REVERB ACOUSTICS

Noise and Vibration Consultants

Noise Impact Assessment
Lake Macquarie Yacht Club
Proposed New Clubhouse, Marina Extensions and Carpark Alterations
Ada Street
Belmont NSW

June 2009

Prepared for Lake Macquarie Yacht Club Limited
Report No. 08-1221-R1

Building Acoustics – Council/DECC Submissions - Modelling - Compliance - Certification

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EXECUTIVE SUMMARY

Reverb Acoustics has been commissioned to conduct a noise impact assessment for redevelopment of the Lake Macquarie Yacht Club site, Ada Street, Belmont. The proposed work will include construction of a new clubhouse, extensions to the marina and alterations to the carpark.

The purpose of this assessment was to determine the noise impact construction and operation of the proposed alterations would have upon nearby neighbours and to recommend practical and cost effective noise control options, where required.

The assessment predicts no exceedance of the criteria from normal operation of the completed site, subject to recommendations detailed in Section 8 of this report, i.e. requisite time restrictions on entertainment, operation of the marina, acoustic barriers, etc.

Construction noise impacts are predicted in Section 8 where suggested noise reduction measures are recommended for work close to neighbouring buildings in Section 9. A regular noise and vibration monitoring program has been recommended to enable prevention and/or immediate action to be taken where unacceptable noise emissions are identified. The majority of potential noise impacts can be overcome by managing and co-ordinating noisy activities during less sensitive time periods and by providing an easily accessible complaints hotline to all concerned parties.

Simultaneous ground vibration monitoring is required when any vibration producing activity (particularly during initial bulk earthworks and pile driving) is conducted within the safe working distance noted in Table 33. It is also recommended that noise and vibration monitoring should be conducted for any activity identified by the construction manager that is not specifically identified within this report.

Subject to noise control recommendations discussed in this report, this assessment has shown the construction and operation of the new clubhouse, extensions to the marina and alterations to the carpark should result in only short-term periods of high noise and no long-term acoustic impact on neighbouring properties.

SECTION 1
Introduction

1.1 INTRODUCTION

Reverb Acoustics has been commissioned by Lake Macquarie Yacht Club to conduct a noise impact assessment for a new clubhouse, marina extensions and carpark alterations at their existing Ada Street, Belmont site. This assessment considers likely sources of noise that may impact upon nearby residential receivers from the new clubhouse (i.e. entertainment, patron activity in outdoor areas, patrons and vehicles in the carpark, and mechanical plant), marina extensions (i.e. workshop activities, mobile plant, vehicle and boat repairs), and the carpark extensions (vehicle movements, car doors slamming, raised speech). The purpose of this report is to recommend appropriate acoustic measures that must be implemented to ensure compliance with the requirements of the Department of Environment and Climate Change NSW (DECC), Roads and Traffic Authority (RTA) and Department of Planning (DoP).

The assessment was requested by Lake Macquarie Yacht Club Limited in support of and to accompany a Development Application to DoP and to ensure any noise control measures required for the development are incorporated during the design stages.

1.2 TECHNICAL REFERENCE / DOCUMENTS

Information supplied by other parties, relied on during preparation of this report include:

Director General's Environmental Assessment Requirements for the development

Detail survey plan supplied by Harper Somers O'Sullivan

Architectural plans supplied by EJE Architecture comprising the following:

-	Cover Sheet	Drawing No.A00	dated May 2009
-	Site Plan	Drawing No.A09	"
-	Car Park Alteration Plan	Drawing No.A10	"
-	Marina Extension Plan	Drawing No.A11	"
-	Clubhouse Ground Floor Plan	Drawing No.A12	"
-	Clubhouse Level 1 Plan	Drawing No.A13	"
-	Clubhouse North & East Elevations	Drawing No.A14	"
-	Clubhouse South & West Elevations	Drawing No.A15	"
-	Section A-A and B-B	Drawing No.A16	"

Other references and documents relied on, but not specifically prepared for the project include:

AS 2107-2000 *"Acoustics-Recommended Design Sound Levels and Reverberation Times for Building Interiors"*.

AS 1276.1-1999 *"Acoustics – Rating of sound insulation in buildings and of building elements. Part 1: Airborne sound insulation"*.

AS 3671-1989 *"Acoustics-Road traffic noise intrusion-building siting and construction".*

NSW Environment Protection Authority (1999). *Industrial Noise Policy*

NSW Environment Protection Authority (1999). *Environmental Criteria for Road Traffic Noise*

NSW Roads and Traffic Authority (2001). *Environmental Noise Management Manual*

NSW Environment Protection Authority (1994). *Environmental Noise Control Manual*
Department of Environment and Climate Change NSW (2008). *Draft New South Wales Construction Noise Guideline.*

Department of Environment and Climate Change NSW (2006). *Assessing Vibration: A Technical Guideline*

Department of Environment and Climate Change NSW (2007). *Noise Guide for Local Government.*

Liquor Administration Board *"Noise Control Guidelines"*

A Glossary of commonly used acoustical terms is presented in Appendix A to aid the reader in understanding the Report.

1.3 PROJECT DESCRIPTION

Lake Macquarie Yacht Club intends to redevelop the existing Yacht Club site at Ada Street, Belmont. The proposal includes the following:

New Two Storey Clubhouse:

Existing and Proposed Ground Level:

- Administration areas
- Yacht Club facilities (change rooms, offices, sailing school, etc)
- Gaming, Lounge areas
- Restaurant (includes alfresco dining terrace)
- Kitchen
- Auditorium (includes outdoor terraces)
- Outdoor BB area
- Dip pool

Proposed First Level:

- Office and storage areas
- Kitchen
- Two function rooms and pre-function room
- Outdoor terrace

The first floor functions rooms will be used for weddings, organised functions, meetings, etc, while the ground level auditorium will be used for similar functions and cabarets. Entertainment will cease in all areas before midnight. Discussions with our client confirm that entertainment will be restricted to perhaps duos/trios with drum machine accompaniment in the smaller Function Room 2, while live bands and Discos may perform in Function Room 1 and the auditorium for larger functions such as weddings.

As stated above, all entertainment will cease by midnight, however, the club may trade to perhaps 1.30am-2.00am. Ground level outdoor terraces will also be used by patrons past midnight.

Marina Extensions:

- Retention of 83 wet berths
- Retention of 19 hardstand berths
- 52 new wet berths on west side of existing berths
- Workshop, store and amenities on south side of clubhouse
- Reduction from 12 to 8 swing moorings

The majority of activities (workshop, yard activities, etc) associated with the marina are expected to occur during the day between the hours 7am and 6pm. Occasional mooring of private boats, unloading, etc, may occur outside this time, although these activities are expected to create insignificant noise.

Only minor maintenance and repairs are expected within the workshop, with major works conducted offsite. Some activities such as repairs to larger craft (scraping barnacles, fibreglass repairs, engine servicing, etc) may occur outside the workshop. Other equipment will include small cranes, power/air tools and a boat travel lift.

Carpark Alterations:

- A total of 127 carpark spaces on lake pontoon
- 19 dry berth spaces on north side of lake pontoon
- Dingy racks in the north east and south east corner of lake pontoon
- 22 foreshore carpark spaces
- 2 foreshore trailer spaces

The amount of vehicles using the carpark will vary from day to day and hour to hour, however, peak periods are expected at the completion of a function at the clubhouse during the night and when regattas are held during the day. Noise from carparks typically originates from vehicle movements, car doors slamming and raised speech.

The location and type of mechanical plant required for site has not been finalised at this stage. We have therefore assumed that the majority of plant required for the clubhouse will be located in the worst-possible location on the roof, with the exception of some refrigeration plant servicing the ground floor which may be positioned above the coolroom. We have further assumed that plant required for the marina will generally be located at ground level. The anticipated number and location of noise generating items associated with the site are shown below, taken from a generic mechanical plant specification for similar sized developments.

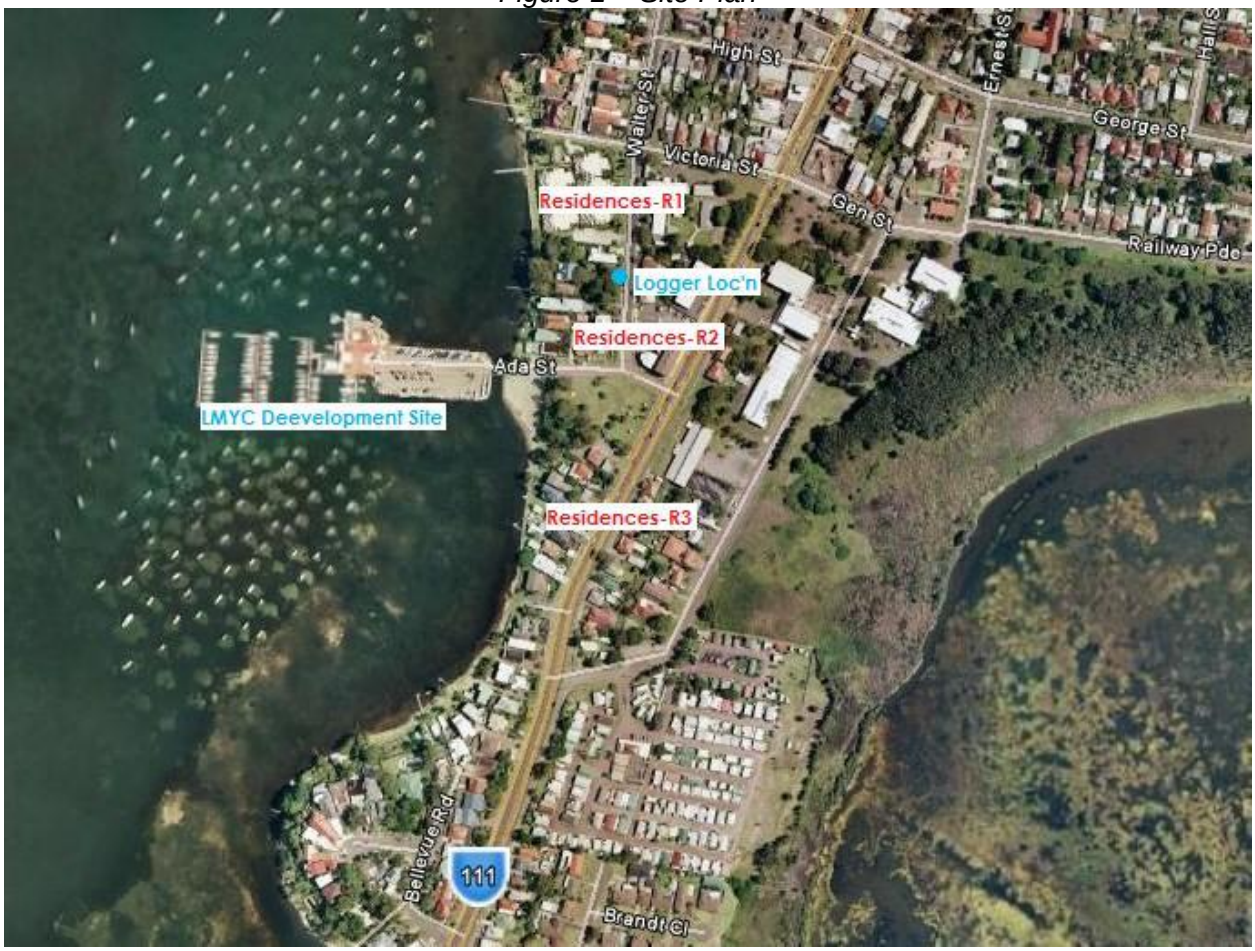
Location	*Plant Item*
Clubhouse Roof	Air conditioning condensers (x8)
	Refrigeration condensers (x2)
	Exhaust fans (x2)
Above clubhouse coolroom	Refrigeration condensers (x2)
	Refrigeration compressors (x2)
Marina	Air compressor (x1)
	Refrigeration condenser (x1)

