| Noise Source | Receiver | Predicted Noise Level | Noise Criterion | Meets Criterion? |
|---|---|---|---|---|
| Travel Lift – Diesel | 57C Lakeview Road, Morisset Park | 38 | **39** | ✓ |
| | Trinity Point Block A | 28 | **39** | ✓ |
| Travel Lift – Electric | 57C Lakeview Road, Morisset Park | 37 | **39** | ✓ |
| | Trinity Point Block A | 27 | **39** | ✓ |
| Hardstand Maintenance | 57C Lakeview Road, Morisset Park | 37 | **39** | ✓ |
| | Trinity Point Block A | 40 | **39** | ✗* **(See Section 6.3)** |
| Workshop | 57C Lakeview Road, Morisset Park | 16 | **39** | ✓ |
| | Trinity Point Block A | 20 | **39** | ✓ |

**Table 17:** Operational Boat Repair Noise Predictions – Receiver 2

## 5.3 Road Traffic Noise

Road traffic noise from the Trinity Point development has been assessed using predictions made at residential receivers along Trinity Point Drive and Henry Road. As discussed in Section 4.4, the majority of traffic movements from Trinity Point are expected to use Trinity Point Drive to access the site[8], although a component of traffic to/from the southern end of the site is expected to use Henry Road for access.

Traffic travelling on Morisset Park Road to/from the Trinity Point development must either use Trinity Point Drive or Henry Road to access the site. Trinity Point Drive and Henry Road are currently dead-end streets and therefore do not experience any significant through traffic. Therefore, the relative impact of the Trinity Point development on traffic noise levels is therefore expected to be greatest along Trinity Point Drive and Henry Road.

Predictions of peak traffic levels were obtained from the Traffic Assessment[18] conducted by Better Transport Futures for the Trinity Point development.

Predicted peak hourly traffic flows from the Trinity Point site are approximately 210 vehicles per hour, with this peak flow occurring during the PM peak hour. See the Traffic Assessment for more details regarding the traffic generation from the site.

No information as to the proportion of heavy vehicles included in this traffic flow was given, but a figure of 7% heavy vehicles was assumed to account for delivery vehicle movements (i.e. light trucks/vans) to and from the workshop and food service areas of the Trinity Point development. A traffic speed of 50 km/h was assumed.

Based on discussions with Better Transport Futures, 67% of the traffic flow from the Trinity Point development was assumed to use Trinity Point Drive to access the site, with the remaining 33% of the flow assumed to use Henry Road.

Traffic noise levels at the residential receivers along Trinity Point Drive and Henry Road were predicted using the *Calculation of Road Traffic Noise* (CoRTN)[19] methodology. Although developed in the UK, CoRTN has been widely validated for the prediction of road traffic noise in Australia, and is an appropriate method to obtain indicative traffic noise levels from the development.

18 Better Transport Futures (2007) Proposed Marina Development, Trinity Point NSW – Traffic Impact Assessment Report
19 United Kingdom Department of Transport (1988) – *Calculation of Road Traffic Noise*

CoRTN predicts a one-hour $L_{A10}$ single number value at a distance of 10 m from the edge of the road.

The residential receivers along Trinity Point Drive are approximately 7.5 m from the road edge. Residential receivers along Henry Road are set-back approximately 13 m from the road edge. Predicted traffic noise levels for each road were corrected to the appropriate source-receiver distance.

For continuous traffic flows, $L_{A10}$ has been found to be approximately 3 dB(A) higher than $L_{Aeq}$[4], and therefore the predicted $L_{A10}$ values have been corrected to $L_{Aeq}$ values using this correlation. It should be noted, however, that the correction was obtained for traffic at higher traffic speeds and the difference between $L_{A10}$ and $L_{Aeq}$ may be greater at low traffic flows. Therefore, the predicted traffic noise levels are expected to be conservative (i.e. actual traffic noise levels from the site may be lower than predicted).

Traffic noise level predictions are summarised in Table 18:

| Receiver Location | Predicted Noise Level $L_{Aeq,(1hr)}$ | Criterion $L_{Aeq,(1hr)}$ | Meets Criterion? |
|---|---|---|---|
| Trinity Point Drive | 63 | 60 | ✗(*) |
| Henry Road | 54 | 60 | ✓ |

**Table 18:** Predicted PM Peak Hour Traffic Noise Levels at Residential Receivers, dB re 20µPa.

*See Section 6.5 for a discussion of mitigation measures for traffic noise from Trinity Point.

## 5.4 Marina Vessel Noise

Noise from vessels within the marina itself has been assessed using previous measurements conducted by Arup Acoustics of noise from powerboats at low speed, with a measured value of 50 dB $L_{Aeq}$ at a distance of 25 m being used for prediction.

An estimate of the number of vessels likely to be manoeuvring in the marina at the same time was made based on information provided by Worley Parsons, based on previous environmental assessments for similar marina developments:

- Day: 11 vessels
- Evening: 4 vessels
- Night: 4 vessels

The SoundPLAN program was used to predict the noise level from a single vessel manoeuvring in the marina at surrounding noise-sensitive receivers using the CONCAWE noise propagation model. The prediction methodology was the same as for the construction noise predictions. The predicted noise levels for one vessel were then scaled to account for multiple vessels manoeuvring simultaneously.

Predicted noise levels from marina vessels are presented in Table 19:

| Receiver | Time Period | Predicted Noise Level | Criterion | Meets Criterion? |
|---|---|---|---|---|
| 57C Lakeview Road, Morisset Park | Day | 32 | 39 | ✓ |
| | Evening | 30 | 39 | ✓ |
| | Night | 30 | 35 | ✓ |
| 28 Pillipai Road, Windermere Park | Day | 28 | 39 | ✓ |
| | Evening | 27 | 39 | ✓ |
| | Night | 27 | 35 | ✓ |
| 52 Buttaba Road, Brightwaters | Day | 30 | 39 | ✓ |
| | Evening | 28 | 39 | ✓ |
| | Night | 28 | 35 | ✓ |
| Block A, Trinity Point | Day | 36 | 39 | ✓ |
| | Evening | 34 | 39 | ✓ |
| | Night | 34 | 35 | ✓ |

**Table 19:** Marina Vessel Noise Level Predictions, dB re 20μPa.

## 5.5 Entertainment Venue Event Noise

Event noise from entertainment venues, including the function room, is required to comply with the Casino, Liquor and Gaming Control Authority (CLGCA) noise criteria at the nearest residential receiver. The nearest residential receiver is Block A of the Trinity Point development, which is approximately 10-20 m away from the function room.

During detailed design of the Trinity Point entertainment venue(s), the building envelope design will be reviewed by a suitably qualified acoustic consultant to control noise emission from the function room and appropriate maximum sound levels for function room events will be established.

Appropriate management of events held in the entertainment venue(s) will also assist in controlling the noise impact of the venue(s). This may consist of measures such as restricting hours of events, limiting the noise output of audiovisual equipment or other measures as required.

