number of events per day, either at present or in the foreseeable future and calculates a single value index.</p>

APPENDIX B DRAWING LIST

STATE SIGNIFICANT DEVELOPMENT APPLICATION

DRAWING LIST

00 GENERAL INFORMATION

A - DA -	001	COVER PAGE
A - DA -	002	SITE ANALYSIS
A - DA -	003	SITE SURVEY

01 DEMOLITION

A - DA -	011	EXISTING SITE PLAN
A - DA -	012	EARLY WORKS DEMOLITION SITE PLAN
A - DA -	013	EARLY WORKS TEMPORARY END STATE SITE PLAN
A - DA -	014	SSDA DEMOLITION SITE PLAN
A - DA -	015	NOCTURNAL HOUSE DEMOLITION PLAN

02 SITE

A - DA -	021	PROPOSED SITE PLAN
A - DA -	022	SITE SECTIONS
A - DA -	023	SITE SECTIONS
A - DA -	024	PHOTOMONTAGE

10 WESTERN PAVILION & ROPES BRIDGE

A - DA -	101	PAVILION & ROPES BRIDGE FLOOR PLAN
A - DA -	102	PAVILION & ROPES BRIDGE SECTIONS & ELEVATIONS

20 TREE HOUSE & KOALA WALK

A - DA -	201	TREE HOUSE & KOALA WALK FLOOR PLAN
A - DA -	202	TREE HOUSE & KOALA WALK ROOF PLAN
A - DA -	203	TREE HOUSE & KOALA WALK SECTIONS

30 EASTERN PLAZA & ESCARPMENT

A - DA -	301	ESCARPMENT AND KOALA TALKS FLOOR PLAN
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40 NOCTURNAL HOUSE

A - DA -	401	NOCTURNAL HOUSE GROUND FLOOR PLAN
A - DA -	402	NOCTURNAL HOUSE SECTIONS & ELEVATIONS

50 BACK OF HOUSE

A - DA -	501	MACROPOD HOLDING YARD FLOOR PLAN, SECTIONS & ELEVATIONS
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60 SOUTHERN LINK

A - DA -	601	SOUTHERN LINK FLOOR PLAN, SECTIONS & ELEVATIONS
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70 LANDSCAPE

A - DA -	701	TREE PROTECTION AND REMOVAL PLAN
A - DA -	702	LANDSCAPE PLAN
A - DA -	703	PLANTING ZONES PLAN
A - DA -	704	PLANTING PALETTE
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A - DA -	706	PLANTING PALETTE
A - DA -	707	SURFACE TREATMENT PLAN
A - DA -	708	LEVELS AND GRADING PLAN

80 SHADOW DIAGRAMS

A - DA -	801	SHADOW DIAGRAMS
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APPENDIX C CONSTRUCTION NOISE CRITERIA

The NSW EPA Interim Construction Noise Guideline (ICNG) provides guidance for assessing noise associated with construction activities. The ICNG sets out management levels above which there may be community reaction to construction noise. A “noise affected” level is derived which is a level above which there may be some community reaction to noise”. A “highly noise affected” level is also nominated for residents, which “represents the point above which there may be a strong community reaction to noise”.

The noise management levels for receivers affected by construction noise are derived from a combination of background noise levels, referred in the ICNG as rating background levels, RBL, and the time period at which the construction work occurs.

The ICNG sets out recommended standard hours for construction work, these are:

- Monday to Friday 0700-1800hrs
- Saturdays 0800-1300hrs
- No work on Sundays or public holidays

The ICNG “noise affected” management level can then be derived by addressing the RBL values and hours at which construction work occurs; by adding 10dB for work during the recommended hours or adding 5dB outside these recommended hours.

The “highly noise affected” level for residents is 75dB $L_{Aeq, 15mins}$.

MDA has deployed an unattended noise logger within the work site location from 20 May 2020 to 02 June 2020. The measured average background sound pressure levels are presented in below. Only the day-time period is considered as no construction work is expected outside of this period.

Table C 1: Average background sound pressure levels measured at the logger position

Location	Background noise level L_{A90} (period) dB		
	Daytime (7am-6pm)	Evening (6pm-10pm)	Night (10pm-07am)
Within work site	43	41	40

The rating background level, RBL, during the day time period, 0700-1800hrs, was calculated to be 43dB $L_{A90(Period)}$.

