11. Noise and Vibration

11.1 Existing Environment

11.1.1 Location and proximity to nearest sensitive places

As outlined in **Section 2.1.1**, the proposed Airlie Beach Marina Development will be located at Boathaven Bay. Land use immediately to the west of the site is predominantly a mix of commercial, residential and resort style accommodation. The nearest sensitive receivers to the proposed marina development site are located along Shute Harbour Road, as seen on **Figure 11-1**. The majority of these receivers have an easterly aspect on land which rises up from the intertidal flats, overlooking Shute Harbour Road and the proposed Port of Airlie.

Tourism, and the provision of short and long-term holiday accommodation in the Airlie Beach area, is an important contributor to the local economy.

11.1.2 Ambient Noise Monitoring

Short-term noise surveys were conducted by WBM in October 1998 as part of the Draft IAS for the previous Marina Development proposal (Burchill, 1998). WBM conducted operator attended and unattended noise monitoring at various residential and commercial locations within the study area. Additional ambient noise monitoring was not considered necessary.

The results of the 1998 monitoring surveys have been used to provide an indication of the existing noise environment at indicative nearest sensitive receiver locations adjacent to the proposed development site, including existing noise sources (receivers are those individuals who might be exposed to noise impacts).

WBM conducted noise monitoring at a number of locations within the Airlie Beach area. The relevant locations are shown on **Figure 11-1**. The range in noise levels reported for each of these locations is summarised in **Table 11-1**.

SINCLAIR KNIGHT MERZ

PORT OF AIRLIE MARINA

PORT OF Airlie

Noise Monitoring Locations

Figure 11-1

■ Table 11-1 Summary of Noise Levels

Location	Time Period #	L_{A90}	L_{A10}	L_{Aeq}	Contributing sources
1. Whitsunday Sailing Club	Day Evening Night	42-46 41-43 35-38	48-55 45-47 41	46-54 44-45 39	Birds, carpark traffic
2. Island Gateway Holiday Resort[1]	Day Evening Night	39-42 40 35-36	55-56 53-55 38-42	52 51-53 36-43	Traffic Jubilee Pocket Rd, birds
3. Sentry Court	Day Evening Night	38-39 51-58 37-46	51-52 56-62 47-52	50-51 55-60 44-50	Traffic Jubilee Pocket Rd, birds
4. 2 Jubilee Pocket Road[1]	Day Evening Night	48-49 44-50 41	62-63 58-59 49	60 49-55 47	Traffic – Shute Harbour Rd, insects
5. Colonial Palms Motor Inn[1]	Day Evening Night	52-53 48-54 40	69 66-73 58	65 62-68 56	Traffic – Shute Harbour Rd, birds
6. Boathaven Lodge[1]	Day Evening Night	50 43-50 37	69-72 66-72 56	65-68 61-67 55	Traffic – Shute Harbour Rd, birds
7. Mandalay Road	Day Evening Night	31-32 33-36 30-31	48-50 40-44 36-41	51-53 42-44 37-45	Birds, intermittent traffic
8. Mazlin St	Day Evening Night	45-47 44-45 46-47	52-53 50 50-55	51-53 49-50 49-53	Wave Noise, boat rigging
9. Timberland Road	Day Evening Night	30-31 54 33	50 51 40	42-50 51 41	Intermittent traffic, birds, insects, dogs
10. Moonlight Drive	Day Evening Night	40 34-35 29-31	52 43-47 35-39	50 43-45 35-37	Intermittent traffic, insects

[1] Potentially significant influence from Road traffic noise along Shute Harbour Road.
day: 6 am-6 pm, evening: 6 pm-10 pm, night: 10 pm-6 am.
Source: WBM, 1998

The results of noise monitoring indicate a relatively high influence of road traffic on the noise environment at locations adjacent to the Shute Harbour Road, particularly locations 2, 4, 5 and 6. Background noise levels at sites located more remotely from the main roads, recorded L_{A90} noise levels as low as 30 dB(A).

Daily traffic flows along Shute Harbour Road, east of Coconut Grove (Locations 2, 4, 5 and 6), have increased by approximately 57% since the October 1998 monitoring surveys were conducted. There is no defined relationship between the background noise and vehicle volumes. Assuming that the majority of this increase in traffic would occur during the 18-hour daytime period between 6 am and 12 midnight, the 2002 daytime L_{A90} noise levels may be up to 2-3 dB(A) higher than those measured during the 1998 surveys. The difference between 1998 and 2002 night-time L_{A90} levels is not likely to be as great as the daytime levels, due to the lower night-time traffic flows, however increases of around 1-2 dB(A) may be expected.