## 5.6 Helicopter Noise

### 5.6.1 In-Flight Noise

Arup Acoustics was advised by Heli-Consultants Pty Ltd of models of helicopters that are likely to use the Trinity Point helipad. From these models, the Bell 407 helicopter was used as a ‘typical’ helicopter for assessment of the noise impact from the Trinity Point helipad. The Bell 407 is a single-turbine helicopter, and is a development of the Bell 206, which is one of the most commonly used civil helicopter types in Australia. Therefore, using the Bell 407 for assessment is expected to be indicative of the typical operation of the Trinity Point helipad.

Measurements of the Bell 407 Helicopter were conducted to obtain source levels for use in the prediction of helicopter noise levels. These measurements were generally conducted in accordance with AS2363[20], using ‘fast’ time response, and consisted of sample measurements of the sound exposure level ($L_{AE}$) and maximum noise level ($L_{max}$) from the

[20] Australian Standard AS2363 (1999) – Acoustics – Measurement of noise from helicopter operations.

Bell 407 helicopter under different flight profiles. Measurements were conducted simultaneously at two measurement locations (under the helicopter flightpath and offset on the tail rotor side of the helicopter) to account for the directivity characteristics of the helicopter.

For details of the measurements, see Appendix C.

The measurements of the Bell 407 in the take-off, approach and flyover flight modes were used as the source levels for prediction.

Source levels used for predictions are presented in Table 20. These source levels are energy-averaged levels from measurements of the helicopter noise at the two measurement positions, as required by AS2363, and therefore account for the directional nature of the helicopter noise source.

The levels are normalised to a distance of 100 m from the helicopter to allow comparison between the noise emission characteristics of the Bell 407 helicopter in the different flight modes.

The measured levels from the ‘front’ measurement location (i.e. under the helicopter flightpath; see Appendix C) have been compared to noise certification data for the Bell 206-L and Bell 407 quoted in accordance with Appendix H of Part 36 of the US Federal Aviation Administration (FAA) Federal Aviation Regulations (which is also measured under the helicopter flightpath, as well as on either side of the flightpath for some measurements).

The measured levels have also been compared to the source data available in the US FAA Integrated Noise Model (INM) computer program. In general, the measured noise levels are conservative (i.e. higher) compared to the FAA Appendix H and INM levels.

| **Flight Mode** | **Sound Exposure Level $L_{AE}$ at 100 m** | **Maximum Noise Level $L_{max}$ at 100 m** |
|---|---|---|
| Takeoff | 93 | 84 |
| Approach | 94 | 86 |
| Flyover | 87 | 84 |
| Start-Up/Idle/Shutdown | 84 | 70 |

**Table 20:** Helicopter Noise Levels used for Predictions, Bell 407 Helicopter Measurements, dB(A) re 20 μPa

It is proposed to have 4 movements per day from the Trinity Point helipad. Arup Acoustics understands that a helicopter ‘movement’ is defined to be a single takeoff or landing from the helipad.

The figure of 4 movements per day results in a maximum of 28 helicopter movements per week, which is below the 30 movements per week threshold for the helipad requiring an Environment Protection Licence under the terms of the Protection of the Environment (Operations) Act.

Helicopter noise predictions were made using flight path details provided by Heli - Consultants Pty Ltd. It is understood that the flight path consists of an approximately 9° approach/descent from the helipad, up to an altitude of approximately 300 m (~1000 ft), which is the legal cruise altitude.

Noise levels have been modelled as the ‘approach’ noise levels for the entire ascent/descent below the 300 m cruise altitude (as these levels are numerically higher than the measured ‘takeoff’ noise levels for the Bell 407 helicopter), and ‘flyover’ noise levels once the helicopter reaches the 300 m cruise altitude. This approach satisfies the requirements of the DGEARs to assess noise from the take-off, approach and "en-route" (i.e. flyover) of helicopters from the development.

The SoundPLAN program was used to predict noise levels at individual receivers in order to assess helicopter noise impact from the development.

Helicopter operations consist of several separate noise events per day, with noise emission represented by a moving noise source that follows the flight path.

When assessing average ($L_{Aeq,24h}$) noise levels from the helicopter movements, it is appropriate to model the flightpath itself as a line noise source, averaging the helicopter noise emissions over the flightpath.

However, when assessing the $L_{Amax}$ maximum noise levels, the maximum noise level at each receiver will result from a single helicopter position (a point source of noise) along the flightpath.

The CONCAWE model was used to model the helicopter noise emission, with the helicopter flightpath modelled as an emission line, with $L_{max}$ levels modelled as a point source. The source sound power levels were calculated from the measured Bell 407 noise levels.

Noise levels were predicted for "downwind" noise propagation conditions, with Pasquill Stability Class 'D' environmental conditions. This results in 'Category 6' propagation conditions under the CONCAWE model, which results in the greatest increase in noise levels compared to "neutral" conditions, and is therefore a "worst case" prediction.

Predicted helicopter noise levels at noise-sensitive receivers are presented in Table 21**Error! Reference source not found.** and Table 22, for the Bell 407 helicopter under "downwind" meteorological conditions. All noise-sensitive receivers are 1.5 m above local ground level.

| Receiver Number | Receiver | Predicted Noise Level, $L_{Aeq,24hr}$ Downwind | Noise Criterion | Meets Criterion? |
|---|---|---|---|---|
| 1 | Block C, Trinity Point | 48 | **50** | ✓ |
| 2 | 57C Lakeview Road, Morisset Park | 43 | **50** | ✓ |
| 3 | 6 Macquarie Road, Morisset Park | 42 | **50** | ✓ |
| 4 | 6 Lakeview Road, Morisset Park | 45 | **50** | ✓ |
| 5 | 28 Pillapai Road, Windermere Park | 50 | **50** | ✓ |
| 6 | Brightwaters Christian College | 47 | **50** | ✓ |
| 7 | 34 Bulgonia Road, Brightwaters | 45 | **50** | ✓ |
| 8 | 52 Buttaba Road, Brightwaters | 45 | **50** | ✓ |
| 9 | 6 Dandaraga Road, Brightwaters | 42 | **50** | ✓ |
| 10 | 11 Omaru Place, Summerland Point | 44 | **50** | ✓ |
| 11 | 14 Scott Road, Vales Point | 33 | **50** | ✓ |
| 12 | 39 Henry Road, Morisset Park | 39 | **50** | ✓ |
| 13 | 34 Rhodes Parade, Windermere Park | 42 | **50** | ✓ |
| 14 | 57 Asquith Avenue, Windermere Park | 42 | **50** | ✓ |
| 15 | 117 Grand Parade, Bonnells Bay | 39 | **50** | ✓ |
| 16 | 21 Riesling Road, Bonnells Bay | 48 | **50** | ✓ |
| 17 | 16 Wilson Street, Bonnells Bay | 45 | **50** | ✓ |
| 18 | 5 Lakeside Close, Bonnells Bay | 43 | **50** | ✓ |
| 19 | 63 Waikiki Road, Yarrawonga Park | 38 | **50** | ✓ |
| 20 | 2 Yoorala Road, Yarrawonga Park | 33 | **50** | ✓ |
| 21 | 4 Kimbul Road, Brightwaters | 40 | **50** | ✓ |
| 22 | 30 Mirrabooka Road, Mirrabooka | 36 | **50** | ✓ |
| 23 | 205 Dandaraga Road, Mirrabooka | 36 | **50** | ✓ |