The construction noise management levels for residential receivers nominated in that will be impacted during the construction phases of this project are provided in Table B 3 overleaf.

Table C 2: Residential receiver locations

Receiver No.	Location	Land Use	Distance to development (Average), m	Distance to development (Worst Case), m
1	1 Bradleys Head Road	Residential	230	180
2	2 Whiting Beach Road	Residential	240	190

Table C 3: Construction noise management levels for representative receivers

Receiver	Type	Time of day	"Noise Affected" management level, dB $L_{Aeq, 15min}$	"Highly noise affected" management level, dB $L_{Aeq, 15min}$
1, 2	Residential	Mon-Fri 0700-1800hrs	53	75
		Sat 0800-1300hrs	53	75

Noise levels apply at the property boundary that is most exposed to construction noise, and at a height of 1.5m above ground level.

Where the "noise affected" management level is predicted to be exceeded, the ICNG requires that all feasible and reasonable work practices are employed and that all potentially impacted receivers should be informed.

APPENDIX D CONSTRUCTION NOISE IMPACT ASSESSMENT

Noise levels during the demolition, excavation and construction phases have been calculated at the nominated occupancies during the demolition, excavation and general construction phases. These noise levels have been predicted under guidance from *AS2436-2010 Guide to noise control on construction, maintenance and demolition sites* and utilising the information provided in *BS 5228-1-2009 Code of practise for noise and vibration control on construction and open sites*.

We have presented data below for “worst-case” situations where noise sources will either be closest to the noise sensitive receiver and/or not screened by existing site structures. Noise levels have also been presented for the “average” situation, with noise sources located towards the centre of the site. The latter is likely to be representative of the long term noise emissions.

For the purpose of our calculation, we have assumed that the following plant items will be working together simultaneously for between 25 to 100% of the time over a 15 minute period for the demolition, excavation and construction phases.

Table D 1: Equipment assumed to be operating simultaneously in a 15 minute period

Construction equipment	Demolition & site preparation	Piling & shoring	Excavation	Construction – structure	Construction – finishes
12 tonne excavator	✓	✓	✓		
22 tonne excavator	✓		✓		
27 tonne excavator			✓		
Jack hammer & breaker	✓	✓	✓		
Compacting plate			✓		
Concrete saw	✓	✓	✓		
Concrete truck & pump		✓		✓	
Auger piling rig		✓			
Tower crane				✓	✓
Core drill				✓	✓
Brick saw				✓	✓
Concrete vibrator				✓	
Concrete floats				✓	
Nail gun				✓	✓
Hydraulic bar cutter				✓	✓
Bogie truck	✓	✓	✓	✓	
Flatbed truck			✓		✓
Generator	✓	✓	✓	✓	✓
Air compressor	✓	✓	✓	✓	✓
Scissor lift					✓

Construction equipment	Demolition & site preparation	Piling & shoring	Excavation	Construction – structure	Construction – finishes
Electric winch & materials hoist				✓	✓
De-watering plant (water pumps)		✓	✓	✓	✓

D1 Demolition phase

Table D 2 details the predicted noise levels at the nominated occupancies during the demolition phase. Noise levels have been calculated at the property boundary that is most exposed to noise from demolition activities. Calculated noise levels include the effects of the noise control recommendations detailed in Section 10.1.

The calculated levels indicate that noise from demolition activities will be up to 1 dB above the “noise affected” goals for the “worst-case” assessment position at both receivers.

The “average noise” levels will likely be below the “noise affected” goals at both receivers.

During the demolition phase, the use of the jack hammer, the concrete saw/ring saw and use of bogie trucks has the highest potential to impact on the noise received at the nominated occupancies.

D2 Piling and shoring phase

Table D 3 details the predicted noise levels at the nominated occupancies during the piling and shoring phase. Noise levels have been calculated at the property boundary that is most exposed to noise from piling and shoring activities. Calculated noise levels include the effects of the noise control recommendations detailed in Section 10.1.

The calculated levels indicate that noise from piling and shoring activities is below the “noise affected” goals for the “worst-case” assessment position at both receivers. Additionally, calculated “average” levels are below the “noise affected” goals for both receivers.