The 2002 daytime L_{A90} noise levels at Locations 2, 4, 5 and 6 are also likely to be higher than those presented in **Table 11-1**. The change in the background noise levels are likely to change by a similar amount as that described above, thus at night an increase of around 1-2 dB(A) would be expected.

11.1.3 Vibration Sources

No vibration monitoring was undertaken as part of this study. A desktop review of the potential sources of vibration in the Boat Harbour development area has been undertaken to provide an indication of the likely current level of vibration impact.

Currently, the main sources of vibration in the area would typically include heavy vehicle traffic travelling along Shute Harbour Road. Currently, heavy vehicle traffic is less than 6% along Shute Harbour Road, east of Coconut Grove, and the average setback of premises along this road is such that, existing vibration impacts from this source are not expected to be significant.

Intermittent road maintenance works carried out on the local road networks may also contribute temporary vibration impacts during the use of vibratory rollers and the like. Generally these sources are not considered significant and where the potential for impacts is expected, studies would be carried out prior to the commencement of works to assess impacts on individual premises.

11.2 Potential Construction Phase Impacts

11.2.1 Construction Activities

The proposed development involves construction of a new 240 berth marina, a ferry terminal, training and commercial facilities, a public boat ramp, car parking spaces, boat maintenance facility, residential and hotel-style apartment accommodation.

The site of the proposed development area is currently intertidal mudflats and will require intensive earthmoving and compaction to provide a suitable base for development. Construction activities associated with the proposed works would generally involve:

- pile driving during the construction of a steel sheet pile wall around the entire marina basin, which will be pumped and maintained in a dry condition throughout the construction works;
- excavation of the top layer of marine muds from the site, which will be transported by truck to the containment site along Shute Harbour Road;
- importation and spreading of fill material within the marina basin to provide a suitable base for the proposed residential and commercial facilities. Fill material would be transported to the site via truck and compacted using rollers;
- during the land reclamation phase, sheet pile coffer dams will be installed, which will eventually form the internal marina wall and part of the external breakwater design. They will remain in place after construction.
- dredging of the proposed marina entrance channel using a cutter suction dredge;
- following land reclamation and compaction works, installation of services and construction of buildings would commence. Typical construction equipment during the building erection phase would include the use of cranes, concrete trucks, hand tools, mobile generators and the like;
- dedicated haulage routes would be established on-site during the excavation, dredge and fill stage of the proposal.

As outlined in **Section 2.7**, construction would be staged. Driving of sheet piles will be undertaken almost continuously over a 5 month period, commencing immediately after the mobilisation of the contractor to site. The piles will be driven from a floating barge, commencing with the breakwater and continuing around the perimeter of the marina and finally closing off the marina basin from the sea. Pile driving will take place during normal working hours.

Dredging and reclamation works would be undertaken during the first 9 months between April and December, installation of services, site infrastructure including roads, buildings and the marina moorings during the next 6 months, then construction of the ferry terminal and transport interchange facilities during the following 12 months. Subsequent construction of the additional commercial, residential and hotel structures is to be staged over a 5 year period.

11.2.2 Construction Noise

Overview

Construction works associated with the proposed Marina Development will result in noise generation, particularly during the pile driving, excavation and land reclamation phases of the project. Detailed information on construction scheduling was not available at the time of preparation of this report. The following sections provide an overview of construction noise criteria applicable to the project, a general description of the construction process, including construction activities and equipment that could reasonably be expected as part of the project, and an estimate of the potential noise impacts that may result.

Criteria

The acoustic environment in Queensland is protected under the *Environmental Protection Act 1994* (EP Act), the objective of which is to allow development that improves the total quality of life using the principles of "Ecologically Sustainable Development". The objective of the EP Act is implemented through the *Environmental Protection (Noise) Policy 1997* (EPP (Noise)), which provides a framework for managing and assessing noise emissions from development proposals and aims to protect and enhance environmental values, namely the wellbeing of the community and individuals.

The EPP (Noise) does not outline specific construction noise level guidelines. The Queensland Nuisance Laws, outlined in Section 6 of the *Environmental Protection Regulation 1998 (EPR,1998)*, indicate provide time restrictions for construction, maintenance and building works having the potential to affect residential premises. Section 6W of the EPR requires that construction works for the proposed Marina development be restricted to the hours of 6:30 am-6:30 pm Monday to Saturday. Building works outside of these hours are permitted, as long as they do not result in audible noise at the nearest noise sensitive place.

Construction Noise Level Predictions and Impact Assessment

The generation of noise from the construction site will be variable, depending on the stage of the works, the types of equipment operating at a particular time and the location within the site. The assessment of construction phase noise impacts is based on a selection of typical items of equipment operating simultaneously during the earthworks and civil phase.