**Table 21:** Average Noise Levels, Bell 407, dB re 20μPa

| Receiver Number | Receiver | Predicted Noise Level, $L_{Amax}$ Downwind | Noise Criterion | Meets Criterion? |
|---|---|---|---|---|
| 1 | Block C, Trinity Point | 77 | **95** | ✓ |
| 2 | 57C Lakeview Road, Morisset Park | 71 | **95** | ✓ |
| 3 | 6 Macquarie Road, Morisset Park | 68 | **95** | ✓ |
| 4 | 6 Lakeview Road, Morisset Park | 74 | **95** | ✓ |
| 5 | 28 Pillapai Road, Windermere Park | 82 | **95** | ✓ |
| 6 | Brightwaters Christian College | 77 | **95** | ✓ |
| 7 | 34 Bulgonia Road, Brightwaters | 73 | **95** | ✓ |
| 8 | 52 Buttaba Road, Brightwaters | 74 | **95** | ✓ |
| 9 | 6 Dandaraga Road, Brightwaters | 68 | **95** | ✓ |
| 10 | 11 Omaru Place, Summerland Point | 73 | **95** | ✓ |
| 11 | 14 Scott Road, Vales Point | 59 | **95** | ✓ |
| 12 | 39 Henry Road, Morisset Park | 64 | **95** | ✓ |
| 13 | 34 Rhodes Parade, Windermere Park | 69 | **95** | ✓ |
| 14 | 57 Asquith Avenue, Windermere Park | 70 | **95** | ✓ |
| 15 | 117 Grand Parade, Bonnells Bay | 69 | **95** | ✓ |
| 16 | 21 Riesling Road, Bonnells Bay | 79 | **95** | ✓ |
| 17 | 16 Wilson Street, Bonnells Bay | 77 | **95** | ✓ |
| 18 | 5 Lakeside Close, Bonnells Bay | 74 | **95** | ✓ |
| 19 | 63 Waikiki Road, Yarrawonga Park | 65 | **95** | ✓ |
| 20 | 2 Yoorala Road, Yarrawonga Park | 60 | **95** | ✓ |
| 21 | 4 Kimbul Road, Brightwaters | 67 | **95** | ✓ |
| 22 | 30 Mirrabooka Road, Mirrabooka | 60 | **95** | ✓ |
| 23 | 205 Dandaraga Road, Mirrabooka | 61 | **95** | ✓ |

**Table 22:** Maximum Noise Levels, Bell 407, dB re 20μPa

Noise levels were also predicted at Block C of the Trinity Point development, which is the closest area of the development to the helicopter flightpath.

#### 5.6.2 On-Ground Noise

Noise levels for helicopters while on the landing pontoon were also predicted from the measured data from the Bell 407 presented in Appendix C and Table 20.

Noise levels at the nearest noise-sensitive receivers have been calculated using the SoundPLAN program and the CONCAWE model. Because flight operations are to be restricted to the hours of 8:00 am, to 6:00 pm, only the 'Day' industrial noise criterion would apply.

Due to the small number of flights per week, no more than two “on-ground” events (each event being either a start-up or a shutdown) are expected to occur in any 15-minute period.

Predicted ‘industrial’ noise levels from the helipad are presented in Table 23.

| Receiver | Time Period | Predicted Noise Level, $L_{Aeq,15min}$ | INP Criterion | Meets Criterion? |
|---|---|---|---|---|
| 57C Lakeview Road, Morisset Park | Day | 31 | 39 | ✓ |
| 28 Pillipai Road, Windermere Park | Day | 27 | 39 | ✓ |
| 52 Buttaba Road, Brightwaters | Day | 38 | 39 | ✓ |
| Block A, Trinity Point | Day | 39 | 39 | ✓ |

**Table 23:** Helipad ‘On-Ground’ Noise Level Predictions, dB re 20μPa.

# 6 Assessment of Effects

## 6.1 Internal Noise Levels

The Trinity Point development will be designed to achieve the internal design sound levels and reverberation times given in Section 4.1. During the detailed design of the development the sound insulation between internal spaces of the development will be designed to achieve appropriate acoustic privacy and achieve the minimum requirements of the Building Code of Australia for Sound Insulation.

The predicted maximum helicopter noise levels at Block C of the Trinity Point development given in Table 22Error! Reference source not found. should be used to design the building envelope to control helicopter noise intrusion, with reference to AS2021[21].

Detailed design of the Trinity Point Development to achieve these requirements will achieve compliance with the BCA and relevant Australian standards such as AS2107.

## 6.2 Construction Noise

The predicted construction noise levels from the Stage 1 construction of the Trinity Point development are predicted to exceed the ENCM construction noise criteria by up to 11 dB(A), and either comply with the DECC Draft Guideline criteria or exceed by up to 6 dB(A). Construction of the travel lift/hardstand area is predicted to have the highest noise levels at the nearest residential receiver.

The noise impact of Stages 2, 3 and 4 is expected to be reduced compared to Stage 1, due to the smaller scope of construction activities, but may still exceed the construction noise criteria.

In part, the construction noise impact is increased by the existing low background noise levels surrounding the site, which mean that a given level of construction noise will be more intrusive than in a site with higher background noise levels.

Indeed the level of construction noise from the various construction activities is predicted to be between 40 -50 dB(A) at the nearest receivers, which is not considered to be excessive in absolute terms, and the predicted levels are significantly below the “highly noise affected level” of 75 dB(A) given in the DECC Draft Guideline. A noise level of 40-50 dB(A) is approximately the same as the background noise level in a typical open-plan office space.

The Rating Background Level (RBL) values that the construction noise criteria are based on typically represent the “minimum repeatable” background noise during the day time period. As can be seen from the logger graphs in Appendix B, the background levels during the day time period vary, and at times when the “immediate” background noise level is higher the relative impact of the construction noise source will be reduced.

The measured $L_{A90}$ noise levels from the attended noise survey (measured during approximately 11:00 am to 3:00 pm) are in the range 42 dB(A) to 46 dB(A) (from Table 2), which would mean that the maximum predicted construction noise levels (50 dB(A)) would be only approximately ~5-10 dB(A) above background during the middle of the day.

Therefore, by restricting the hours of construction to times when the background noise is higher, it may be possible to significantly reduce the “relative” impact of the predicted construction noise levels.