Nearest residential receivers are as follows:

R1 – Residential units to the north east on the corner of Victoria Street and Walter Street.
R2 - Residence to the east along Ada Street and Walter Street.
R3 – Residences to the south east adjacent to the lake along the Pacific Highway.

This assessment focuses on the noise impact at nearest residences listed above. It should be acknowledged that compliance with the criteria at these residences implies compliance at more remote locations.

Figure 1 – Site Plan



SECTION 2
Existing Acoustic Environment
Assessment Criteria

2.1 EXISTING ACOUSTIC ENVIRONMENT

To establish the existing background noise level at the site we have sourced data collected over several days by Reverb Acoustics in 2005 for another client. The logger was located in Walter Street, approximately 60 metres from the Ada Street intersection. The logged data was collected almost 4 years ago, therefore supplementary attended monitoring was conducted at the western end of Ada Street to confirm background noise levels had not reduced, and also to record a typical frequency spectrum of the background noise environment. The measured frequency spectrum was then adjusted to give a total level equivalent to the average background noise level between 6pm and midnight, i.e. when entertainment is expected.

Table 1 below shows a summary of our noise level surveys, including the Assessment Background Level's (ABL's) for the day, evening and night periods. The ABL's were determined according to the procedures described in the DECC's Industrial Noise Policy (INP) and by following the procedures and guidelines detailed in Australian Standard AS1055-1997, "Acoustics - Description and Measurement of Environmental Noise, Part 1 General Procedures".

Table 1: Measured Noise Levels, dB(A)

Time Period	Background L90			Ambient Leq		
	Day 7am-6pm	Evening 6pm-10pm	Night 10pm-7am	Day 7am-6pm	Evening 6pm-10pm	Night 10pm-7am
RBL*	46	43	36	--	--	--
LAeq	--	--	--	63	59	56
CNR. Ada and Walter Street						
Current Leq, peak (day) = 61dB(A)			Current Leq, 1hr (night) = 58dB(A)			

Site, weather and measuring conditions were all satisfactory during our noise surveys. We therefore see no serious reason to modify the results because of influencing factors related to the site, weather or our measuring techniques.

Tables 2 shows the adopted background noise level in the receiver area between the hours of 6pm to midnight, which is when entertainment is expected to take place at the clubhouse.

Table 2: Adopted Background Noise Level Spectrum, L(A)90 – 6pm to Midnight

	Octave Band Centre Frequency, Hz								
dB(A)	31.5	63	125	250	500	1k	2k	4k	8k
41	18	29	36	34	34	31	32	30	22

A summary of the measured noise environment at the site appears in Table 3, taken from our logger results. The measured noise levels are typical for a locality providing a range of uses located near a collector road.

Table 3: Existing Source Noise levels

Time Period	Leq		Lmax		L10		L90	
	Range	Average	Range	Average	Range	Average	Range	Average
Day	52-73	62	69-100	81	52-76	65	44-60	48
Evening	49-69	58	65-96	79	49-66	58	38-51	45
Night	37-71	51	48-95	71	39-70	49	35-51	40

2.2 CRITERIA

2.2.1 Road Traffic Noise

The RTA describes criteria for the assessment of road traffic noise impacts upon residential developments in their Environmental Noise Management Manual. Reference to Page 160 of the RTA's Manual, indicates that noise reduction measures for new developments should endeavour to meet the noise level targets set out in the DECC's Environmental Criteria for Road Traffic Noise (ECRTN). The ECRTN contains a number of criteria applied to a variety of road categories (freeway, collector and local roads) and situations (new, upgraded roads and new developments creating additional traffic on roads). Table 4 shows the relevant categories, taken from Table 1 of the ECRTN:

Table 4: - Extract from Table 2 of ECRTN Showing Relevant Criteria.

Development Type		Day	Night	Where Criteria are Already Exceeded
7	Land use developments creating additional traffic on freeway /arterial roads	60 LAeq,15hr	55 LAeq,9hr	Should not lead to an increase in noise of more than 2dB.
8	Land use developments creating additional traffic on collector roads	60 LAeq,1hr	55 LAeq,1hr	Should not lead to an increase in noise of more than 2dB.
13	Land use developments creating additional traffic on local roads	55 LAeq,1hr	50 LAeq,1hr	Should not lead to an increase in noise of more than 2dB.

Road categories are defined in the ECRTN as follows:

Freeway/arterial includes sub-arterial roads and refers to roads handling through traffic, with characteristically heavy and continuous traffic flows during peak periods. Through traffic is traffic passing through a locality bound for another locality.

Collector road refers to a road situated in a built up area that collects local traffic leaving a locality and connects to a sub-arterial road.

Local road refers to a road handling local traffic with characteristically intermittent traffic flows.

Based on the above definitions Ada Street is classified as a local road.

2.2.2 Site Noise

Noise from industrial noise sources scheduled under the Protection of Environment Operations Act is assessed using the DECC's INP. However, local Councils may also apply the criteria for land use planning, compliance and complaints management. The INP specifies two separate criteria designed to ensure existing and future developments meet environmental noise objectives. The first limits intrusive noise to 5dB(A) above the background noise level and the other aims to protect against progressively increasing noise in developing areas, based on the existing (Leq) noise level from industrial noise sources. Project Specific Noise Levels are established for new developments by applying both criteria to the situation and adopting the more stringent of the two.

The existing L(A)eq for the receiver area is dominated by traffic on nearby roads, natural noise sources and some industrial activity during the day and evening. Reference to Table 2.1 of the INP shows that the area is classified as urban, and industrial noise contributions are more than 6dB(A) below the recommended Leq, so the recommended Acceptable Noise Level (ANL) applies in this case, i.e. no ANL reduction required for industrial noise contributions. Similarly, at night average industrial noise contributions are more than 6dB(A) below the recommended Leq and the ANL applies.

Table 5 specifies the applicable base objectives for the proposal at nearest residences. In high traffic areas where the existing traffic noise levels are at least 10dB above the Acceptable Noise Level, the high traffic amenity criterion applies.

Table 5: - Base Noise Level Objectives

Period	Intrusiveness Criterion	Amenity Criterion
Day	51 (46+5)	60
Evening	48 (43+5)	50
Night	41 (36+5)	45
Receiver Type: Urban (See DECC's INP - Table 2.1)		

Project specific noise levels, determined as the more stringent of the intrusiveness criterion and the amenity / high traffic criterion, are as follows:

Day **51dB LAeq,15 Minute** 7am to 6pm Mon to Sat or 8am to 6pm Sun and Pub Hol.
Evening **48dB LAeq,15 Minute** 6pm to 10pm
Night **41B LAeq,15 Minute** 10pm to 7am Mon to Sat or 10pm to 8am Sun and Pub Hol.

2.2.3 Sleep Arousal

Section 2.4.5 of the DECC's Noise Guide for Local Government and Chapter 19-3 of their Environmental Noise Control Manual (ENCM) state *"the L1 level of any specific noise source should not exceed the background noise level (L90) by more than 15dB(A) when measured outside the bedroom window"*. This criterion is applied to residential situations between the hours of 10.00pm and 7.00am where a receptor's sleep may be interrupted by noise. It is applied in this case to residents likely to receive noise from vehicles, entering and leaving the site, and patron activity in the carpark and in outdoor areas of the clubhouse.

Based on an average minimum background noise level of 36dB(A),L90 for night (10pm-7am) the sleep arousal criterion is set at **51dB(A),L1(1min)** at the bedroom window of any affected residential receiver.

2.2.4 Entertainment

Since this assessment relates to control of noise from licensed premises, together with determination of a Development Application to DoP, two relevant criteria may apply, namely the Liquor Administration's (LAB's Standard Noise Conditions and the DECC's INP Project Specific Noise levels. The outdoor areas will generally be used as break-out areas for patrons, while entertainment will occur in the function rooms and auditorium. Repetitive low frequency drum and base noise, that is a feature of all live and recorded music, may be a source of offensive noise for neighbouring residents and simply applying the DECC criteria will underestimate its intrusive nature. We have therefore applied the LAB's Standard Noise Conditions for the assessment of entertainment noise.

The LAB's Standard Noise Conditions are as follows:

"The LA10 noise level emitted from the licensed premises shall not exceed the background noise level in any Octave Band Centre Frequency (31.5Hz - 8kHz inclusive) by more than 5dB between 07:00 am and 12:00 midnight at the boundary of any affected residence.

The LA10 noise level emitted from the licensed premises shall not exceed the background noise level in any Octave Band Centre Frequency (31.5Hz - 8kHz inclusive) between 12:00 midnight and 07:00 am at the boundary of any affected residence.

Notwithstanding compliance with the above, the noise from the licensed premises shall not be audible within any habitable room in any residential premises between the hours of 12:00 midnight and 07:00 am".

Note that the LAB's Conditions require noise from entertainment to be inaudible in any premises after midnight. Typical measures for theoretical assessments include imposing the additional condition that low frequency (31.5Hz-250Hz) noise levels must be at least 5dB(A) below the total planning level or 5dB(A) below the background noise level in that frequency band. In our experience, when entertainment noise is below the background noise level in all frequency bands within a residence, there is great difficulty in hearing the noise. This is supported by the opinion of the Institute of Acoustics (IOA).