At the time of preparation of this report, no detailed information relating to the proposed construction scheduling or equipment use was available. As such, noise levels generated by indicative construction scenarios have been reviewed and used to determine the likely level of impact on adjacent residential receivers.

WBM (in Burchill 1998) list indicative construction noise level calculations for the operation of various earth moving and construction equipment operating within the proposed marina site. Sound Power levels for typical activities were sourced by WBM from AS2436-1981 (Guide to Noise Control on Construction, Demolition and Maintenance Sites) and previous experience on similar construction projects.

The results of calculations showed that at times, when equipment is working in close proximity to receivers (within 50-100 m), contributed noise levels could be up to 60 dB(A), depending on the type and number of items operating and the prevailing meteorological influences. Earthworks and reclamation works would therefore result in construction noise levels somewhat higher than the existing background noise levels at a few locations adjacent to the proposed development site while earthworks are taking place close to Shute Harbour Road. Properties along Shute Harbour Road are less likely to experience disturbance due to already high daytime background noise levels resulting from traffic. The topography of the site is such that little or no shielding will be provided to nearby receivers from natural barriers.

Noise levels generated during the construction of buildings and civil works, with the exception of road building and pile driving works (refer below), are likely to result in less impact than during the dredging and land reclamation phase of the works, due to the less intense nature of the works.

Construction Traffic

As outlined in **Section 2.7**, the dredging and land reclamation stage of construction is likely to generate approximately70 truck trips per day to and from the site. Over the period 6:30 am – 6:30 pm, this equates to an average of approximately 6 trips per hour.

The impact on daytime road traffic noise levels at receivers located adjacent to Shute Harbour Road is likely to be an marginal increase of less than 0.5 dB(A). Potential noise impacts from an increase of this order would not be expected, as long as the majority of these truck movements occurred during normal working hours. A community consultation program should also be maintained throughout the construction period, as outlined in **Section 11.4.1**.

Any impacts from construction traffic will also be reduced following the major earthworks and dredging stage of the works, as heavy vehicle movements are likely to reduce to around 18 truck trips per day.

Piling

The potential for high construction noise levels may occur during piling activities. Two types of piling would be expected. Sheet piling would be used to construct a wall around the entire marina basin, and driven concrete piles would likely be used during construction of the marina berths.

Annoyance caused during sheet piling and driven-piling differs to that caused by other more continuous operations such as earth moving. Driven piling produces a series of very loud impact noises followed by periods of relative quite repeatedly throughout the period during which the pile is being driven (typically over a period of days). The number of piles has not been determined, though it would be expected sheet-piling activities should take about 4 months.

For this project, sheet-piling is likely to be undertaken almost continuously during working hours for a period of approximately 3-4 months from project commencement. Sheet piling typically generates higher noise levels, depending on the method used.

Typical A-weighted sound power levels (PWL) for the operation of various piling equipment is listed in *AS2436-1981 – Guide to Noise Control on Construction, Maintenance and Demolition sites*. Indicative maximum A-weighted noise levels for a 2.5-5 tonne drop hammer (or equivalent) have been used to provide an indication of the likely level of impact from driven piling. The resultant $L_{AMAXadj,\ T}$ construction noise levels at various distances from the works site, considered indicative of nearest residential receiver locations, are outlined in **Table 11-2**. Noise levels from vibratory piling is likely to be similar, but slightly louder, depending on the piling rig used.

■ Table 11-2 Calculated Indicative Noise Levels During Piling

Residence	$L_{AMAXadj,\ T}$ Noise Level (dBA)
50m	70
100m	64
200m	58
300m	53
400m	51

[#] Based on simplistic ENM model incorporating a nominal spectral distribution and +5 dB(A) penalty for impulsiveness, and -15 dB(A) base $L_{A,MAX}$ to $L_{AMAXadj,\ T}$ correction

[##] Based on simplistic ENM model, incorporating a nominal spectral distribution and –2 dB(A) for $L_{A,MAX}$ to $L_{AMAXadj,\ T}$ correction

The pile driving noise levels presented in **Table 11-2** are up to 20-30 dB(A) higher than the measured L_{A90} background noise levels at locations within 50-100 m of the works. The noise levels likely to result from sheet piling are likely to be slightly higher than those for driven piling. Given the expected 4 month duration of sheet pile driving activities, it is likely that a substantial loss of amenity will occur at nearby sensitive places, including residences, hotels and resort-style accommodation facilities, during this time.

Due to the progressive nature of the sheet piling works, noise levels from pile driving operations will vary at each sensitive receiver, declining as the piling rig moves further away from the residences.