### 6.2.1 Mitigation Measures

The ENCM provides no guidance on procedures to mitigate exceedances of construction noise; however, the DECC Draft Guideline provides a methodology for mitigating the construction noise impact from a project, and gives details of recommended noise control measures to minimise the noise impact.

21 Australian Standard AS2021 (2000) Acoustics – Aircraft noise intrusion – Building siting and construction

AS2346[14] and BS5228[15] also provide guidelines for controlling the construction noise impact from the development.

Table 4.1 of the DECC Draft Guideline states that where the predicted construction noise level is greater than the "noise affected level", all feasible and reasonable work practices should be applied to minimise noise.

Section 6 of the Draft Guideline presents options for work practices that may be followed to reduce the construction noise emission from a site, including a list of "universal work practices" that should be adopted for all construction sites, as well as supplementary practices which may be adopted as appropriate for each construction site.

The following work practices are recommended to be followed to minimise the construction noise impact from Trinity Point. These practices have been adapted from the Draft Guideline, supplemented by guidance from BS5228 and AS2436, the NSW Transport Infrastructure Development Corporation (TIDC) *Construction Noise Policy (Rail Projects)* and Arup Acoustics' previous experience with construction noise control. These work practices may be suitable for incorporation into a construction noise management plan.

- Workers, delivery drivers and contractors on site should be regularly trained (e.g. during site inductions and at regular toolbox talks) to use equipment in ways which minimise noise, and be made aware of the need to minimise noise from the site
- Minimise shouting, loud conversations, swearing, dropping of materials from height, and slamming of car doors on site
- Radios/stereos should not be used outdoors if they are audible at the site boundary
- Site managers should periodically check the site and nearby residences for noise problems so that control measures can be quickly applied
- Surrounding residents should be notified before the commencement of construction works with details of the construction process, including total expected duration of construction, type and duration of "noisy" works, measures that are being followed to minimise noise, and what respite periods from noise will occur.
    - Noise-sensitive receivers that are predicted to experience an exceedance of the DECC Draft Guideline construction noise criteria should be notified by phone call of impending construction activities.
    - Residential properties around Bardens Bay (the suburbs of Morisset Park, Windermere Park and Brightwaters) should be notified of impending construction activities by a letterbox drop.
- A site information board should be provided at the entrances to the Trinity Point site with contact details for the site manager, hours of operation of the site and regular information updates
- A toll-free contact phone number and a website should be provided for enquiries and complaints handling
- A documented complaints pro-forma, complaints register and complaints handling procedures (including an escalation procedure in the event that a complainant is unhappy with the response) should be prepared and followed
- Complaints should be responded to promptly
- Plant used on site should be selected to be the quietest plant and equipment available. No equipment used on site should exceed the maximum noise levels (measured at 7 m distance) given in Schedule 1 of the City of Sydney *Construction Hours/Noise within the Central Business District* Code of Practice 1992.

- Alternate work methods to reduce construction noise should be considered, and implemented where feasible, during the planning of the construction works. Examples include substituting vibratory or hydraulic piling for impact piling; hydraulic splitters instead of rockbreakers; electric or hydraulic-powered equipment instead of diesel/petrol or pneumatic equipment.
- Work in the immediate vicinity of residential receivers should be conducted with hand tools only, wherever feasible.
- Stationary equipment, such as pumps, generators or compressors, should be mounted in acoustic enclosures or be acoustically screened. Examples of screens/enclosures for construction equipment are given in Appendix F of AS2436.
- All plant and equipment should be regularly maintained and inspected to ensure that noise-control devices are working properly. Engine access panels/hatches should be kept closed at all times. Door seals on equipment access panels/hatches should be checked to ensure they are in good working order
- Residential-grade exhaust mufflers/silencers should be fitted to mobile plant/equipment
- Plant and equipment should be shut down when not in use. Vehicles and/or equipment should not be left idling on site.
- Where feasible, all construction activities should be acoustically screened. Temporary or permanent acoustic screens should be used at the site boundary, around work areas, or at the boundary of noise-sensitive receivers
- Site planning should locate noisy activities and equipment as far away from residential premises as possible, and should plan the site to minimise noise. For example, materials stockpiles, stationary equipment or fabrication areas should be located away from residential premises, and site offices and/or shipping containers may be used for screening.
- Access routes to the site and internal site layout should be designed to minimise reversing movements.
- Deliveries to the site should be planned to minimise the overall number of vehicle movements
- All equipment used on site should be fitted with non-tonal reversing alarms – e.g. “smart alarms” which adjust volume based on the ambient noise level, or broadband alarms which do not emit a tonal “beep”
- Noisy construction activities (e.g piling, rockbreaking) should be scheduled during times when noise impact on residents or other sensitive receivers is likely to be lowest, e.g. No heavy work before 09:00, or during school examination periods
- Noisy activities should be scheduled around times of higher background noise (e.g. during peak traffic flows or when other local noise sources are active) where possible to provide a degree of noise masking to these events or to reduce the amount that the construction noise intrudes above the background.
- Respite periods should be incorporated during the day or at weekends where no noisy construction work can take place. These periods should be determined through consultation and negotiation with affected stakeholders.
- Attended noise monitoring should be conducted at the most-affected noise-sensitive receivers for each construction operation (see Table 15) at the commencement of each component of construction.

In accordance with the requirements of Lake Macquarie City Council’s DCP No.1, the construction works for Stage 1 require a Noise Management Plan to be filed, as the construction period is in excess of 26 weeks duration. This Noise Management Plan should be prepared by an accredited acoustic consultant. The management measures contained in this section should be considered for inclusion in the noise management plan.

Stages 2-4 of the construction works are scheduled to be less than 26 weeks duration, and therefore may not require a Noise Management Plan to be filed. However, given the close proximity of the nearest noise sensitive receivers to the construction works, it is recommended that a noise management plan to be prepared for these stages of the works.

During these stages, internal receivers within the Trinity Point development will be sensitive to noise from the construction works, and therefore the construction noise management plan should consider minimising the construction noise impact for internal as well as external receivers.

All stages of construction works should incorporate all feasible and reasonable noise mitigation measures in order to control the noise impact of the development on the surrounding noise sensitive receivers.

## 6.3 Boat Repair Noise

Predicted noise levels from the boat repair operations show that the maintenance operations on the hardstand and the repair operations in the workshop are likely to comply with the industrial noise criteria.

Noise levels at Block A of the Trinity Point development are predicted to exceed the criteria by 1 dB(A), however this is a marginal exceedance and a difference of 1 dB(A) in noise level is considered to be imperceptible. There is also scope to reduce noise levels from the hardstand maintenance activities by using portable acoustic screens around areas where maintenance activities occur.

Noise from the travel lift was predicted to comply with the noise limits at all receivers, for both powerplant options being considered (diesel engine with high-performance exhaust mufflers; and electric motor).