The IOA is the European equivalent of the Australian Acoustic Society and the Acoustic Society of America. Section 2 of a report prepared by Hepworth Acoustic for DEFRA[1] references work carried out by the IOA who conducted extensive research into the effects of noise from pubs and clubs. The IOA gives the following definition, "Noise is considered to be inaudible when it is at a sufficiently low level that it is not recognisable as emanating from the source in question and it does not alter the perception of the ambient noise environment that would prevail in the absence of the source in question.

The IOA Annex expresses numerical limits as shown in Table 6:

Table 6: Institute of Acoustics Numerical Limits

Venue Where….	Suggested Regulations	Outcome if Criteria Met
Entertainment < 30 times/yr	LAeq,15min (EN) should not exceed LA90 (WEN) by more than 5dB.	EN will generally be audible but not overly obtrusive inside the noise sensitive property.
Entertainment > 30 times/yr	LAeq (EN) should not exceed LA90 (WEN) by more than 5dB. L10 should not exceed L90 by more than 5dB in any 1/3 octave 40Hz-160Hz	EN will generally be audible but not overly obtrusive inside the noise sensitive property.
Entertainment > once/week or continues beyond 2300hrs	LAeq (EN) should not exceed LA90 (WEN). And the L10 (EN) should not exceed L90 (WEN) in any 1/3 octave band between 40Hz and 160Hz	EN will be virtually inaudible inside noise sensitive property.

EN = Entertainment noise level. WEN = Representative background noise level without the entertainment noise, both measured 1m from the facade of the noise sensitive premises.

Reference to Table 6 shows that entertainment noise will be inaudible within a residence when the L_{10} (entertainment noise level) does not exceed L_{90} (background noise level) in any 1/3 octave band between 40Hz and 160Hz. For theoretical assessments, we impose the additional condition that low frequency (31.5Hz-250Hz) noise levels must be at least 5dB(A) below the LAB's planning level for the frequencies of concern, when entertainment takes place after midnight.

[1] W.J. Davies, P. Hepworth, A. Moorhouse, R. Oldfield (October 2005). *Noise from Pubs and Clubs, Phase 1.*

We understand that no entertainment will take place beyond midnight, therefore clauses relating to restrictions from 12am-7am do not apply in this case. Planning limits adopted for assessment purposes are shown below for the pre midnight period only:

Table 7: Entertainment Noise Planning Level, L(A)10 – 6pm to 12am

Octave Band Centre Frequency, Hz									
dB(A)	**31.5**	**63**	**125**	**250**	**500**	**1k**	**2k**	**4k**	**8k**
46	23	34	41	39	39	36	37	35	27

2.2.5 Construction Noise

Various authorities have set maximum limits on allowable levels of construction noise in different situations. Arguably the most universally acceptable criteria, and those which will be used in this Report, are taken from the DECC's Draft NSW Construction Noise Guideline (DCNG). Since the project involves a significant period of construction activity, a "quantitative assessment" is required, i.e. comparison of predicted construction noise levels with relevant criteria. Table 4.1 of the DCNG is reproduced below in Table 8:

Table 8 - Table 4.2 of DCNG Showing Relevant Criteria at Residences

Time of Day	Management Level Leq (15min)	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(A) i.e**. 56dB(A) day**	- The noise affected level represents the point above which there may be some community reaction to noise. - Where the predicted or measured $L_{AEQ\ (15min)}$ is greater than the noise affected level, the proponent should apply all feasible and reasonable work practices to minimise noise. - The proponent should also inform all potentially impacted residents of the nature of works to be carried out, the expected noise levels and duration, as well as contact details
	Highly noise affected 75dB(A)	- The highly noise affected level represents the point above which there may be strong community reaction to noise. - Where noise is above this level, the proponent should consider very carefully if there is any other feasible and reasonable way to reduce noise to below this level. - If no quieter work method is feasible and reasonable, and the works proceed, the proponent should communicate with the impacted residents by clearly explaining the duration and noise level of the works, and by describing any respite periods that will be provided.
Outside recommended Standard hours	Noise affected RBL =5dB(A) i.e. **48dB(A) evening and 41dB(A) night**	- 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 5dB(A) above the noise affected level, the proponent should negotiate with the community. - For guidance on negotiating agreements see Section 7.2.2

2.2.6 Construction Vibration

Personal Comfort

The majority of maximum limits on allowable ground and building vibration in different circumstances and situations are directed at personal comfort rather than building damage. This usually leads, in virtually every situation, to people who interpret the effects of a vibration to ultimately determine its acceptability. The DCNG recommends that the recently released DECC guideline, *Assessing Vibration: A Technical Guideline (2006)*, should be used for assessing construction vibration. Limits set out in the DECC Guideline are for vibration in buildings, and are directed at personal comfort for continuous, impulsive and intermittent vibrations. Table 9 shows the Vibration Dose Values for intermittent vibration activities such as pile driving and use of vibrating rollers etc, taken from Table 2.4 of the Guideline, above which various degrees of adverse comment may be expected.

Table 9: Acceptable Vibration Dose Values ($m/s^{1.75}$)
Above which Degrees of Adverse Comment are Possible

Location	Day (7am-10pm)		Night (10pm-7am)	
	Preferred	Maximum	Preferred	Maximum
Critical areas #	0.10	0.20	0.10	0.20
Residences	0.20	0.40	0.13	0.26
Offices	0.40	0.80	0.40	0.80
Workshops	0.80	1.60	0.80	1.60

Hospital operating theatres, precision laboratories, etc.

Building Safety:

Other criteria specifically dealing with Building Safety Criteria include Australian Standard AS2187.2-1993, dealing specifically with blasting vibration, specifies a maximum peak particle velocity of 10mm/sec for houses and a preferred limit of 5mm/sec where site specific studies have not been undertaken.

German Standard DIN 4150 - 1986, Part 3 Page 2, specifies a maximum vibration velocity of 5 to 15 mm/sec in the foundations for dwellings and 3 to 8 mm/sec for historical and sensitive buildings, for the range 10 to 50Hz.

British Standard BS 7385 Part 2, specifies a maximum vibration velocity of 15mm/sec at 4Hz increasing to 20mm/sec at 15Hz increasing to 50mm/sec at 40Hz and above, measured at the base of the building. Additionally, The Australian and New Zealand Environment Conservation Council (ANZECC) guideline *"Technical basis for guidelines to minimise annoyance due to blasting overpressure and ground vibration"* limit peak particle velocities from blasting to below 5mm/sec at residential receivers, with a long term regulatory goal of 2mm/sec.

The above listed criteria vary from 3mm/sec up to 15mm/sec, therefore, the more conservative limit of **3mm/sec** will be adopted for the purposes of Building Safety Criteria. It should be acknowledged, however, that intermittent ground vibration velocities at 5mm/sec are generally considered the threshold at which architectural (cosmetic) damage to normal dwellings may occur and velocities at 10mm/sec should not cause any significant structural damage, with the exception of the most fragile and brittle of buildings.

SECTION 3
Noise Impact Assessment
New Clubhouse

3.1 METHODOLOGY

3.1.1 Outdoor Terraces

Reverb Acoustics has completed a detailed analysis of patron noise levels under various situations in licensed premises with the following findings:

Table 10: Noise Levels from Various Types of Occupied Areas within Licensed Premises

Situation/Location	Noise Rating	Typical Noise Levels dB(A),L10 #	Comments
Auditorium courtyard *Breakout for patrons during functions*	1	85+	During functions up to 1/3 of patrons may occupy outdoor area. Monitoring recommended.
General courtyard *Servicing lounge areas, public bars, etc*	2	80-85	Patrons may remain in area for extended periods. Monitoring recommended.
Bistros *Internal eating area*	3	75-80	Continuous conversation typical at self-service areas.
Alfresco dining *Seating outdoors*	4	70-80	Patrons generally quiet, although may remain for extended periods and produce higher noise levels.
Restaurant *Internal eating area with open doorway*	5	70-75	Generally quiet. Only low level conversation. Patrons typically vacate area once meal completed.
Club Gaming area *Poker machine, TAB areas*	6	65-70	Patrons typically quiet. Rarely talk. Some noise from machines, TV's, monitors, etc.
Gaming courtyard *Smokers breakout*	7	<70	Patrons typically quiet. Rarely talk. Anxious to return to gaming area.

 # Typical noise level at inside surfaces or edge of area.

Restaurant Terrace (Ground Floor) – Noise Rating 4. Alfresco Dining Area
- Up to 40 patrons.
- All seated.
- Not used after midnight.

Auditorium Terraces (Ground Floor) – Noise Rating 1. Will be used during functions
- 50 patrons on each terrace.
- Equal number seated and standing.
- Numbers expected to significantly reduce after midnight.

Function Room Terrace (First Floor) – Noise Rating 1. Will be used during functions
- 60 patrons on terrace.
- Equal number seated and standing.
- Not used beyond midnight

The sources were placed randomly over each available area and the resulting sound pressure level at each surface opening was propagated to nearest residences using an equation[2] giving the sound field due to an incoherent plane radiator. The combined sound pressure level (SPL) at the receiver is then compared to the criteria. Where noise impacts above the criteria are identified, suitable noise control measures are implemented and reassessed to demonstrate satisfactory received noise levels.

[2] Equation (5.104), DA Bies and CH Hansen, *Engineering Noise Control*, E & FN Spon, 1996.

3.1.2 Entertainment

A theoretical assessment of live and recorded entertainment was carried out to predict the noise level at the nearest potentially affected residential boundaries. As previously stated, discussions with our client confirm that entertainment will be restricted to perhaps duos/trios with drum machine accompaniment in the smaller Function Room 2, live bands and Discos in Function Room 1, and live bands, Discos and cabaret type entertainment in the auditorium. Using noise data for the above scenarios and the known criterion at nearby residences enabled calculation of the required transmission loss of each building element. Inspection of the supplied plans and observations during our site visits has identified the following significant noise leakage paths:

Function Room 1*:*	South lightweight wall cladding and glazing West lightweight wall cladding and operable doors Roof/ceiling
Function Room 2*:*	North lightweight wall cladding and glazing West lightweight wall cladding and operable doors Roof/ceiling
Auditorium:	West wall, glazing and operable doors North wall, glazing and operable doors Roof/ceiling (partial north section)

Other surfaces have not been considered, as other sections of the clubhouse form a noise buffer to residences.

The Sound Power Levels, Lw dB(A), of the various types of entertainment expected at the premises are shown in the following Tables. The noise source was placed in the centre of each room, as the exact location of the stage was not known, then theoretically propagated to nearest residences taking into account reverberant field loss to internal surfaces and transmission loss through each building element.