Most residences and accommodation are further than 100m from any pile driving activities and at least 50m from the closest earthmoving activities. Given that activities in these areas will be much less than the total construction period of 9 months, these impacts will be short lived.

Noise control from piling activities will need to be investigated further during the detailed design stage of the works in order to determine if mitigation strategies are necessary. In-principal control measures for piling works are included in **Section 11.4.1**.

Noise Impacts on Marine Fauna

The major activities which will generate underwater noise emissions include dredging and piling.

Construction noise from pile driving has potential to cause temporary avoidance of the local area by mammals such as Dugong and whales. After the works are completed, mammals will return to the area. Turtles would only be affected by pile driving activities if they are kept from breeding sites during the breeding period (October to February) at night. Given that the area of Boathaven Bay is not a turtle breeding site due to its muddy intertidal zone, noise impact on turtles is unlikely.

Dredging operations are expected to increase levels of underwater noise in Boathaven Bay, possibly resulting in avoidance of the area.

Piling and dredging works are planned to occur primarily in the first nine months between April and December. Where possible, dredging activities should occur during winter (between May and September) to avoid disturbance to seabird and migratory wader feeding and fish reproductive seasons.

Summary of Impacts

The noise generated from construction works is likely to result in some loss of amenity for receivers located adjacent to Boathaven Bay, particularly during the sheet and driven piling activities. Due to the fact that the existing background noise levels (refer **Table 11-1**) vary between sensitive receiver locations, and the level and location of construction activities will vary throughout the construction period, the level of impact from construction works will also vary.

Following the major earthworks and dredging stage of the works, which is estimated to take an approximate 9 month period, any loss of amenity will be reduced due to a change in the types of activities being undertaken.

In order to mitigate the potential impacts from construction works, and minimise any potential financial effects resulting from a potential decline in tourist value of the area, management measures are recommended in **Section 11.4.1**.

11.2.3 Vibration

Overview

The construction program has the potential to result in vibration impacts at nearby sensitive receiver locations, and on buildings located within close proximity to the site. The level of vibration impact will vary, depending on the type of activity, the proximity to receivers and the intervening ground structure. Following is a preliminary assessment of potential vibration impacts resulting from construction works.

Vibration Criteria

British Standard 7385:Part 2-1993 *Evaluation and measurement of vibration in buildings Part 2*, outlines vibration thresholds which are set to protect buildings against damage caused from ground vibration. The levels are based on a minimum risk of vibration-induced damage and were set following an extensive review of UK and other national and international standards and data.

Table 11-3 lists the guidance values, outlined in BS 7385 Part 2, for transient vibration levels associated with minimal risk of cosmetic damage to residential and industrial buildings.

■ Table 11-3 Transient Vibration – Minimal Risk of Cosmetic Damage to Buildings

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

Reproduced from BS7385 Part 2 - 1993

These guidance levels relate to vibration effects from blasting, demolition, piling, ground treatments, construction equipment, tunnelling, road and rail traffic and industrial machinery. The Standard states that vibration levels which are more than double those listed in **Table 11-3** are likely to cause minor structural damage to a building, and values greater than four times these guideline values may result in major structural damage.

Compliance with the above criteria does not exclude the likelihood that the vibration will be detectable to residents or occupants of the building. Vibration can cause disturbance (and possible annoyance) to the occupants of buildings at levels significantly lower than the damage criteria for buildings. BS 6472:1992 *Evaluation of human exposure to vibration in buildings (1Hz to 80Hz)* provides guidance in assessing the impacts of vibration from construction works on humans in buildings. The standard relates annoyance from vibration to a dose at a particular vibration level. The human comfort criteria are based on levels associated with a "low probability of adverse comment".

The vibration threshold values listed in **Table 11-7** are based on BS 6472:1992, but have been adapted to take account of the non-continuous or impulse nature of pile driving operations. The Standard adopts a crest factor (peak to RMS level) of 1.4 which *has been determined empirically from typical vibration environments having low crest factors*. The vibration resulting from the driving of piles does not fall into that description, and based on previous experience a crest factor of 4 is more appropriate. The values listed in **Table 11-7** incorporate this crest factor of 4.

■ **Table 11-4 Construction Vibration Limits - Human Comfort (Velocity in mm/s)**

Occupancy / Location	Peak Limit (sinusoidal) Peak/RMS factor = 1.4	Peak Limit (Non Sinusoidal) Peak/RMS factor = 4
Residential	0.45	1.6
Offices	0.6	3.2
Workshops	1.2	6.4

Derived from BS6472:1992

The vibration criteria for protecting against human annoyance at the nearest residential dwellings and offices to the proposed marina development during pile driving works would be 1.6 mm/s and 3.2 mm/s respectively. During general earthmoving and filling works, the relevant criteria for residential dwellings and offices would be 0.45 mm/s and 0.6 mm/s respectively.