During the piling and shoring phase, the use of the jack hammer, the auger piling rig and use of bogie trucks has the highest potential to impact on the noise received at the nominated occupancies.

D3 Excavation phase

Table D 4 details the predicted noise levels at the nominated occupancies during the excavation phase. Noise levels have been calculated at the property boundary that is most exposed to noise from excavation activities. Calculated noise levels include the effects of the noise control recommendations detailed in Section 10.1.

The calculated levels indicate that noise from excavation activities will be up to 2 dB above the “noise affected” goals for the “worst-case” assessment position at both receivers.

The “average noise” levels will likely be below the “noise affected” goals at both receivers.

During the excavation phase, the use of the jack hammer, concrete saws, compacting plate and use of bogie trucks has the highest potential to impact on the noise received at the nominated occupancies.

D4 Construction (Structure) phase

Table D 5 details the predicted noise levels at the nominated occupancies during the construction (structure) phase. Noise levels have been calculated at the property boundary that is most exposed to noise from construction (structure) activities. Calculated noise levels include the effects of the noise control recommendations detailed in Section 10.1.

The calculated levels indicate that noise from construction (structure) activities is below the “noise affected” goals for the “worst-case” assessment position at both receivers. Additionally, calculated “average” levels are below the “noise affected” goals for both receivers.

During the construction (structure) phase the use of the tower crane, concrete truck, bogie truck, concrete saw/ring saw and the concrete pump has the highest potential to impact on the noise received at the nominated occupancies.

D5 Construction (Finishes) phase

Table D 6 details the predicted noise levels at the nominated occupancies during the construction (finishes) phase. Noise levels have been calculated at the property boundary that is most exposed to noise from construction (finishes) activities. Calculated noise levels include the effects of the noise control recommendations detailed in Section 10.1.

The calculated levels indicate that noise from construction (finishes) activities is below the “noise affected” goals for the “worst-case” assessment position at both receivers. Additionally, calculated “average” levels are below the “noise affected” goals for both receivers.

During the construction (finishes) phase, the use of the tower crane, flatbed truck and hydraulic bar-cutter has the highest potential to impact on the noise received at the nominated occupancies.

Table D 2: Predicted noise levels during demolition works

Receiver	Period	Assessment	Calculated noise level ² , dB L _{Aeq, 15min} ³	“Noise affected”		“Highly noise affected”		External	
				Management level, dB L _{Aeq, 15min}	Exceedance, dB	Management level, dB L _{Aeq, 15mins}	Exceedance, dB	Noise Level, dB L _{Aeq, 15mins}	Exceedance, dB
1	Within guideline hours ¹	Worst-case	54	53	1	75	--	N/A	N/A
		Average	51		--		--		
2	Within guideline hours ¹	Worst-case	53	53	--	75	--	N/A	N/A
		Average	51		--		--		

¹ Monday – Friday: 0700-1700hrs, Saturday 0800-1300hrs

² Calculations included the recommended noise controls detailed in Section 0

³ Unless noted otherwise, noise level calculated at 1.5m above ground level at the property boundary most exposed to construction noise in accordance with the requirements of the CNG. Noise levels at upper floors without shielding are likely to be higher.

Table D 3: Predicted noise levels during piling and shoring works

Receiver	Period	Assessment	Calculated noise level ² , dB L _{Aeq, 15min} ³	“Noise affected”		“Highly noise affected”		External	
				Management level, dB L _{Aeq, 15min}	Exceedance, dB	Management level, dB L _{Aeq, 15mins}	Exceedance, dB	Noise Level, dB L _{Aeq, 15mins}	Exceedance, dB
1	Within guideline hours ¹	Worst-case	53	53	--		--		
		Average	50		--	75	--	N/A	N/A
2	Within guideline hours ¹	Worst-case	52	53	--		--		
		Average	50		--	75	--	N/A	N/A

¹ Monday – Friday: 0700-1700hrs, Saturday 0800-1300hrs

² Calculations included the recommended noise controls detailed in Section 0

³ Unless noted otherwise, noise level calculated at 1.5m above ground level at the property boundary most exposed to construction noise in accordance with the requirements of the CNG. Noise levels at upper floors without shielding are likely to be higher.