Table 11: Lw, Typical Duo/Trio with Drum Machine – Function Room 2, dB(A),L10

	Octave Band Centre Frequency, Hz								
dB(A)	**31.5**	**63**	**125**	**250**	**500**	**1k**	**2k**	**4k**	**8k**
102	58	75	83	92	96	97	92	93	78

Table 12: Lw, Typical Live Band/Disco – Function Room 1/Auditorium, dB(A),L10

	Octave Band Centre Frequency, Hz								
dB(A)	**31.5**	**63**	**125**	**250**	**500**	**1k**	**2k**	**4k**	**8k**
116	72	89	97	106	110	111	106	107	92

From consideration of the known dimensions and orientation of each building element (roof, windows, walls, etc) the sound pressure level immediately outside was propagated to nearest residences using an equation[3] giving the sound field due to an incoherent plane radiator.

[3] Equation (5.104), DA Bies and CH Hansen, *Engineering Noise Control*, E & FN Spon, 1996.

3.2 ANALYSIS AND DISCUSSION

3.2.1 Received Noise Levels – Outdoor Terraces

Table 13 shows a sample calculation of the noise impact from patrons on the north terrace of the auditorium, propagated to the nearest residences north east of the site (R1).

Table 13: Sample Calculation - Noise Impact, Patrons on Auditorium Terrace (North) Propagated North East to Residences (R1), dB(A),L10

		Octave Band Centre Frequency, Hz								
Item	**dB(A)**	**31.5**	**63**	**125**	**250**	**500**	**1k**	**2k**	**4k**	**8k**
SPL at opening	85	19	35	64	79	80	80	77	65	57
Barrier loss[1]		5	5	5	5	5	5	5	5	5
SPL at rec	**34**	**-**	**-**	**13**	**27**	**28**	**29**	**26**	**14**	**6**
Crit (pre 12am)	**46**	**23**	**34**	**41**	**39**	**39**	**36**	**37**	**35**	**27**
Impact	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**

2. Acoustic barrier 1500mm in height at terrace perimeter.

Similar calculations have been made for each outdoor area, taking into account variations in architecture (balustrade, etc). The following Tables show the combined noise impact at these receivers, assuming all outdoor areas are in use at full capacity.

Table 14: Combined Noise Impact – All Exposed Outdoor Areas Propagated North East to Residences (R1), dB(A),L10

		Octave Band Centre Frequency, Hz								
Noise Path	**dB(A)**	**31.5**	**63**	**125**	**250**	**500**	**1k**	**2k**	**4k**	**8k**
Auditorium terrace	34	-	-	13	27	28	29	26	14	6
Function terrace	32	-	-	9	23	25	27	27	15	7
Combined	**36**	**-**	**-**	**15**	**29**	**30**	**31**	**30**	**18**	**10**
Crit (pre 12am)	**46**	**23**	**34**	**41**	**39**	**39**	**36**	**37**	**35**	**27**
Impact	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**

Table 15: Combined Noise Impact – All Exposed Outdoor Areas Propagated South East to Residences (R3), dB(A),L10

		Octave Band Centre Frequency, Hz								
Noise Path	**dB(A)**	**31.5**	**63**	**125**	**250**	**500**	**1k**	**2k**	**4k**	**8k**
Function terrace	33	-	-	10	24	26	28	28	16	8
Restaurant terrace	27	-	-	6	20	21	22	19	7	-
Combined	**34**	**-**	**-**	**12**	**26**	**27**	**29**	**29**	**17**	**9**
Crit (pre 12am)	**46**	**23**	**34**	**41**	**39**	**39**	**36**	**37**	**35**	**27**
Impact	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**

Table 16: SPL Patrons in Outdoor Areas – Short Term Noise Events
Propagated North East to Nearest Residences R1, dB(A),L1

Location / Situation	Auditorium Terrace	Function Terrace	Restaurant Terrace
Lw source	96dB(A),L1	96dB(A),L1	96dB(A),L1
Barrier height	1500mm	1200mm	0
Average Barrier loss	5	4	24[1]
Received	**37dB(A),L1**	**38dB(A),L1**	**<20dB(A),L1**
Crit. (10pm-7am)	**51dB(A),L1 (1 min)**		
Impact	**-**	**-**	**-**

1. Intervening building

Table 17: SPL Patrons in Outdoor Areas – Short Term Noise Events
Propagated East to Nearest Residences R2, dB(A),L1

Location / Situation	Auditorium Terrace	Function Terrace	Restaurant Terrace
Lw source	96dB(A),L1	96dB(A),L1	96dB(A),L1
Barrier height	1500mm	1200mm	0
Average Barrier loss	5	24[1]	24[1]
Received	**40dB(A),L1**	**<20dB(A),L1**	**<20dB(A),L1**
Crit. (10pm-7am)	**51dB(A),L1 (1 min)**		
Impact	**-**	**-**	**-**

Table 18: SPL Patrons in Outdoor Areas – Short Term Noise Events
Propagated South East to Nearest Residences R3, dB(A),L1

Location / Situation	Auditorium Terrace	Function Terrace	Restaurant Terrace
Lw source	96dB(A),L1	96dB(A),L1	96dB(A),L1
Barrier height	1500mm	1200mm	0
Average Barrier loss	24[1]	4	0
Received	**40dB(A),L1**	**37dB(A),L1**	**41dB(A),L1**
Crit. (10pm-7am)	**51dB(A),L1 (1 min)**		
Impact	**-**	**-**	**-**

Theoretical results in the above Tables show that the combined noise impact from patrons on terraces will be compliant with the LAB (and therefore Council and DoP) criteria at all nearby residences, subject to erection of acoustic barriers at terrace perimeters, where required. The restaurant and function room terraces will not be used after midnight, however, the auditorium terraces are expected to be used by patrons after this time. The predicted noise impact, assuming patron numbers will reduce after midnight, at nearest residences is in the order of 28dB(A)-29dB(A) from these terraces, which is compliant with the more stringent post midnight criteria. See Section 9.1 for location, construction details and required heights of acoustic barriers at terrace perimeters.

3.2.2 Received Noise Levels – Entertainment

Table 19 shows a sample calculation of noise propagated through the roof ceiling of Function Room 2, while a Trio with drum machine is playing, and the resulting impact at the nearest residential boundaries south east of the site (R3).

Table 19: Calculated SPL (Entertainment) – Nearest South East Residence (R3) Propagated through Roof/Ceiling of Function Room 2

		Octave Band Centre Frequency, Hz								
Item	**dB(A)**	**31.5**	**63**	**125**	**250**	**500**	**1k**	**2k**	**4k**	**8k**
Source Lw	**102**	58	75	83	92	96	97	92	93	78
TL[1] roof/ceiling		4	8	17	26	34	41	46	42	51
Exterior SPL	64	46	59	58	58	54	48	38	43	19
SPL at rec	24	6	19	18	18	14	8	-	3	-
Crit (6pm-12am)	**46**	**23**	**34**	**41**	**39**	**39**	**36**	**37**	**35**	**27**
Impact	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**

1 Metaldeck roof - building blanket under, suspended acoustic tile ceiling with 50mm overlay.

Similar calculations to those in Table 19 have been made for each building element, taking into account variations in architecture (windows, roof, walls, etc). The following Tables show the combined entertainment noise impact during prior to midnight at all nearby residential boundaries.

Table 20: Noise Impact 6pm to Midnight – All Entertainment Areas Propagated North East to Nearest Residences (R1)

		Octave Band Centre Frequency, Hz								
Noise Path	**dB(A)**	**31.5**	**63**	**125**	**250**	**500**	**1k**	**2k**	**4k**	**8k**
Function Room 1	41	19	32	31	33	34	34	28	30	14
Function Room 2	24	6	19	18	18	14	8	-	3	-
Auditorium	35	-	8	16	25	29	30	25	26	11
Combined	**42**	**19**	**32**	**32**	**34**	**35**	**35**	**30**	**31**	**16**
Crit (6pm-10pm)	**46**	**23**	**34**	**41**	**39**	**39**	**36**	**37**	**35**	**27**
Impact	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**

NOTE 1: West operable doors Function Room 1 open. NOTE 2: West operable doors Function Room 2 open.
NOTE 3: West operable doors Auditorium open, north operable doors closed.

Table 21: Noise Impact 6pm to Midnight – All Entertainment Areas Propagated East to Nearest Residences (R2)

		Octave Band Centre Frequency, Hz								
Noise Path	**dB(A)**	**31.5**	**63**	**125**	**250**	**500**	**1k**	**2k**	**4k**	**8k**
Function Room 1	39	21	34	33	33	30	26	20	22	5
Function Room 2	28	8	21	21	21	21	20	15	16	-
Auditorium	31	-	4	12	21	25	26	21	22	7
Combined	**40**	**21**	**34**	**33**	**34**	**32**	**30**	**24**	**26**	**10**
Crit (6pm-10pm)	**46**	**23**	**34**	**41**	**39**	**39**	**36**	**37**	**35**	**27**
Impact	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**

NOTE 1: West operable doors Function Room 1 open. NOTE 2: West operable doors Function Room 2 open.
NOTE 3: West operable doors Auditorium open, north operable doors closed.

Table 22: Noise Impact 6pm to Midnight – All Entertainment Areas Propagated South East to Nearest Residences (R3)

		Octave Band Centre Frequency, Hz								
Noise Path	**dB(A)**	**31.5**	**63**	**125**	**250**	**500**	**1k**	**2k**	**4k**	**8k**
Function Room 1	39	18	31	30	31	31	31	26	27	11
Function Room 2	35	7	20	22	27	30	30	25	26	11
Auditorium	33	-	6	14	23	27	28	23	24	9
Combined	**41**	**18**	**32**	**31**	**33**	**34**	**35**	**30**	**31**	**16**
Crit (6pm-10pm)	**46**	**23**	**34**	**41**	**39**	**39**	**36**	**37**	**35**	**27**
Impact	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**

NOTE 1: West operable doors Function Room 1 open. NOTE 2: West operable doors Function Room 2 open.
NOTE 3: West operable doors Auditorium open, north operable doors closed.

Theoretical results in the above Tables show that noise emissions from entertainment in the function rooms and auditorium will be compliant with the LAB (and therefore DECC) criteria at all nearby residences up until midnight, subject to construction details and strategies discussed in Section 9.1.

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SECTION 4
Noise Impact Assessment
Site Traffic/Carpark Alterations

4.1 METHODOLOGY

4.1.1 Site Traffic Noise

Due to the non-continuous nature of traffic flow to and from the site, noise generated by traffic associated with the development, on public roads, is assessed using the DECC approved US Environment Protection Agency's Intermittent Traffic Noise guidelines.