Likely Vibration Level Calculations

Table 11-3 provides indicative construction vibration levels that could potentially be generated during the fill and compaction works and the piling works associated with the proposed marina development. The likely vibration levels from earthworks and pile driving have been estimated at the nearest sensitive dwelling using average literature values for hydraulic hammers (*Hiller and Crabb 2000*) and vibratory rollers.

■ **Table 11-5 Indicative Vibration Levels During Construction**

Residence	Earthworks, Filling and Compaction works[#]	Pile Driving works
20 m	2 - 6	3.5 - 15
50 m	0.05 –3	0.9 - 4
100 m	0.01 – 0.6	0.3 - 2

[#] *range of literature measured and theoretical values for vibratory roller*
Source: Hiller and Crabb 2000

The actual vibration levels experienced during pile driving will depend upon the soil type (mix of sand, clay, rock etc) and the ground structure between the work site and receiver. The levels listed above are considered indicative of the range in levels that may be likely to occur.

Assuming that the nearest potential residential or commercial receiver to the site of the proposed construction works may be located within 50 m of the works, minor vibration impacts are likely to be experienced during the pile driving and site filling and compaction works carried out close to Shute Harbour Road. The vibration levels resulting from the operation of vibratory rollers and pile driving rigs are not likely to cause exceedance of the cosmetic damage vibration guidance values at these distances. However the vibration limits for human comfort may be exceeded to distances of up to around 50 m during pile driving works and potentially up to 50 m during the use of vibratory rollers during the fill compaction stage. Note that this will only be an issue when pile driving works are being undertaken close to Shute Harbour Road.

Summary

The vibration calculations show that pile driving operations for the majority of site works are not likely to cause exceedance of the cosmetic damage or human discomfort vibration guidance values (**Table 11-3** and **Table 11-4**) at the nearest residential or commercial dwelling. However, some impacts are likely during a portion of the construction works when activities are within 50 m of the dwellings.

It is recommended that following finalisation of the intended construction schedule, potential vibration impacts be investigated in more detail, in order to ascertain an appropriate mitigation and management strategy for the works. In-principle control measures for minimising construction vibration levels are provided in **Section 11.4.2**. The feasibility of implementing these should be examined to minimise the potential impacts of the piling and construction works, particularly during works located in close proximity to adjacent dwellings.

11.3 Potential Operational Impacts

11.3.1 Noise

Overview

The proposed marina development has the potential to result in noise impact at adjacent sensitive receiver places. The main noise sources would typically include mechanical plant, such as air conditioning and refrigeration systems associated with the main hotel, retail and commercial areas, noise from boat maintenance and building activities, noise from the licensed entertainment areas, and boat mooring noises. The potential impacts of these sources are discussed in the following sections.

Operational Noise Criteria

Environmental Protection (Noise) Policy 1997

The EPP (Noise) specifies an "acoustic quality objective" of achieving an ambient $L_{Aeq\ (24\ hour)}$ level of 55 dB(A) or less for the majority of Queensland's residential population. It is not correct to interpret it as a contributed noise criteria for specific activities or developments, instead it lists the issues that the administering authority must consider when making a decision with regard to development applications. These issues include:

- the characteristics of the noise from the noise-relevant activity;
- other noises ordinarily present at or near the relevant place; and
- any other information or other matter concerning the effect of the noise-relevant activity on the acoustic environment.

The User's Guide for the *Environmental Protection (Noise) Policy 1997* adds that the administering authority should also consider the:

- background level;
- ambient level;
- number of noise events emerging above the background;
- maximum sound pressure level of the events;
- characteristics of the noise emissions; and
- receiving environment.

Schedule 1 of the EPP (Noise) sets planning levels for road traffic noise at sensitive locations:

- 68 dB(A) for state controlled roads assessed as the $L_{A10\ (18\ hour)}$ level;
- 63 dB(A) for another public road assessed as the $L_{A10\ (18\ hour)}$ level;
- 60 dB(A) assessed as the highest 1 hour equivalent continuous A-weighted sound pressure level between 10.00 p.m. and 6.00 a.m.; and
- 80 dB(A) assessed as a single event maximum sound pressure level.