Table D 4: Predicted noise levels during excavation works

Receiver	Period	Assessment	Calculated noise level ² , dB LAeq, 15min ³	“Noise affected”		“Highly noise affected”		External	
				Management level, dB LAeq, 15min	Exceedance, dB	Management level, dB LAeq, 15mins	Exceedance, dB	Noise Level, dB LAeq, 15mins	Exceedance, dB
1	Within guideline hours ¹	Worst-case	55	53	2		--		
		Average	52		--	75	--	N/A	N/A
2	Within guideline hours ¹	Worst-case	54	53	1		--		
		Average	52		--	75	--	N/A	N/A

¹ Monday – Friday: 0700-1700hrs, Saturday 0800-1300hrs

² Calculations included the recommended noise controls detailed in Section 0

³ Unless noted otherwise, noise level calculated at 1.5m above ground level at the property boundary most exposed to construction noise in accordance with the requirements of the CNG. Noise levels at upper floors without shielding are likely to be higher.

Table D 5: Predicted noise levels during construction (structure) works

Receiver	Period	Assessment	Calculated noise level ² , dB LAeq, 15min ³	“Noise affected”		“Highly noise affected”		External	
				Management level, dB LAeq, 15min	Exceedance, dB	Management level, dB LAeq, 15mins	Exceedance, dB	Noise Level, dB LAeq, 15mins	Exceedance, dB
1	Within guideline hours ¹	Worst-case	51	53	--		--		
		Average	48		--	75	--	N/A	N/A
2	Within guideline hours ¹	Worst-case	50	53	--		--		
		Average	48		--	75	--	N/A	N/A

¹ Monday – Friday: 0700-1700hrs, Saturday 0800-1300hrs

² Calculations included the recommended noise controls detailed in Section 0

³ Unless noted otherwise, noise level calculated at 1.5m above ground level at the property boundary most exposed to construction noise in accordance with the requirements of the CNG. Noise levels at upper floors without shielding are likely to be higher.

Table D 6: Predicted noise levels during construction (finishes) works

Receiver	Period	Assessment	Calculated noise level ² , dB L _{Aeq, 15min} ³	“Noise affected”		“Highly noise affected”		External	
				Management level, dB L _{Aeq, 15min}	Exceedance, dB	Management level, dB L _{Aeq, 15mins}	Exceedance, dB	Noise Level, dB L _{Aeq, 15mins}	Exceedance, dB
1	Within guideline hours ¹	Worst-case	50	53	--		--		
		Average	47		--	75	--	N/A	N/A
2	Within guideline hours ¹	Worst-case	49	53	--		--		
		Average	46		--	75	--	N/A	N/A

¹ Monday – Friday: 0700-1700hrs, Saturday 0800-1300hrs

² Calculations included the recommended noise controls detailed in Section 0

³ Unless noted otherwise, noise level calculated at 1.5m above ground level at the property boundary most exposed to construction noise in accordance with the requirements of the CNG. Noise levels at upper floors without shielding are likely to be higher.

APPENDIX E CONSTRUCTION NOISE SOURCES

A variety of demolition, piling and construction equipment will be used for this project. provides a schedule of construction equipment that is anticipated to be used on this site and their noise levels as taken from:

- AS2436-2010: *Guide to noise and vibration control on construction, demolition and maintenance sites*
- BS5228-1-2009: *Code of practice for noise and vibration control on construction and open sites – Part 1: Noise*

Table E 1: Construction noise source sound power levels , dB L_{Aeq}

Noise source	A-weighted sound power level, L _{Aeq} dBW	Source
12 tonne excavator	98	BS5228-1-2009
22 tonne excavator	99	AS2436-2010
27 tonne excavator	103	BS5228-1-2009
Jack hammer & breaker	121	AS2436-2010
Compacting plate	117	BS5228-1-2009
Concrete saw	117	BS5228-1-2009
Concrete truck & pump	108	AS2436-2010
Auger piling rig	111	AS2436-2010
Tower crane	105	AS2436-2010
Core drill	113	BS5228-1-2009
Brick saw	107	BS5228-1-2009
Concrete vibrator	103	AS2436-2010
Concrete floats	100	BS5228-1-2009
Nail gun	101	BS5228-1-2009
Hydraulic bar cutter	107	BS5228-1-2009
Bogie truck	107	AS2436-2010
Flatbed truck	107	AS2436-2010
Generator	99	AS2436-2010
Air compressor	101	AS2436-2010
Scissor lift	106	BS5228-1-2009
Electric winch & materials hoist	96	BS5228-1-2009
De-watering plant (water pumps)	99	BS5228-1-2009