Equation 1 outlines the mathematical formula used in calculating the Leq,T noise level for intermittent traffic noise.

Equation 1:

$$L_{eq},T = L_b + 10\log\left[1+\frac{ND}{T}\left(\frac{10^{(L\max - Lb)/10}-1}{2.3}-\frac{\left(L_{\max}-L_b\right)}{10}\right)\right]$$

Where L_b background noise level (dB(A))
T is the time for each group of vehicles (min)
D is duration of noise of each vehicle (min)
L_{MAX} is vehicle noise (dB(A))
N is number of vehicle trips

Typical vehicle noise levels were sourced from our library of technical data, while background noise levels are those described in Section 4. The Lmax vehicle noise levels used in Equation 1 are the maximum predicted noise levels produced at the facade of the residence by vehicles entering and departing the site.

4.1.2 Carpark Noise

Future noise sources on the site cannot be measured at this time, consequently typical noise levels from similar developments have been sourced from manufacturers' data and/or our library of technical data. This library has been accumulated from measurements taken in many similar situations on other sites, and allows theoretical predictions of future noise impacts at each receiver and recommendations concerning noise control measures to be incorporated in the design of the site.

The sound power level of each activity was determined according to the procedures described in AS2102 or AS1217 as appropriate, and theoretically propagated at to nearby receivers. Propagation calculations were carried out using the following in-house equation. Where noise impacts above the criteria are identified, suitable noise control measures are implemented and reassessed to demonstrate satisfactory received noise levels in the residential area.

Equation 2:

$$L_{eq},T = Lw - \left[10\ log\ (20\ log\ R + 8) + 10\log\frac{(D\ x\ N)}{T}\right]$$

Where Lw is sound power level of source (dB(A))
R distance to receiver (m)
D is duration of noise for each event (sec)
N is number of events
T is total assessment period (sec)

4.2 ANALYSIS AND DISCUSSION

4.2.1 Received Noise Levels – Road Traffic

Traffic due to the proposal travelling on nearby public roads is assessed separate to site noise and is subject to the criteria described in Section 2.2.1 of this Report. All patron, employee and delivery vehicles will approach the site along Ada Street.

Delivery Trucks

This assessment assumes up to 10-15 small delivery trucks may visit the site each day to deliver stock to the clubhouse or to unload/load items at the marina, during the hours 7am-6pm. Based on the above assumptions, up to 15 trucks may enter and 15 trucks may leave the site each day (or 30 movements) along Ada Street each day. This equates to perhaps 6 trucks movements during the busiest 1 hour period and 2 movements during normal periods.

Truck noise varies from one machine to another, with more modern larger trucks consistently producing a sound power in the range 102 to 106 dB(A) at full power. This assessment assumes a typical truck sound power of 104dB(A), as full engine power is not typically required to approach and depart the site at low speed.

Patrons'/Employees' Vehicles

As the anticipated number of patrons driving in and out of the site varies considerably, the assessment is based on the assumption that the carpark is typically half full and 25% of these vehicles leave in the same hour. With a carpark capacity of approximately 150 vehicles, average vehicle movements during normal periods are taken to be 115 vehicles movements each hour. Peak periods are also assessed, where the carpark is assumed to be full, 25% of these vehicles leave and the carpark fills once more, resulting in 225 vehicle movements each hour.

Traffic Noise Calculations

Table 23 shows calculations to determine received traffic noise levels at worst affected receivers along Ada Street, for typical and peak periods during the day and night.

Table 23: Traffic Noise Calculations Busiest 1 Hr Period, Ada Street - dB(A)Leq,1hr

Traffic and Receiver	**Typical Day**		**Peak Day**		**Night**	
Vehicle Type	Cars	Trucks	Cars	Trucks	Cars	Trucks
Movements per hour	115	2	225	6	225	0
Vehicle Sound Power	92	104	92	104	92	104
Received Noise Level, Lmax	60.5	72.5	60.5	72.5	60.5	72.5
Average Distance to Rec, m	15					
Received Noise Level	49.6	45.4	52.5	50.2	52.5	-
Total Received	**51.0**		**54.5**		**52.5**	
Criterion	**55dB(A),Leq 1hr**				**50dB(A),Leq 1hr**	
Impact	**-**		**-**		**-**	
Existing Noise level	**61dB(A),Leq 1hr**				**58dB(A),Leq 1hr**	
Sum current & future	**61.4**		**61.9**		**59.1**	
Criteria (existing Leq +2dB)	**63dB(A),Leq 1hr**				**60dB(A),Leq 1hr**	
Impact	**0.4**		**0.9**		**1.1**	
Acceptable	**Yes**		**Yes**		**Yes**	

Table 23 shows the noise impact from traffic movements associated with the development are compliant with the ECRTN criteria during the day (7am-10pm) and night (10pm-7am) for all residences near the site. Note that where the criteria are already exceeded, i.e. prior to occupation of the development, the ECRTN requires that the combined impact from existing and future traffic must not raise the noise level by more than 2dB(A). As can be seen by the above results, vehicle movements will only raise noise levels by 0.4-0.9dB(A) during the day and by 1.1dB(A) at night, which are considered acceptable.

Table 3 shows existing average Lmax noise levels as high as 71dB(A) already exist in the nearby residential area at night, which are more than 10dB(A) above noise levels produced by cars approaching and departing the site. Therefore, it is unlikely that there will be any noticeable change in received noise levels due to vehicles entering and leaving.

4.2.2 Received Noise Levels – Carpark Activities

Vehicles entering, leaving and manoeuvring in the carpark have the potential to cause disturbance to nearby residents. The greatest impact will occur during peak periods when use of both the lake pontoon carpark and foreshore carpark coincide with a regatta. Table 24 shows a sample calculation of noise from activities in the carpark, propagated to nearest residential receivers in Ada Street.

Table 24: Received Noise – Carpark Activities
Propagated to Nearest Residential Boundaries (R2)

Activity/Item	Unhitch Trailer	Reverse Trailer	Car Leave	Car Reverse	Car Door	Raised Speech
Lw dB(A)	90	78	82	78	92	88
Ave Dist to rec (m)	40	40	60	60	50	50
Duration event (sec)	30	20	5	10	0.25	5
No. of events	10	10	50	50	75	10
Rec dB(A),Leq	**45.2**	**31.4**	**32.9**	**31.9**	**33.2**	**33.5**
Combined	**46**					
Crit (day/evening)	**51dB(A)Leq,(15 min) / 48dB(A)Leq,(15 min)**					
Impact	**- / -**					

1. Acoustic fence 2400mm in height along east site boundary between carpark and No.13 Grose Street.

The above Table shows that noise created by activities associated with the carparks are compliant with the criteria during the day and evening at all nearby residences during peak periods. Peak carpark usage may occur at night at the completion of a function in the clubhouse. However, trailers will note be unhitched in the foreshore carpark at night (10pm-7am), therefore peak traffic noise at night is in the order of 40dB(A),Leq at nearest residential boundaries, which is acceptable.

SECTION 5
Noise Impact Assessment
Marina Extensions

5.1 METHODOLOGY AND ANALYSIS

The Acoustic Power Levels of plant and machinery associated with operation of the marina that which were input into our computer model, are shown in Table 25. The Table give the A-weighted sound power levels for each listed plant item, principally based on manufacturers' data and our library of technical data, which has been accumulated from measurements taken in many similar situations on other sites. Also shown is the number of items operating at each location on the site. Each operating scenario assumes a worst-case situation during the busiest 15 minute assessment period.

Table 25: Item/Activity – Day

	Location and Number					
Machine/Process	**Lw dB(A)**	**Yard**	**Outside Workshop**	**Inside Workshop**	**Boat Ramp**	**Wet Berths**
Boat Travel lift	102	2				
Electric motor	95		2			
Air compressor	87		10			
Angle grinder	112	5		5		
Air tools	105			10		
Hammering	98		5	5		
Boat Engine	85					5
Crane	85				2	

Table 26 shows calculation of received noise levels from worst-case site activities and equipment associated with the marina during the day (7am-10pm), propagated to nearest residential receivers. All calculations are based on distances scaled from plans supplied by EJE Architecture and through measurement during our site visits.

Table 26: Received Noise – Marina Site Activities/Equipment, dB(A),Leq Propagated to Nearest Residential Receivers

Location	North East (R1)	East (R2)	South East (R3)
Rec dB(A),Leq	**47**	**51**	**49**

The above Table shows that noise created by activities associated with the marina are compliant with the criteria at all residential receivers, providing activities only occur during the day and subject to implementing noise control modifications detailed in Section 9.2.

Other noise sources encountered on the site include repairs and maintenance to individual craft in the wet berths, welders, bench drills, sanders, etc, all of which produce a sound power less than 85dB. Collectively, with up to 3 or 4 sources operating simultaneously on occasion, the sum could be as high as 90dB. This overall sum is at least 10dB below significant sources shown in Table 25, therefore they will not contribute or raise the sound level at nearby receiver.

SECTION 6
Noise Impact Assessment
Mechanical plant

6.1 METHODOLOGY

The majority of mechanical plant will be located on the roof of the clubhouse or at ground level at the marina. The sound power of anticipated plant is propagated to nearest receivers taking into account sound intensity losses due to spherical spreading, acoustic barriers, etc. Additional minor losses such as molecular absorption, directivity and ground absorption have been ignored in the calculations. As a result, predicted received noise levels are expected to slightly overstate actual received levels and thus provide a measure of conservatism. Comparison of the predicted noise levels produced by the plant and the allowable level are then compared to give the noise impact at the receiver.

As previously stated, the type and location of mechanical plant has not been finalised at this stage. Therefore, the following locations and types of plant have been assumed for assessment purposes, taken from a generic plant specification for a similar sized development.

Location	*Plant Item*
Clubhouse Roof	Air conditioning condensers (x8)
	Refrigeration condensers (x2)
	Exhaust fans (x2)
Above clubhouse coolroom	Refrigeration condensers (x2)
	Refrigeration compressors (x2)
Marina	Air compressor (x1)
	Refrigeration condenser (x1)

6.2 ANALYSIS AND DISCUSSION

Table 27 shows a sample calculation of noise from anticipated mechanical plant on a roof of the clubhouse, propagated east to residences R2.