The Queensland Department of Main Roads (QDMR), in their document *Road Traffic Noise Management: Code of Practice* (January 2000) set noise level guidelines for state-controlled roads. Where the future amenity of a proposed residential development is likely to be impacted by road traffic noise, amelioration strategies outlined in Code of practice B6 should be taken into account as part of planning considerations for the project. Specific external noise levels are specified for habitable floors, balconies and external open space areas based on the existing measured noise levels.

No assessment of road traffic noise impacts has been made with respect to the QDMR code of practice, due to limited detail available on the design of the proposed residential, apartment and resort-style accommodation facilities. During the detailed design stage of these projects, the individual developers would undertake a noise impact assessment in accordance with the criteria outlined in Code of Practice B6, to ensure that road traffic noise levels to not have an adverse impact on the amenity of these dwellings. The assessment should consider appropriate noise attenuation measures, including buffers, reducing exposed window and doors and architectural design features.

Environmental Protection Regulation, 1998

The Queensland Nuisance Laws, developed under the *Environmental Protection Regulation, 1998*, provide limits for the operation of various items of plant, hand held tools and specific activities. **Table 11-6** provides an outline of relevant operational noise level and time limits for various activities associated with the proposed marina development, as outlined in Section 6 of the *EPR, 1998*.

Table 11-6 Operational Noise Limits for Particular Activities

Plant Item	Time Restriction	Limit on Audible Noise	Source
Air Conditioning Equipment	7 am - 10 pm 10 pm - 7 am	▪ 50 dB(A) ▪ 40 dB(A) or background + 5, whichever is highest	6Z *EPR, 1998*
Refrigeration Equipment	7 am - 10 pm 10 pm - 7 am	▪ 50 dB(A) ▪ the greater of 40 dB(A) or background + 5	6ZA *EPR, 1998*
Regulated Devices[1]	7 am - 7 pm, Monday – Saturday 8 am – 7 pm, Sunday & Public Holidays	▪ 50 dB(A) ▪ the greater of 40 dB(A) or background + 5	6X *EPR, 1998*
Amplifier Device (PA Systems	8 am-6 pm, Saturday, Sunday or Public Holiday 7 am-10 pm, business days other times	▪ background + 10 dB(A) ▪ background + 10 dB(A) ▪ no audible noise	6ZB *EPR, 1998*
Indoor Venues (sporting, musical or other entertainment, excluding educational institutions)	prior to 7 am any day 7 am-10 pm, any day after 10 pm any day	▪ no audible noise ▪ 50 dB(A) ▪ the lesser of 40 dB(A) or background + 10	6ZB *EPR, 1998*

[1]*Under the meaning of the EPR a regulated devices include: a compressor, a ducted vacuuming system, a generator, grass-cutter, impacting tool, leaf-blower, mulcher, oxyacetylene burner, electrical, mechanical or pneumatic power tool. This would cover boat repair and maintenance activities carried out at the marina facilities area.*

No specific limits exist for the movement of boats or rigging on boats into and out of moorings at a marina or use of a boat ramp. Operational limits and time restrictions do, however, exist for the operation of power boat engines at premises. **Table 11-7** summarises the requirements of Section 6ZE, *EPR 1998.*

■ **Table 11-7 Noise from Power Boat Engines at Premises**

Time Period	Noise Level Limit
6:30 pm – 8 am, Sundays and Public Holidays	no audible noise
7:00 pm – 7:00 am, Saturday or Business Days	no audible noise

The majority of the nuisance laws have been derived to minimise the occurrence of audible noise within the most exposed room of the nearest affected sensitive receiver, particularly during night-time hours, when sleep disturbance impacts may result.

Management of the boat ramp will be the responsibility of Whitsunday Shire Council and Council may choose to regulate the hours which the boat ramp is in operation. It should be noted that, in the event that a Stage 2 development is approved in the future, the boat ramp would be relocated further from any noise sensitive uses. This is likely to occur within 5-10 years of the commencement of the currently proposed development, provided that environmental and planning approvals for the Stage 2 development are granted.

Liquor Regulation 2002

Noise, including music and entertainment noise, from Licensed areas associated with retail and hotels, is currently controlled by the Liquor Licensing Division. Section 40 of the *Liquor Regulation 2002* prescribes limits for noise that constitutes unreasonable noise, as outlined in **Table 11-8**.