APPENDIX F EPA NOISE ASSESSMENT DETAILED DERIVATION

In NSW, the NPfI is the guideline for assessing noise emissions from industrial facilities. Whilst the NPfI is intended for the assessment of large industrial premises scheduled by the EPA it is also used by some Councils and consent authorities to assesses smaller commercial sites. The NPfI sets out a procedure where an industrial facility can be assessed against a series of noise levels. In the NPfI, these project specific noise levels are derived from an analysis of the background noise environment and zoning information.

The background noise levels for this project are summarised in Table F 11 below. In the NPfI, the background noise level is called the Rating Background Level (RBL).

Table F 11: NPfI time periods and measured Rating Background Levels

Period	Time of day	RBL LA90, 15min dB	LAeq, 15min dB
Day	0700-1800hrs	43	55
Evening	1800-2200hrs	41	48
Night	2200-0700 hrs	40	46

Intrusiveness noise levels

The intrusiveness noise assessment is applicable to residential receivers and is based on knowledge of the background noise level at the receiver location. The Intrusiveness Noise Level is the background noise level at the nearest noise sensitive location plus 5dB. Therefore, the noise emissions from the premises are considered to be intrusive if the A-weighted source noise level ($L_{Aeq, 15min}$) is greater than the background noise level (L_{A90}) plus 5dB.

Based upon the data for summarised in Table F 11, the Intrusiveness Noise Levels have been calculated in accordance with the NPfI and are presented in Table F 12 below.

Table F 12: Derived Intrusiveness Noise Levels

Period	Rating Background Level, LA90, 15min dB	Intrusiveness Noise Level (RBL + 5 dB), LAeq, 15 min dB
Day	43	48
Evening	41	46
Night	40	45

¹ Evening level has been adjusted to not be over the RBL measured for the daytime period as per section 2.3 of the NPfI.

Amenity noise levels

The Amenity Noise Levels are designed to prevent industrial noise continually increasing above an acceptable level. The initial stage in determining the amenity level is to correct the acceptable noise levels set for the appropriate amenity area with the baseline noise monitoring.

A review of the noise levels measured indicates that the residential noise environment is typical of a Urban area with mostly traffic related noise sources. Further modification is undertaken to account for standardisation of the assessment time periods (as detailed in Section 2.2 of the NPfI). The resultant levels and the relevant modifications are detailed in Table F 13 below.

Table F 13: Derived Amenity noise levels

Receiver	Period	Recommended Amenity Noise Level $L_{Aeq, \text{Period}}$ dB	Modified Amenity Noise Level $L_{Aeq, 15\text{min}}$ dB
Residential (Suburban)	Day	55	53
	Evening	45	43
	Night	40	38

Source: Table 2.2 NSW Noise Policy for Industry

Determination of Project Noise Trigger Levels

The final process in determining the operational noise limits for the development is to derive the Project Noise Trigger Levels. The Project Noise Trigger Levels are levels that, if exceeded, would indicate a potential noise impact on the community, and so 'trigger' a management response; for example, further investigation of mitigation measures.

The Project Noise Trigger Levels are derived by selecting the more stringent of either the Intrusiveness or Amenity noise levels. For residential receivers each assessment time period is evaluated individually. For commercial receivers, only the Amenity noise level applies. The Project Noise Trigger Levels applicable to the Subject site are shown in Table F 14 .

Table F 14: Project Noise Trigger Levels

Receiver	Period	Project Noise Trigger Level, $L_{Aeq, 15\text{min}}$, dB
Residential	Day	48
	Evening	43
	Night	38

Note: The NPfI Project Trigger Noise Levels are applicable at the property boundary of the nearest affected receivers.

APPENDIX G NOISE SURVEY DATA