Table 27: Calculated SPL, Clubhouse Roof-Top Plant – Propagated East to R2

		Octave Band Centre Frequency, Hz							
Item	**dB(A)**	**63**	**125**	**250**	**500**	**1k**	**2k**	**4k**	**8k**
Combined Lw plant	88	56	72	79	81	83	82	77	68
Barrier loss[1]		5	5	5	5	5	5	5	5
SPL at Receiver	**28**	-	12	19	21	23	22	17	8
Criterion (night)	**41**								
Impact	**-**								

1. Acoustic barrier equal in height to highest plant item.

As can be seen by the results in Table 27, noise emissions from mechanical plant on the roof of the clubhouse will be compliant with the night criterion of 41dB(A),Leq at nearest residences to the east, providing an acoustic barrier equal in height to the top of the plant is erected along the east edge of the deck. Note that parapet walls or intervening building structures of equivalent height will achieve the same purpose, removing the need for acoustic barriers. See Section 9.3 for barrier details for all plant areas.

SECTION 7
Cumulative Noise Impact Site Operation

7.1 Cumulative Noise Impact

The cumulative noise impact from all activities associated with the site must be considered to confirm compliance. The clubhouse will operate during the day and night, while the marina is only expected to operate during the day. The acoustic sum of all noise generating items expected to operate at the site during each time period has been propagated to nearest residential receivers, as shown in Table 28. Entries in bold type highlight exceedances of the criteria.

Table 28: Cumulative Noise Impact - Propagated to Nearest Residences

Rec/Item	Clubhouse Ent	Club Terraces	Carpark Activities	Marina	Mech Plant	Sum
DAY						
R1 North east	42	36	<25	47	31	49
R2 east	40	<25	46	51	35	**53**
R3 South east	41	34	<25	49	32	50
NIGHT						
R1 North east	**42**	36	<20	-	31	**43**
R2 east	40	25	40	-	35	**44**
R3 South east	41	34	<20	-	32	**42**

As can be seen by the above results, the noise impact from individual activities associated with operation of the site will be compliant with the criteria at nearest residential receivers during all time periods, subject to our recommendations. However, Table 28 indicates that the cumulative noise impact from all activities associated with the site may exceed the criteria at residences east of the site (R2) during the day and all receivers at night. The following points will demonstrate that compliance during all time periods is in fact achieved:

1. When the carpark is operating at full capacity during the day, say when a regatta is being held, activities/equipment associated with the marina will be idle, i.e. workshop, etc. Therefore compliance will be achieved.
2. Entertainment in the clubhouse will cease by midnight. The criteria up until midnight is 46dB(A) and after this time reduces to 41dB(A). Therefore, providing all entertainment ceases by midnight, overall compliance with the night criterion will be achieved.

SECTION 8
Construction Noise and Vibration Impact Assessment

8.1 METHODOLOGY

Future noise and vibration sources on the site cannot be measured at this time, consequently noise and vibration levels produced by plant and machinery to be used on the site have been sourced from manufacturers' data and/or our library of technical data, which has been accumulated from measurements taken in many similar situations on other sites for others.

All noise level measurements were taken with a Svan 912AE Sound and Vibration Analyser. This instrument is Type 1 accuracy, in accordance with the requirements of AS1259, and has the capability to measure steady, fluctuating, intermittent and/or impulsive sound, and to compute and display percentile noise levels for the measuring period. A calibration signal was used to align the instrument train prior to measuring and checked at the conclusion. Difference in the two measurements was less than 0.5dB.

Each measurement was taken over a representative time period to include all aspects of machine/process operation, including additional start-up noise where applicable. Items of equipment, which produced a brief burst of noise, were measured for a similarly brief time period to ensure the results were not influenced by long periods of inactivity between operations. Sound measurements were generally made around all sides of each machine, to enable the acoustic sound power (dB re 1pW) to be calculated. The sound power level is then theoretically propagated to the receiver, with allowances made for spherical spreading. Atmospheric absorption, directivity and ground absorption have been ignored in the calculations. As a result, predicted received noise levels are expected to slightly overstate actual received levels, thus providing a measure of conservatism. Addition of the received Sound Pressure Level (SPL) for each of the individual operating sources gives the total SPL at each receiver, which is then compared to the relevant criterion. Where noise impacts above the criterion are identified, suitable noise control measures are implemented and reassessed to demonstrate satisfactory received noise levels.

Typical vibration levels for construction activities were measured at other sites for various ground types and situations primarily using a Vibroch V801 Seismograph coupled to a triaxial geophone. A sandbag was placed over the geophone or it was glued to the surface location during each measurement to ensure elevated readings were not recorded due to bouncing and movement, which may occur at higher vibration amplitudes. The unit is capable of measuring and storing peak Z-axis vibration velocities, as well as vibration in three directions simultaneously and gives peak velocity and acceleration on the x, y and z axes.

The theoretical assessment is based on a worst-case scenario, where all plant items are operating simultaneously in locations most exposed to the receiver. In reality, most plant will be located in shielded areas, so actual received noise is expected to be less than the predictions shown in this report, or at worst equal to the predicted noise levels for only part of the time.

8.2 CONSTRUCTION PLANT AND EQUIPMENT

Received noise produced by anticipated construction activities is shown in Table 29 below, for a variety of distances to a typical receiver, with no noise barriers or acoustic shielding in place and with each item of plant operating at full power. Entries in bold type highlight exceedances of the construction noise criterion of **56dB(A),Leq** (See Table 8).

Table 29: Predicted Plant Item Noise Levels, dB(A)Leq

		Distance to Receiver					
Plant/Activity	**(Lw)**	**50m**	**100m**	**200m**	**300m**	**400m**	**500m**
Pile Driving	(126)	**84**	**78**	**72**	**68**	**66**	**64**
Air compressor	(98)	56	50	44	40	38	36
Hammering	(95)	53	47	41	37	35	33
Air wrench (silenced)	(98)	56	50	44	40	38	36
Compactor	(113)	**71**	**65**	**59**	55	53	51
Dump truck	(108)	**66**	**60**	54	50	48	46
Grader	(108)	**66**	**60**	54	50	48	46
Backhoe	(103)	**61**	55	49	45	43	41
Kerb machine	(105)	**63**	**57**	51	47	45	43
Mobile crane	(112)	**70**	**64**	**58**	54	52	50
Gas gun	(94)	52	46	40	36	34	32
Framing gun	(95)	53	47	41	37	35	33
Angle grinder	(108)	**66**	**60**	54	50	48	46
Concrete Agitator	(112)	**70**	**64**	**58**	54	52	50
Concrete Pump	(110)	**68**	**62**	56	52	50	48
Road truck	(108)	**66**	**60**	54	50	48	46
Circular saw	(115)	**73**	**67**	**61**	**57**	55	53
Excavator	(106)	**64**	**58**	52	48	46	44
Bull dozer	(116)	**76**	**70**	**64**	**60**	**58**	56

8.3 PREDICTED CONSTRUCTION NOISE IMPACTS

Only bulk earthworks and pile driving are predicted to exceed the daytime construction noise criteria for prolonged periods. Table 29 demonstrates the advantage of minimising construction time, with higher received noise levels allowed for shorter construction periods. Noise levels as high as 72dB(A) are predicted during pile driving at nearest residences, however, simultaneous operation of other construction activities is not expected to exceed 65dB(A). Earthworks are expected to occur in the early stages of the project, while more sedate construction activities will occur for the remainder of the time. It should be noted that calculations are based on plant items operating in exposed locations and at full power, with no allowances made for intervening topography or shielding provided by intervening structures. Cumulative impacts, from several machines operating simultaneously, may be reduced when machines are operating in shielded areas not wholly visible to receivers. In saying this, if two or more machines were to operate simultaneously on the site, received noise levels would be raised and higher exceedances may occur. For instance, a concrete agitator and concrete pump, in exposed locations, will produce a combined noise level of **72dB(A),Leq** at a distance of 50 metres.

Constructing temporary barriers of plywood, excess fill, etc, at least 2m high, may be considered for mitigating some of the construction noise at the residential boundary. These barriers will offer the additional benefit of securing the site from unwanted visitors.

With barriers in place, worst case construction will reduce by up to 10dB(A), although, as previously stated, these noise levels are expected to occur for a relatively short time and reduce as work progresses to a new area.

The potential for undue noise impact is reduced by noting that the daytime LAeq level is above 65dB(A). Noise levels are dominated by passing road traffic. As the character and amplitude of the construction noise will be similar to the existing road traffic noise, it will be less intrusive than an unfamiliar introduced source.

The majority of construction activities are 150-200 metres of major construction works. Once again exceedances of the construction noise goals are predicted during pile driving and some earthworks.

The majority of noise will enter buildings through entries and glazed partitions. Should excessive noise prevent normal use of an occupied area, erection of hoarding at exposed locations may be considered. Noise reductions of 10-15dB(A) or more can be expected by applying these strategies.

8.4 PREDICTED CONSTRUCTION VIBRATION IMPACTS

Occupants of neighbouring buildings may have concerns about ground vibration levels from vibrating machinery (pile driving, tracked machines, ripping, rollers, etc). Ground vibration measurements carried out previously, on other sites, can be used to indicate the likely range of vibration levels produced by construction activities. Previous results do not necessarily apply to this site without considering influencing factors such as ground resonant frequency, energy produced, etc. Table 30 lists the results of previous vibration measurements, with each measurement corrected to a standard distance of 20m to represent the nearest receivers.

Table 30: Average Maximum Ground Vibration Measurement Results, mm/s Peak.

Ground Type	Measured Distance to Vibration mm/sec	Minimum 50m to Receiver mm/sec
Ripping on clay soil	80m, 0.02	0.06
Ripping on dry alluvial soil	15m, 1.86	1.80
Ripping on wet alluvial soil	100m, 0.4	2.4
Road truck on potholes	10m, 0.15-2.7	0.15-2.7
Smooth drum roller on clay	40m, 0.12	0.21
Padfoot vibrating roller on clay	30m, 0.36	0.40
Vibrating roller on moist soil	80m, 0.80	0.60
2x vibrating rollers on clay	50m, 0.84	1.6
Dozer walking on sandy soil	75m, 0.63	0.75

Table 30 shows a variety of vibration levels mainly due to differences in ground conditions from one site to the next. The Table shows a marked difference between clay and dry ground, with low resulting vibration, and water saturated ground with vibration levels an order of magnitude higher. Results from measurements on wet alluvial or clay soil are likely to apply to the site.