■ **Table 11-8 Noise from Licensed Premises**

Time Period	Noise Level Limit
6 am-10 pm	$L_{AMAXadj,T}$ (including adjustments for tonal and impulse components) must not exceed a level of background + 10 dB(A)
10 pm –6 am	L_{OCT10}, [#]in a full octave band with centre frequencies from 63 Hz to 200 HZ, shall not exceed a background (L_{OCT90} by more than 8 dB in any octave band

[#] *the linear (flat) frequency rating for a stated octave band that is equalled or exceeded for 10% of the specified time interval.*

Impact of Operations

As outlined above, the proposed marina development will involve a number of different uses including public use, commercial, tourism and accommodation. Noise emissions and Environmental Authority limits for each type of activity associated with the marina operation would be determined at the time that each individual business applies for an Environmental Authority for the development. No detailed noise prediction of the development as a whole has therefore been undertaken as part of this study. However, the noise level restrictions listed in **Table 11-6** to **Table 11-8** can be used as a general guide as to the likely maximum noise level emission resulting from each type of activity.

Noise from refrigeration units, air conditioning plant, ventilation fans, generators and the like can be controlled using acoustically designed plant rooms, strategically positioned barriers, duct silencers and the like. Detailed design of the individual buildings should allow for consideration of appropriate shielding from nearest sensitive receiver locations to enable the limits listed in **Table 11-6** to be satisfied.

Noise from the marina facilities would most likely involve the use of regulated devices, including hand held power tools, traveller cranes and the like. The use of these items would typically be restricted to the hours listed in **Table 11-6**, and would be intermittent in nature. Noise from any testing and maintenance of power boat engines at the workshop areas, would generally be restricted to the times listed in **Table 11-7**, if audible at the nearest sensitive place. The orientation of buildings at the marina facilities area will be determined such that these buildings provide maximum acoustic screening for adjacent properties. Noisy activities can also be carried out inside buildings or other enclosures if necessary to ensure that noise guidelines are met.

Particular attention will be required with respect to the use of potentially high impact devices such as circular saws and angle grinding tools. An indicative noise calculation, using the Environmental Noise Model, was performed to determine the likely noise levels resulting from the operation of an angle grinder, at the nearest potentially affected receiver, located approximately 80 m from the source. The model assumed the grinder was operating continuously, at maximum power, approximately 5-10 m from the ocean side of the marina buildings (assumed to be 3 m tall), approximately 1 m above sea level. The receiver was located at an elevation of approximately 12 m above sea level, overlooking the site. In reality, the power tools would not be operating continuously. The results presented below are therefore considered to be indicative of a worst case scenario.

The resultant $L_{AMAXadj,\ 15\text{-}minute}$ noise level from the operation of the angle grinder, incorporating a +5 dB(A) penalty for possible tonality, was approximately 48 dB(A) at the receiver (located 80 m from the source) when operating within 5m from the building. Given the fact that the topography of the surrounding land rises to residential receivers adjacent to the location of the proposed marina, the effectiveness any barrier protection provided by the buildings reduces as the source to barrier distance increases. The operation of an angle grinder at a distance of 10 m from the 3 m high building results in a calculated noise level of 56 dB(A) at the receiver (located 80 m from the source). The effectiveness of the building as an acoustic shield, when operating at 10 m from the façade, would be improved if the height of the building was increased, however other regulations outlining height restrictions for the development may inhibit this.

The existing L_{A90} noise levels recorded within the area adjacent to the site of the proposed marina, as outlined by WBM (1998), were between 50-53 dB(A) during the daytime hours. These noise levels were heavily influenced by road traffic noise along Shute Harbour Road. The operation of hand tools at the proposed marina, including angle grinders, is likely to generate audible noise at nearest receivers, located approximately 80 m away, and has the potential for annoyance impacts. Annoyance is not expected to be significant provided these operations are restricted to daytime hours and are carried out within close proximity to the site maintenance buildings (within 5 m) or within the buildings themselves.

In order to minimise possible regeneration of noise from reverberations within the building, the use of absorptive panels should be considered and testing of the reverberation time should be undertaken during the detailed design stage of the works. The use of absorptive panels (refer **Figure 11-2**), which are designed to minimise the passage of noise energy through them, would assist in reducing reverberation noise from the operation of angle grinders and hand tools within the building, and would also minimise the potential for adverse noise impacts at nearby sensitive receivers.

Noise from the use of privately owned and moored vessels at the marina would typically include boat motors as the vessels move in and out of the marina, clanging sounds from rigging ropes on masts and noise associated with humans visiting the area. At the time of preparation of this report, limited detail was available on the types of boats using the marina and ferry terminal, and the scheduled usage times for entering and leaving the marina. As such, a detailed assessment of noise impacts from this source has not been undertaken. In order to mitigate the potential impacts from vessel movements (including pleasure craft), management procedures for the mitigation of noise impacts would be included as part of the marina operational environmental management plan. Typical options for controlling noise from this potential source are included in **Section 11.4.1**

Public address systems may be installed within the commercial precincts and would be controlled to the levels outlined in **Table 11-6**. The potential for significant noise impacts from this source is not considered high for this proposal.