Care should be taken during selection of the boat repair equipment with consideration to the noise emission of the selected equipment. This is especially important for the travel lift engine, which should be selected to minimise noise emissions, regardless of whether diesel or electric drive is used. The sound power levels given in Table 16 may be used for guidance during selection of equipment.

## 6.4 Mechanical Plant Noise

The mechanical services of the Trinity Point development have not been designed at this stage. Noise control treatments will be incorporated into the design of the mechanical systems so that the 35 dB $L_{Aeq,15min}$ industrial noise criterion is met at all noise sensitive receivers.

During detailed design of these systems, noise control measures, such as acoustic enclosures or louvres and attenuation, will be incorporated where necessary to ensure that the industrial noise criteria for noise from these systems are met.

## 6.5 Road Traffic Noise

The predicted road traffic noise levels on Trinity Point Drive resulting from traffic generated from the Trinity Point site are 63 dB $L_{Aeq(1h)}$, which is 3 dB(A) in excess of the 60 dB $L_{Aeq(1h)}$ noise target. Therefore, in accordance with the ECRTN, “feasible and reasonable” mitigation measures are required to be applied to reduce the traffic noise impact for residential receivers on Trinity Point Drive.

Traffic noise levels on Henry Road are predicted to be 54 dB $L_{Aeq(1h)}$, which is 6 dB(A) below the 60 dB $L_{Aeq(1h)}$ noise target. Therefore, no further mitigation measures are considered necessary for Henry Road.

It should be noted that the predicted noise levels are likely to be conservative, and therefore noise levels may be less than predicted; however

The predicted noise levels are increased by the presence of heavy vehicles in the peak traffic flows, and therefore reducing heavy vehicle movements in peak periods may assist in reducing the traffic noise impact. Where possible, deliveries and other heavy vehicle movements to site should be rescheduled to occur outside peak traffic periods.

Reducing the speed of vehicles on Trinity Point Drive, either by changing the posted speed limit or the use of traffic calming devices (such as chicanes) may also assist in reducing traffic noise levels from the development.

Further noise control measures for traffic noise from the Trinity Point development are limited due to the nature and scope of the development and surrounding area.

Use of low-noise pavements is not considered feasible for controlling traffic noise from the development as the low speed of traffic from the development (anticipated to be 50 km/h) means that the traffic noise emission will be dominated by engine noise rather than tyre noise. Low-noise pavements are only effective for reducing the tyre noise component of road traffic noise, which is typically only dominant above 70 km/h.

Noise barriers are not considered feasible or reasonable, as Trinity Point Drive and Morisset Park Road pass through residential areas and a continuous barrier would block access to residential premises and cause a significant visual impact. Breaking up a barrier to allow access to driveways of residential properties would significantly degrade the acoustic performance of the barrier to the point where

The mitigation measures considered for traffic on Trinity Point Drive are summarised in Table 24.

| Mitigation Measure | Feasible? | Predicted Noise Reduction | Reasonable? |
|---|---|---|---|
| Scheduling heavy vehicle deliveries outside peak hours | Yes | 3 dB(A) | Yes |
| Reducing Traffic Speed | Yes | 1 dB(A) | Yes |
| Noise Barriers | No | N/A | N/A |
| Low-Noise Pavement | No | N/A | N/A |

**Table 24:** Traffic Noise Control Measures considered for Trinity Point Drive

With delivery vehicle movements scheduled outside of peak hours, the predicted noise level at the receivers on Trinity Point Drive is 60 dB $L_{Aeq(1hr)}$, which is equal to the ECRTN target.

Further noise reduction, if desired, could be achieved by implementing traffic calming devices on Trinity Point Drive or by changing the posted speed limit; however the additional benefit of these measures is only predicted to be 1 dB(A), which is a marginal benefit.

Therefore, it is recommended that traffic noise from the Trinity Point development be controlled by restricting delivery vehicle movements to outside of the peak traffic flows. This should be documented and managed as part of the day-to-day operation of the development.

## 6.6 Marine Vessel Traffic Noise

There are currently no numerical noise criteria for marine vessel traffic resulting from a development. The Protection of the Environment Operations (Noise Control) Regulations[22] stipulate that marine vessels are not to emit offensive noise, but the definition of offensive noise does not provide a numerical criterion for assessment.

It is considered reasonable to restrict consideration of the noise impact of vessels from the Trinity Point site to noise from vessels within the site itself. Once vessels leave the marina area (i.e. once vessels are outside of the area enclosed by the breakwater and the marina access channel) any offensive noise emitted by these vessels is the liability of the vessel's owner[22], and therefore it is not considered reasonable to assess this source of noise as part of this environmental assessment.

The Industrial Noise Policy has been applied in previous marina assessments for noise resulting from within the marina itself, but would not be applicable once vessels depart the immediate marina area.

Predicted noise levels at surrounding receivers from low-speed boat operations in the marina area are significantly below the industrial noise criteria.

It is recommended that administrative controls be used to control the noise from vessels within the marina area.

Restrictions on the speed of vessels, combined with no-wash zones within the marina itself are considered to be suitable in reducing the noise impact of vessels within the marina. It is understood from discussions with Worley Parsons that to comply with a no-wash zone, the maximum speed of vessels in the marina would be approximately 4 knots. Signage reminding marina users of the need to reduce noise at surrounding premises may also be appropriate.

A marina noise management plan (potentially incorporating a code of conduct for marina users) may be a useful management tool to formally establish these management measures. It is recommended that a noise management plan for the marina be developed and adopted by the Trinity Point development.

It is considered that the overall noise impact of the marine vessel traffic due to the Trinity Point development is minimal and can be satisfactorily controlled by administrative measures.

## 6.7 Helicopter Noise

The helicopter noise levels predicted in Section 5.6 comply with the AirServices Australia helicopter noise criteria and the INP industrial noise criteria at all receivers. At Receiver 5, 28 Pillapai Road, Windermere Park, which is the most-affected residential receiver for helicopter noise, the $L_{Aeq,24h}$ noise level complies with the criterion of 50 dB(A).

Nevertheless, these noise predictions are considered to be 'worst-case', as they were for adverse meteorological conditions that will increase the noise levels at the receivers. However, the predicted levels mean that some helicopter types may be excluded from the helipad on acoustic grounds, or else may only be able to operate for a reduced number of flights per day.

In general, smaller single-engine helicopters, such as the Bell 206 and Eurocopter AS350 have similar Appendix H certification noise levels to the Bell 407 and therefore noise levels from single engine helicopters are not expected to exceed the noise criteria during normal use of the site.

[22] NSW Government (2008) Protection of the Environment Operations (Noise Control) Regulation

However, the $L_{Aeq}$ criterion does impose restrictions on the number of helicopter movements allowable each day. These restrictions would apply to all helicopter operations using the helipad, including joy flights as well as transport movements.