Since vibration varies over time for each process the DECC Guideline recommends that the following formula be used to estimate the vibration dose at the receiver location:

Equation 3: $eVDV = 1.4 \times a \times t^{0.25}$

where: k is nominally 1.4 for crest factors below 6 a_{rms} = weighted rms accel (m/s^2)
t = total cumulative time (seconds) of the vibration event(s)

Assuming each ripping and vibrating rollers may operate for up to 4-5 hours, the following estimated vibration doses are expected at nearest receivers when construction activities are at closest locations:

	eVDV
Pile Driving	0.45
Vibrating rollers (x2)	0.60

Based on the above results, estimated vibration dose values up to $0.45 m/s^{1.75}$ are expected at nearest receivers from pile driving and $0.60 m/s^{1.75}$ from two vibrating rollers operating in tandem. Therefore, adverse comment may occur from these activities. We therefore recommend that no vibrating rollers are used within 40 metres of any structure, unless attended vibration monitoring is carried out. If excessively high vibration amplitudes are measured we recommend ceasing activities immediately and employing alternate techniques. On the other hand if vibration amplitudes are at acceptable limits, activities may proceed. To avoid costly delay and inconvenience, we recommend commencing piling at locations closest to nearest neighbouring buildings and moving to more remote locations. Once vibration levels reduce to acceptable levels and/or closest piles have been driven, it is reasonable to assume that attended vibration monitoring will no longer be required.

The effect of vibration in a building is observed in two ways, namely, it is felt by the occupant, or it causes physical damage to the structure. Subjective detection can be one of direct perception from rattling of windows and ornaments, or dislodgement of hanging pictures and other loose objects. The second is structural damage which may be either architectural (or cosmetic) such as plaster cracking, movement or dislodgement of wall tiles, cracked glass etc, or major such as cracking walls, complete falls of ceilings, etc, which is generally considered to impair the function or use of the dwelling. Vibration can be felt at levels well below those considered to cause structural damage. Complaints from occupiers are usually due to the belief that if vibration can be felt then it is likely to cause damage. Slamming of doors or footfall within a building can produce vibration levels above those produced by construction activities.

Any future structural damage, whether cosmetic or major, which may occur to any building will only be a result of natural causes such as differential settlement of foundations (particularly if on poorly compacted fill), expansion and contraction cycles due to changes in temperature, shrinkage due to drying out of timber framing and pre-stressed areas of the building. Obvious structural damage from any of these sources can usually be identified with the particular cause. Generally, one particular source is not the cause of damage to a structure, but rather a combination of two or more.

Vibration levels are unlikely to cause direct failure, and it is considered the main action is triggering cracks in materials already subjected to stress or natural forces, however, as previously mentioned, this may also arise from internal forces such as slamming of doors. In our experience, vibration will only begin to trigger "natural cracking" at levels above 1mm/sec.

Findings by the Road Research Laboratory in the early 1970's, reproduced in Table 31, gives an indication of the effects from varying magnitudes of vibration.

Table 31: Reaction of People and Damage to Buildings

Peak Vel (mm/s)	Human Reaction	Effect on Buildings
0 to 0.15	Imperceptible by people – no intrusion	Highly unlikely to cause damage
0.15 to 0.3	Threshold of perception – possibility of intrusion	Highly unlikely to cause damage
2.0	Vibrations perceptible	Recommended upper level of vibration for historical buildings
2.5	Level at which vibration becomes annoying	Very little risk of damage
5	Annoying to occupants	Threshold at which the risk of damage to houses is possible
10 to 15	Vibrations considered unpleasant and unacceptable	Will cause cosmetic damage and possibly structural damage

Construction noise and vibration strategies are discussed in detail in Section 9.4.

SECTION 9
Summary of Recommended Noise Control

9.1 RECOMMENDED NOISE CONTROL – CLUBHOUSE

a) All outdoor terraces may be used during club trading hours with the exception of the restaurant terrace that must not be used after midnight. We recommend placing a rope barrier or similar after this time. Signs may also be erected informing patrons that the restaurant terrace must not be used.

b) Acoustic barriers are required at the perimeter of outdoor terraces at the following locations:

Terrace	*Height*	*Location*
Auditorium terrace	1500mm	north edge and east end
Function room 1 terrace	1200mm	north edge
Function room 2 terrace	1200mm	south edge

c) All entertainment at the clubhouse must cease by midnight.

d) The following construction details and noise control strategies are required for the function rooms and auditorium:

Function Room 1:
F1.1. Discos, club bands, etc, may perform in the function room.

F1.2. Roof/ceiling construction should consist of sisalation or wire mesh laid down on roof purlins/battens. This is to be completely covered with a 50mm foil faced building blanket hard under the roof sheeting (in situations where battens are at centres close enough to avoid excessive sagging of the blanket, the sisalation/wire mesh may be omitted). Close off eaves gaps between roof sheeting and purlins with Unisil Eaves Filler Strips or bituminous compound. Install an impervious suspended ceiling consisting of 1 sheet of taped and set 13mm fire rated plasterboard. To further assist in low frequency attenuation, all ceiling voids should contain a layer of fibreglass or rockwool insulation. The insulation is to be installed in addition to, not in lieu of the building blanket. Specialised acoustic insulation is preferred, however dense thermal insulation (eg, S3/R3 polyester/fibreglass batts) will suffice and is much less expensive ($15/$m^2$ for Rockwool 350 and $6/$m^2$ for R3 batts).

F1.3. All glazing to be minimum 6.38mm laminated glass. Proprietary acoustic deals must be fitted at all window sliders and door surrounds.

F1.4. Only the south section of the bifold doors may be left open during functions to allow patron access to the terrace. The northern section must be closed

F1.5. All lightweight wall cladding is to be backed with 10mm plasterboard, 9mm FC sheeting, or material of equivalent surface mass.

Function Room 2:
F2.1. Only duos, trios with drum machine accompaniment may perform in the function room, i.e. no Discos, club bands.

F2.2. Roof/ceiling construction should consist of sisalation or wire mesh laid down on roof purlins/trusses. This is to be completely covered with a 50mm foil faced building blanket hard under the roof sheeting (in situations where battens are at centres close enough to avoid excessive sagging of the blanket, the sisalation/wire mesh may be omitted). Close off eaves gaps between roof sheeting and purlins with Unisil Eaves Filler Strips or bituminous compound. Install a suspended acoustic tile ceiling (Renhurst RH90, CSR Ecophon, or similar). Provide a 50mm overlay in the ceiling void above the acoustic tile ceiling.

F2.3. All glazing to be minimum 6.38mm laminated glass. Proprietary acoustic deals must be fitted at all window sliders and door surrounds.

F2.4. The bifold doors may be left open during functions.

F2.5. All lightweight wall cladding is to be backed with 10mm plasterboard, 9mm FC sheeting, or material of equivalent surface mass.

Auditorium:
A1.1. Discos, club bands, etc may perform in the auditorium.

A1.2. Roof/ceiling construction should consist of sisalation or wire mesh laid down on roof purlins/trusses. This is to be completely covered with a 50mm foil faced building blanket hard under the roof sheeting (in situations where battens are at centres close enough to avoid excessive sagging of the blanket, the sisalation/wire mesh may be omitted). Close off eaves gaps between roof sheeting and purlins with Unisil Eaves Filler Strips or bituminous compound. Install a suspended acoustic tile ceiling (Renhurst RH90, CSR Ecophon, or similar). Provide a 50mm overlay in the ceiling void above the acoustic tile ceiling.

A1.3. All glazing to be minimum 6.38mm laminated glass. Proprietary acoustic deals must be fitted at all window sliders and door surrounds.

A1.4. Only the west bifold doors may be left open during functions to allow patron access to the terrace. All north doors must be closed.

A1.5. All lightweight wall cladding is to be backed with 10mm plasterboard, 9mm FC sheeting, or material of equivalent surface mass.

9.2 RECOMMENDED NOISE CONTROL – MARINA

e) The workshop, site activities (cranes, boat travel lift, etc) should only occur during the day (7am-6pm). Sedate activities such as setting out, routine maintenance, etc, should occur outside these times. Occasional emergency repairs are permitted, providing it can be shown that no exceedance of the criteria will occur.

f) All compressors, electric motors, etc should either be located in acoustic enclosures, within the workshop, or in a shielded location behind other structures.

g) Waste disposal bins are to be located in shielded areas, ideally behind walls or buildings, to reduce impacts during collection. It is recommended that waste collection be restricted to weekdays 7.00am to 6.00pm.

h) Deliveries should only occur during the day (7am-6pm).

i) Only registered seaworthy boats are permitted to moor or visit the marina. The owners of noisy boats should be asked to make necessary repairs or leave the site until repairs have been made.

j) Signs are to be erected in conspicuous locations, instructing boat owners to undertake repairs and routine maintenance during the day only and asked not to rev motors unnecessarily. This can be reinforced with reminders in newsletters, on bulletin boards, etc.

9.3 RECOMMENDED NOISE CONTROL – MECHANICAL PLANT

k) Acoustic barriers must be erected at the perimeter of plant on the roof of the Clubhouse to the heights nominated in Table 32. Barrier construction is to consist of an outer layer of 12mm fibre cement sheeting, 25mm construction plywood, Hebel Powerpanel, or similar material, with an absorbent inner surface of Woodtex (available through Enviro Acoustics Ph. 9605 1333) fixed to furring channels, with a cavity infill of S1.5 polyester insulation. Alternatively use QBK60 Acoustic Foam or PQ Absorption panels (available through Peace and Quiet) faced with perforated metal, 10-15% open area.

The acoustic barrier must continue below any plant deck to within 200mm of roof sheeting.

Table 32 shows the results of our calculations, including the recommended noise control to be implemented for the plant room and any plant decks.

Table 32: Calculated SPL, Mechanical Plant – Propagated to Nearest Residences

Item/Location	Received Noise	Recommended Noise Control
North East Residences (R1)		
Clubhouse Plant Deck	28	Barrier equal in height top of plant – north edge
Clubhouse exhaust	24	See Note 2
Marina plant	27	See Note 3
East Residences (R2)		
Clubhouse Plant Deck	32	Barrier equal in height top of plant – east edge
Clubhouse exhaust	27	See Note 2
Marina plant	30	See Note 3
South East Residences (R3)		
Clubhouse Plant Deck	28	Barrier equal in height top of plant – south edge
Clubhouse exhaust	24	See Note 2
Marina plant	28	See Note 3

NOTE 1: All barrier heights are above top of plant, not height above plant deck.

NOTE 2: Any supply/exhaust fans must not produce an SLP >65dB(A) at 1 metre. Fans producing above this SPL must be acoustically treated, i.e. silencers, positioned behind acoustic barriers, etc.