Potential Traffic Noise Impacts

As outlined in **Section 13**, the proposal is likely to generate traffic above the normal background growth levels. An indicative investigation of the potential effects of this change in traffic noise as a result of the proposal is provided below.

During the year 2010, the development is likely to generate approximately 1,600 vehicles trips per day along the section of Shute Harbour Road adjacent to the site access, compared with the forecast background level of approximately 14,800 vehicle trips per day. A change of this order would result in an increase of less than 1 dB(A), assuming a 6% heavy vehicle content, as for the existing situation. An increase in traffic noise of this order is not considered significant.

During the year 2020, the development is likely to generate approximately 1,860 vehicle trips per day along the section of Shute Harbour Road adjacent to the site access, compared with the forecast background level of approximately 26,500 vehicle trips per day. This would typically result in a change of approximately 0.5 dB(A), which is not considered significant.

Proposed management and mitigation measures for maintaining acceptable noise levels at nearby sensitive receiver locations are provided in **Section 11.4.1**.

11.3.2 Vibration

Vibration impacts are not expected to occur as a result of the operation of the proposed marina.

The proposal is not expected to generate significant traffic, above the natural background growth. As such, the proposal is not expected to generate significant vibration impacts from traffic and no formal assessment of traffic vibration impacts during operation of the proposed marina development has been made.

11.4 Mitigation Measures and Recommendations

11.4.1 Noise

Construction

As outlined in **Section 11.2.2**, construction works would be limited to the hours of 6:30 am-6:30 pm Monday to Saturday, where they are audible within any habitable room of a nearby sensitive place adjacent to the site. This includes no warming up or queuing of trucks outside the worksite before the specified hours.

The proposed construction works would be undertaken using best available means to limit noise intrusion from noise generating activities. This would typically include:

- performing regular maintenance of the construction vehicle fleet;
- use of the best practical available noise attenuation devices, such as residential grade mufflers on mobile plant and enclosures, shrouds or dampening devices for pile driving rigs for activities being conducted close to Shute Harbour Road and Coconut Grove. Particular attention should be given to minimising noise from piling activities, given the likely high noise levels generated and the extended duration of the proposed works. Further investigation into controlling noise from piling works should be undertaken during the detailed design stage of the works;
- Investigate the feasibility of restricting piling activities to hours of 8 am - 4 pm to minimise annoyance from this source;
- the use of dedicated on-site haulage routes;
- regular measurement of site equipment noise emission levels throughout the duration of construction works.

Should construction works be required outside of these hours, given the 9 month construction period, it is considered reasonable to limit construction noise levels to a level of background plus 10 dBA at the nearest sensitive place during the daytime hours and background plus 3 during the night. No pile driving works, or other similar high intensity noise sources, should be undertaken during night-time hours. This should be achievable, especially given that most of the works will take place more than 50m from any residences.

Operation

The operational environmental management plan for the proposed marina development should consider the potential impact of known regular activities, including scheduled vessel movements into and out of the marina and workshop / maintenance type activities. This would include potentially limiting the operational hours of ferry services, and the business hours for the proposed commercial facilities. In addition, limiting the speed of vessels entering and exiting the marina moorings would also minimise noise emissions from powerboat motors.

Noise from refrigeration, air conditioning plant and the like would be assessed and controlled, where necessary to meet relevant guidelines, during the detailed design stage of the works. Similarly, noise emissions from the use of hand tools, such as angle grinders, as part of the maintenance facilities, should be considered during the detailed design of the works. Due to the potential tonal emissions from these types of tools (utilising a constant speed motor) consideration of appropriate shielding within acoustically insulated buildings should be undertaken during the detailed design stage of the works. The noise controls would be designed by an accredited acoustic consultant in such a way as to ensure minimal break out noise from these sources.

11.4.2 Vibration

Construction

In order to minimise vibration impacts from fill and compaction and piling works at the nearest dwellings and sensitive places, a number of possible mitigation measures are possible:

- Consultation with the affected residents and community members prior to and during construction works would ensure residents would be aware of potential vibration impacts and that these remained acceptable;
- A detailed vibration impact investigation, including a dilapidation survey of dwellings located within 30 m of the works is recommended prior to the commencement of works. This would ensure that damage to the buildings from vibrations caused by the works would be maintained at a minimum;
- It may also be necessary to conduct vibration monitoring at dwellings during different phases of the works, to allow the effects of particular vibration levels to be monitored and further mitigation strategies developed and employed if necessary.

■ **Figure 11-2 Indicative Acoustic Controls for Building Panelling**