The proposed noise criteria include restrictions on helicopter movements outside the hours of 8 am – 6 pm except for emergency flights. However, as the Trinity Point development is not a medical facility, it is anticipated that emergency helicopter movements would only occur in the event of an emergency either within the development or in the immediate area, and are likely to be infrequent, isolated events.

The noise impact on residential acoustic amenity resulting from the helipad operations at Trinity Point is within the guidelines of AirServices Australia. However, due to the low background levels in the area helicopter noise is likely to be clearly audible above the ambient noise environment.

To minimise the noise impact of helicopter operations, it is recommended that the types of helicopter and the number of helicopter movements per day be restricted so that no more than four helicopter movements are allowed in one day, except under emergency conditions. This is predicted to result in $L_{Aeq,24hr}$ values at all receivers within the recommended range given by AirServices Australia.

Based on the Appendix H noise certification levels, the following helicopter types are expected to be suitable for use at the Trinity Point helipad without exceeding the noise criteria:

- Agusta A109 A/C/E
- Agusta A119
- Eurocopter AS350
- Eurocopter AS355
- Eurocopter BO105
- Eurocopter EC120
- Eurocopter EC135
- Robinson R22/R44
- Schweizer 300
- Enstrom EF28/EF280
- Bell 206/206-L
- Bell 407
- Bell 427

If it is intended to allow access by future or different helicopter types not included in the above list at the Trinity Point Marina helipad, then the party proposing to use the different type should be required to provide the FAA Part 36 Appendix H (or ICAO Technical Annex 16) certification noise data for that helicopter type to the marina operator.

If the noise levels thus submitted are equal to or less than those published for the Bell 407, then that new helicopter type should be added to the list and allowed to operate at that site.

If any of the certification levels for the new type exceed the respective levels published for the Bell 407, then supplementary acoustic testing should be conducted to measure the noise levels and determine whether that new type can be operated at Trinity Point - and, if so, whether a reduced number of daily movements for the new types may be required to ensure continued compliance with the noise acceptability criteria.

The Director-General of the Department of Planning's requirements for the Trinity Point development also require an assessment of the noise impact of helicopter operations on land and aquatic fauna and on aquatic flora. This assessment is presented in the following sections.

#### 6.7.1 Impact on Land Fauna

Studies of the impact of aircraft noise on land fauna, and of helicopter noise in particular, have not been conclusive in establishing numerical levels at which damage to land fauna may occur. However, studies have concluded that high levels of aircraft noise can have a detrimental effect on the health of animals, through a combination of direct physical damage, masking crucial audible information such as mating calls or predators, and by causing high levels of stress and/or behavioural changes.

Most studies have involved very high noise levels or extended continuous exposure to high levels of noise, at noise levels which human receivers would likely find distressing or offensive. Therefore, it is difficult to conclude from the available research the levels at which noise-related damage to land fauna occurs.

This is compounded by the fact that most research has been conducted on overseas species of animals, and that the findings from one species may not be able to be extrapolated to another species, even if closely related.

However, the US Department of the Interior, in conjunction with the US Air Force, has presented a summary of the effects of aircraft noise on wildlife[23], which suggests that airborne sound levels above 90 dB(A) are "likely to be adversive to mammals".

As an initial assessment, it is considered appropriate to set an assessment level of 90 dB $L_{Amax}$ as a noise guideline for noise from helicopters at areas of sensitive habitat.

The maximum predicted noise level from the helicopter operations over land is 82 dB(A), occurring at Receiver 5 (82 Pillipai Road, Windermere Park) which is situated in a residential area and is directly under the proposed helicopter flightpath. The noise levels at all other land locations within the study area are less than this 82 dB(A) maximum level, including areas within the Lake Macquarie State Conservation Area located to the west of the Trinity Point site. All locations are therefore expected to experience noise levels below the 90 dB(A) fauna noise guideline.

#### 6.7.2 Impact on Aquatic Flora and Fauna

Underwater noise levels resulting from airborne noise levels are typically negligible, and therefore no significant noise impact on aquatic flora or fauna is expected.

The air-water interface is a very good reflector of acoustic energy. The acoustic impedance of water is approximately 3600 times the acoustic impedance of air, and therefore at the air-water interface 99% of the acoustic energy contained in an incident sound will be reflected and only 1% transmitted to the water.

The maximum noise level at water level is predicted to occur in the immediate vicinity of the helipad on Bardens Bay, and is approximately 107 dB $L_{Amax}$.

When converted to an underwater sound level, this is approximately 134 dB re 1μPa (just under the surface). Note that the reference sound level underwater is 1μPa, as opposed to 20μPa in air, and therefore underwater sound levels cannot be directly compared with airborne sound levels.

Studies of underwater impacts of human-generated (anthropogenic) noise have not produced firm conclusions as to the levels at which damage to underwater species will occur. Additionally, the auditory characteristics of different underwater species can be quite variable, with different species of fish having substantially different hearing characteristics.

23 US Air Force Engineering and Services Center & US Department of the Interior Fish and Wildlife Service (1988) – *Effects of Aircraft Noise and Sonic Booms on Domestic Animals and Wildlife: A literature synthesis*. NERC 88/29

Some species of fish (such as trout) are only sensitive to low-frequency sound, whereas other species have extensive high-frequency hearing. Similarly for airborne noise, when underwater sound exceeds 90 dB above the hearing threshold of the species (i.e. 90 $dB_{ht\ (Species)}$, expressed using the $dB_{ht\ (Species)}$ metric, which weights noise levels according to the hearing characteristics of the species – analogous to the dB(A) metric for humans), it is "likely to cause significant behavioural effects and in particular avoidance"[24].

Therefore, adopting a criterion of 90 $dB_{ht\ (Species)}$ is likely to result in no significant behavioural impacts or damage to species.

Other research[25] has also adopted a 90 $dB_{ht\ (Species)}$ criterion as a threshold above which adverse behavioural effects or hearing damage may occur, and therefore adopting this criterion is considered reasonable.

The thresholds of hearing for fish have been investigated by several researchers, although only a few species have been studied. The hearing thresholds for several fish species[26] ranged from approximately 60 dB re 1μPa to approximately 110 dB re 1μPa, and were most sensitive to low-frequency noise (below approximately 400 Hz). This results in the lowest expected limit to avoid adverse to marine life to be approximately 150 dB re 1μPa (based on a hearing threshold of ~60 dB re 1μPa).

Based on the available research on the sensitivity of fish to anthropogenic noise, it is considered likely that the underwater helicopter noise levels of approximately 120 - 130 dB re 1μPa will be audible to fish.

This is expected to be at least 20 dB below the most stringent 90 $dB_{ht(Species)}$ criterion (based on a hearing threshold of ~60 dB re 1μPa), and are therefore not considered likely to cause adverse noise impact to fish.