NOTE 3: All plant should be positioned in a shielded location within the workshop, behind acoustic barriers or other structures on the site.

l) In-duct silencers are to be fitted to plant room exhaust/intake fan openings. Required insertion loss values are as follows:

Required Insertion Loss Values for Intake/Outlet Fans – dB

	Octave Band Centre Frequency, Hz							
	63	**125**	**250**	**500**	**1k**	**2k**	**4k**	**8k**
dB	3	4	7	13	14	18	18	14

l) In-duct silencers are to be fitted to any ducted supply/exhaust air associated with the emergency generator.

m) The contractor responsible for supplying and installing mechanical plant must provide evidence that installed plant meets this noise emission limit, or that noise control included with the plant is effective in reducing the sound level to the specified limit. Once the plant layout has been finalised, details should be forwarded to the acoustic consultant for approval. Revision of the plant layout may result in lowering of acoustic barriers.

9.4 RECOMMENDED NOISE CONTROL – CONSTRUCTION

9.4.1 Noise & Vibration Monitoring Program

We recommend that attended noise and vibration should be carried out at commencement of each process/activity with the potential to generate excessive noise. Attended monitoring offers the advantage of immediate identification of unacceptable noise or vibration at the receiver and ameliorative action may be introduced to minimise the duration of exposure. Unattended long-term monitoring only identifies a problem at a later date and for this reason is not recommended.

Table 33 should be used as a guide for the construction team to consider and follow. When the nominated activity occurs within the safe working distance, attended vibration monitoring should be conducted at the relevant receiver type. It is usual practice to conduct attended noise monitoring in conjunction with vibration monitoring, as activities that produce high vibration amplitudes also regularly produce high levels of noise.

Table 33: Vibration Monitoring Program
Minimum Distance when Monitoring is Required

Activity/Process	Receiver Type	Distance to Receiver (m)
Piling	Residential	150
	Heritage structure	200
	Commercial building	180
Ripping (Dozer)	Residential	80
	Heritage structure	100
	Commercial building	50
Earthworks (track machine)	Residential	80
	Heritage structure	100
	Commercial building	50
Vibrating roller	Residential	60
	Heritage structure	80
	Commercial building	100
Smooth drum roller	Residential	20
	Heritage structure	30
	Commercial building	10
Truck movements	Residential	20
	Heritage structure	30
	Commercial building	10

Note: Attended vibration monitoring should also be conducted for other activities identified by the contractor that are not noted in the above Table.

9.4.2 Equipment Selection

All combustion engine plant, such as generators, compressors and welders, should be carefully checked to ensure they produce minimal noise, with particular attention to residential grade exhaust silencers and shielding around motors.

Trucks and other machines should not be left idling unnecessarily, particularly when close to buildings. Machines found to produce excessive noise compared to industry best practice should be removed from the site or stood down until repairs or modifications can be made.

Framing guns and impact wrenches should be used sparingly, particularly in elevated locations, with assembly of modules on the ground preferred.

Table 34 shows common construction equipment, together with noise control options and possible alternatives.

Table 34: - Noise Control, Common Noise Sources

Equipment / Process	Noise Source	Noise Control	Possible Alternatives
Compressor Generator	Engine	Fit residential muffler. Acoustic enclosure.	Electric in preference to petrol/diesel. Plant to be located outside building Use centralised generator system.
	Casing	Shielding around motor. Rubber tyred or stand on waffle pads and matting.	
Concrete breaking Drilling Core Holing	Hand piece	Fit silencer, reduces noise but not efficiency Enclosure / Screening	Rotary drill/thermic lance (used to burn holes in and cut concrete) Laser cutting technology
	Bit	Dampened bit eliminate ringing. Once surface is broken, noise reduced. Enclosure / Screening.	
	Air line	Seal air leaks, lag joints	
	Motor	Fit residential mufflers.	
Drop/circular saw Brick saw	Vibration of blade/product.	Sharp saws. Dampen blade. Clamp product.	Use handsaws where possible. Retro-fitting.
Hammering	Impact on nail		Screws
Brick bolster	Impact on brick	Rubber matting under brick	Cut bricks in a shielded area.
Rotary drills Boring	Drive motor and bit.	Acoustic screens and enclosures	Thermic lance Laser cutting technology.
Explosive tools (i.e. ramset gun)	Cartridge explosion	Use silenced gun	Drill fixing.
Dozer, Loader, Crane, Truck, Excavator, Grader, Scraper	Engine, track noise	Residential mufflers, shielding around engine, rubber tyred machinery.	
Pile driving	Hammer impact	Placing shipping containers between pile and receiver. Resilient dolly, hammer shroud	Manual boring techniques

9.4.3 Acoustic Barriers/Screening

Consideration should be given to constructing temporary barriers of plywood, excess fill, etc, at least 2-3m high at the perimeter of the construction site or individual activities. To minimise noise impacts during construction, early work should concentrate on grading and levelling the areas closest to buildings.

In the event of complaints arising from occupants of nearby buildings, we offer the following strategies for consideration:

- Erect hoarding at exposed entries and doorways.
- Place acoustic enclosures or screens directly adjacent to stationary noise sources (compressors, generators, etc).
- Erect temporary fences 2-3 metres high at the perimeter of outdoor areas or single storey buildings. The fence should be constructed from impervious material such as construction plywood.

9.4.4 Consultation/Complaints Handling Procedure

Nearest neighbours should be notified of the intended construction timetable and kept up to date as work progresses, particularly as work changes from one set of machines and processes to another. In particular, occupants should understand how long they will be exposed to each source of noise and be given the opportunity to inspect plans of the completed development. Encouraging understanding and "participation" gives a sense of ownership in the development and promotes a good working relationship with construction staff.

The site manager and construction contractor should take responsibility and be available, perhaps only during working hours, to consult with complainants. Response to complaints or comments should be made in a timely manner and action reported to the concerned party.

All staff and employees directly involved with the construction project should receive informal training with regard to noise control procedures. Additional ongoing on the job environmental training should be incorporated with the introduction of any new process or procedure. This training should flow down contractually to all sub contractors.

While the above measures will not necessarily result in eliminating construction noise, they will serve to reduce impacts to levels most affected parties will find acceptable considering the relatively short-term nature of construction work and anticipated benefits upon completion.

9.5 RECOMMENDED NOISE CONTROL – CERTIFICATION

n) Construction Certificate documentation must be forwarded to an accredited acoustic consultant to ensure all of recommendations within this report have been incorporated into the design of the centre.

o) For both staff and customers, some form of education campaign is suggested to ensure satisfactory noise levels at nearby residences. For staff, the education can be part of in-service training, while for visitors reminders may be included in promotional material and reinforced with erection of appropriate signage.

SECTION 10
Conclusion

10.1 CONCLUSION

A noise impact assessment for a new clubhouse, marina extensions and carpark alterations at Lake Macquarie Yacht Club, has been completed, resulting in noise control recommendations summarised in Section 9 of this Report. The site is suitable for the intended purpose providing recommendations outlined in this report are incorporated into the design. With these or equivalent measures in place, noise from the site will be either within the criterion or generally below the existing background noise level in the area for the majority of the time.

The existing average Leq noise levels already impacting the residential areas is equal to or above that predicted by the proposal and since the character and amplitude of activities associated with the site will be similar to those already impacting the area, it will be less intrusive than an unfamiliar introduced source.

Given the abundance of existing commercial activities and continuous traffic flows on the nearby Pacific Highway, the relatively small number of vehicle movements associated with the proposal are unlikely to result in a noticeable traffic noise increase at any receiver along the incoming or outgoing transport routes.

Theoretical results show no exceedance of the LAB (and therefore DoP and Council) noise criteria, during allowable time periods, due to entertainment and patron activity at the Clubhouse, however, in the unlikely event of complaints arising, appropriate noise management strategies are available and described in Section 8

During construction the total impact at each receiver is related to the received noise level and the duration of excessive noise. Generally, construction noise will comply with the criteria, however, during major construction activities, exceedances are expected to occur. The local community should accept periods of high noise, considering the relatively short-term nature of construction activities and the benefit to the local economic community as a whole.

To reduce the impact in the area during construction, we recommend that louder construction activities, should be completed with the minimum of undue delay. In any case, all reasonable attempts should be made to complete significant noisy activities within as short a time as possible.

Construction activities should be restricted to the nominated hours. Further reduction in operating hours should only be considered if exceedance of criteria are identified through site measurement. Significant variation in measured vibration levels may occur due to site specific conditions such as the ground resonant frequency, driving frequency of equipment and energy of the associated process. Therefore, a regular noise and vibration monitoring program should be implemented, as described in Section 9.4. This program will verify our predictions and in the event that complaints may arise, enable strategies to be implemented, where required.

To minimise the chances of excessive vibration during site preparation, tracked machines or vibrating rollers should not be used at any one time within 80m of any nearby building. Two vibrating rollers should not be operated in tandem within the minimum safe distance specified in Table 33, unless simultaneous attended vibration monitoring is conducted at the nearest receiver(s). Where practicable, required compaction should be achieved by heavy non-vibrating rollers.

We conclude, with a high degree of confidence, that vibration levels at the predicted magnitudes will not cause direct structural damage to any building. We suspect any damage that may occur to nearby buildings during construction activities would be the result of natural forces, as discussed in the previous section. It should be noted, however, that vibration may be noticed at times while a person is standing or seated quietly. Other noticeable indicators are rattling of window frames and ornaments, and visible movement of hanging pictures, etc.

Providing the recommendations presented in this report are implemented, operation and construction of the development will not have any long term adverse noise impact upon the acoustic amenity of nearby residents. We therefore see no acoustic reason why the proposal should be denied.

REVERB ACOUSTICS

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APPENDIX A
Definition of Acoustic Terms

Definition of Acoustic Terms

Term	Definition
dB(A)	A unit of measurement in decibels (A), of sound pressure level which has its frequency characteristics modified by a filter ("A-weighted") so as to more closely approximate the frequency response of the human ear.
ABL	*Assessment Background Level* – A single figure representing each individual assessment period (day, evening, night). Determined as the L90 of the L90's for each separate period.
RBL	*Rating Background Level* – The overall single figure background level for each assessment period (day, evening, night) over the entire monitoring period.
Leq	Equivalent Continuous Noise Level - which, lasting for as long as a given noise event has the same amount of acoustic energy as the given event.
L90	The noise level which is equalled or exceeded for 90% of the measurement period. An indicator of the mean minimum noise level, and is used in Australia as the descriptor for background or ambient noise (usually in dBA).
L10	The noise level which is equalled or exceeded for 10% of the measurement period. L_{10} is an indicator of the mean maximum noise level, and was previously used in Australia as the descriptor for intrusive noise (usually in dBA).