Additionally, measurements of underwater noise levels from boats have obtained underwater sound pressure levels from boats in excess of 140 dB re 1μPa at a distance of 1 m[27]. The existing noise exposure for underwater life in Bardens Bay from boating activities is therefore likely to consist of underwater noise levels of similar or higher magnitude than the underwater noise levels from helicopter movements.

Considering that helicopter operations will be restricted to only 4 movements per day, the additional underwater noise impact of helicopter operations is anticipated to be low.

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24 Nedwell, J and Howell, D (2004) A review of offshore windfarm related underwater noise sources. Subacoustech Ltd.

25 Nedwell, Parvin, Edwards, Workman, Brooker, Kynoch (2007) *Measurement and interpretation of underwater noise during construction and operation of offshore windfarms in UK waters* COWRIE. Report NOISE-03-2003

26 Popper, AN (2003) *Effects of anthropogenic sounds on fishes* Fisheries 2003, 28:24-31

27 Erbe, C (2002) Underwater Noise of Whale-Watching Boats and Potential Effects on Killer Whales (orcinus orca), based on an acoustic impact model. Marine Mammal Science 18 (2) pp 394-418

# 7 Proposed Noise Mitigation Measures

- The acoustic consultant engaged for the detailed design phase of the project will review all plant and equipment selections so that the noise levels comply with the appropriate noise criteria.
- Noise control measures will be employed during the detailed design of the travel lift (treating diesel engine with residential grade exhaust silencer; substitution of diesel engine with electric motor; or other appropriate measures as determined by the acoustic consultant engaged for the detailed design phase).
- The building envelope of the proposed function room will be reviewed by the acoustic consultant engaged for detailed design, and a noise management plan for the operation of the function room will be prepared.
- A construction noise management plan will be prepared for the construction of the marina and development, incorporating work practices that will be followed to minimise noise from the construction works
- Community correspondence and liaison should be conducted to mitigate construction noise impact
- Best-practice construction methods will be adopted to minimise construction noise emissions from site.
- A noise management plan for the marina will be prepared, including speed restrictions and/or no-wash zones for vessels within the marina. Consideration should be made into incorporating a 'code of conduct' for marina users, with the need to minimise the noise impact on surrounding residents emphasised.
- Design of the development will be conducted to control the noise intrusion of external noise sources, including traffic and operational noise, in accordance with the internal design criteria specified in this Arup Acoustics report and relevant Australian Standards, including AS2021[28], AS2107[29] and AS3671[30].
- Design of the development will achieve the sound insulation requirements of the Building Code of Australia (BCA).

[28] Australian Standard AS2021 (2000) – Acoustics – Aircraft noise intrusion – Building siting and construction
[29] Australian Standard AS2107 (2000) – Acoustics – Recommended design sound levels and reverberation times for building interiors
[30] Australian Standard AS3671 (1989) – Acoustics – Road traffic noise intrusion – Building siting and construction

# 8 Conclusions

The proposed development at Trinity Point has been assessed against the acoustic requirements set out in the Director-General's requirements, appropriate EPA policies, relevant Australian Standards and the Lake Macquarie City Council DCP No.1.

Design of the proposed development will be conducted to achieve internal design conditions set from appropriate Australian Standards, in particular AS2107:2000, and to comply with the environmental noise criteria derived in this report from the EPA Industrial Noise Policy and the requirements of the NSW Liquor Administration Board.

Construction noise levels from the proposed development are expected to exceed the criteria set out in the EPA Environmental Noise Control Manual and exceed at some receivers the criteria from the DECC NSW Draft Construction Guideline.

However, management of the noise impact of the construction works through the substitution of equipment and adoption of best practice work practices to minimise noise is expected to mitigate the noise impact of the development, following the management process outlined in the DECC Draft Construction Guideline. This will include the adoption of specific work practices to minimise noise and a Noise Management Plan involving all feasible and reasonable methods for reducing noise levels.

Operational noise levels from the Trinity Point site are generally expected to meet the criteria, however some noise control measures may be necessary as part of the detailed design of the development and the final selection of equipment.

Traffic noise impacts from the development are expected to be able to be effectively managed through appropriate engineering and administrative controls.

Helicopter noise levels from the proposed helipad operations are expected to comply with the AirServices Australia helicopter noise guidelines, and no significant impacts on land or aquatic flora and fauna from the helipad operations are expected to occur.

Appendix A

# Acoustic Terminology

# A1 Glossary of Acoustic Terminology

### ASSESSMENT BACKGROUND LEVEL (ABL)

A single-number figure used to characterise the background noise levels from a single day of a noise survey. ABL is derived from the measured noise levels for the day, evening or night time period of a single day of background measurements. The ABL is calculated to be the tenth percentile of the background $L_{A90}$ noise levels – i.e. the measured background noise is above the ABL 90% of the time.

### 'A'-WEIGHTED SOUND LEVEL dB(A)

The unit generally used for measuring environmental, traffic or industrial noise is the A-weighted sound pressure level in decibels, denoted dB(A). An A-weighting network can be built into a sound level measuring instrument such that sound levels in dB(A) can be read directly from a meter. The weighting is based on the frequency response of the human ear and has been found to correlate well with human subjective reactions to various sounds. An increase or decrease of approximately 10 dB corresponds to a subjective doubling or halving of the loudness of a noise. A change of 2 to 3 dB is subjectively barely perceptible.

### DECIBEL

The ratio of sound pressures which we can hear is a ratio of $10^6$ (one million:one). For convenience, therefore, a logarithmic measurement scale is used. The resulting parameter is called the 'sound level' (L) and the associated measurement unit is the decibel (dB). As the decibel is a logarithmic ratio, the laws of logarithmic addition and subtraction apply.

Some typical noise levels are given below:

| Noise Level dB(A) | Example |
|---|---|
| 130 | Threshold of pain |
| 120 | Jet aircraft take-off at 100 m |
| 110 | Chain saw at 1 m |
| 100 | Inside disco |
| 90 | Heavy lorries at 5 m |
| 80 | Kerbside of busy street |
| 70 | Loud radio (in typical domestic room) |
| 60 | Office or restaurant |
| 50 | Domestic fan heater at 1m |
| 40 | Living room |
| 30 | Theatre |
| 20 | Remote countryside on still night |
| 10 | Sound insulated test chamber |
| 0 | Threshold of hearing |

### EFFECTIVE PERCEIVED NOISE LEVEL (EPNL)

Perceived Noise Level (PNdB) is a single-number aircraft noise level that incorporates a weighting to account for the annoyance characteristics of aircraft noise, based on a series of perceived-noisiness contours. PNdB levels are also corrected for prominent tonal characteristics.

EPNL is a measure of the acoustic energy contained in an aircraft event (takeoff, approach or flyover). EPNL is similar to the Sound Exposure Level, although EPNL is based on an exposure time of 10 s.

The EPNL is the constant perceived noise level that would produce in a period of ten seconds the same amount of acoustic energy contained in the aircraft event.

### EQUIVALENT CONTINUOUS SOUND LEVEL ($L_{Aeq}$)

Another index for assessment for overall noise exposure is the equivalent continuous sound level, $L_{eq}$. This is a notional steady level, which would, over a given period of time, deliver the same sound energy as the actual time-varying sound over the same period. Hence fluctuating levels can be described in terms of a single figure level.

### FREQUENCY

The rate of repetition of a sound wave. The subjective equivalent in music is pitch. The unit of frequency is the Hertz (Hz), which is identical to cycles per second. A thousand hertz is often denoted kilohertz (kHz), eg 2 kHz = 2000 Hz. Human hearing ranges from approximately 20 Hz to 20 kHz. The most commonly used frequency bands are octave bands, in which the mid frequency of each band is twice that of the band below it. For design purposes, the octave bands between 63 Hz to 8 kHz are generally used. For more detailed analysis, each octave band may be split into three one-third octave bands or, in some cases, narrow frequency bands.

### MAXIMUM SOUND LEVEL, $L_{max}$

The maximum sound level is the maximum weighted sound pressure level experienced during the measurement period.

### RATING BACKGROUND LEVEL (RBL)

A single-number figure used to characterise the background noise levels from a complete noise survey. The RBL for a day, evening or night time period for the overall survey is calculated from the individual Assessment Background Levels (ABL) for each day of the measurement period, and is numerically equal to the median (middle value) of the ABL values for the days in the noise survey.

### REVERBERATION TIME ($RT_{60}$)

The time, in seconds, taken for a sound within a space to decay by 60 dB after the sound source has stopped is denoted at the reverberation time. The RT is an important indicator of the subjective acoustic within an auditorium. A large RT subjectively corresponds to an acoustically ‘live’ or ‘boomy’ space, while a small RT subjectively corresponds to an acoustically ‘dead’ or ‘flat’ space.

### SOUND EXPOSURE LEVEL (SEL/$L_{AE}$)

The Sound Exposure Level or Single Event Noise Exposure Level, denoted SEL or $L_{AE}$, is a measure of the total amount of acoustic energy contained in an acoustic event. The SEL is the constant sound pressure level that would produce in a period of one second the same amount of acoustic energy contained in the acoustic event.

### SOUND POWER AND SOUND PRESSURE

The sound power level ($L_w$) of a source is a measure of the total acoustic power radiated by a source. The sound pressure level ($L_p$) varies as a function of distance from a source. However, the sound power level is an intrinsic characteristic of a source (analogous to its mass), which is not affected by the environment within which the source is located.

### STATISTICAL NOISE LEVELS

For levels of noise that vary widely with time, for example road traffic noise, it is necessary to employ an index, which allows for this variation. A weighted statistical noise levels are denoted $L_{A10}$, $dBL_{A90}$ etc. The reference time period (T) is normally included, eg. $dBL_{A10, 5min}$ or $dBL_{A90, 8hr}$.

$L_{A90(T)}$

Refers to the sound pressure level measured in dB(A), exceeded for 90% of the time. This is also often referred to the background noise level. For the purposes of this report the duration interval (T) shall be 15 minutes.

$L_{A10(T)}$

Refers to the sound pressure level measured in dB(A), exceeded for 10% of the time. This is often referred to as the average maximum noise level and is frequently used to describe traffic noise.

Appendix B

# Background Noise Levels at Trinity Point Site

# B1 Noise Logger Graphs

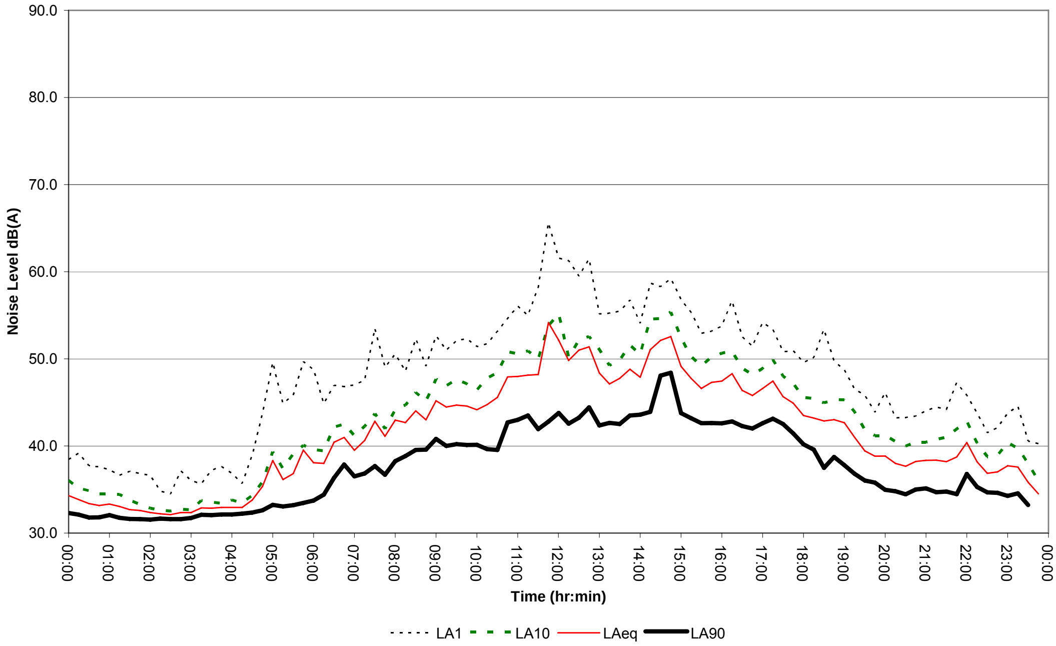


**Figure 5:** Average Ambient Noise Levels, dB re 20μPa, measured at the north end of the Trinity Point site (Logger 1) from 9 October to 19 October 2007.

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Appendix C

# Helicopter Noise Data

# C1 Helicopter Noise Measurements

Helicopter noise measurements were conducted on 1 October 2008 of noise emission from a Bell 407 helicopter (registration VH-DKG) at Cooranbong Airfield, Cooranbong NSW. These measurements were conducted specifically for the Trinity Point project and data from these measurements is not to be reproduced without the express permission of Arup Acoustics or Johnson Property Group.

Simultaneous measurements were conducted at two locations, one approximately 45 m to the side from the helicopter flightpath (on the tail-rotor side of the helicopter) and one location approximately 50 m in front of the helicopter landing site, in the line of the helicopter flightpath. Measurement and flighpath locations are shown in Figure 6 below.

All measurements were made with Brüel and Kjær Type 2250 sound level meters, calibrated with Brüel and Kjær Type 4231 calibrators. The sound level meters were mounted on tripods approximately 1.5 m above the ground surface, and set to 'fast' time response. The site measurements were also recorded to digital audio tape to allow later analysis of the waveform. Measured noise levels are presented in Table 25.

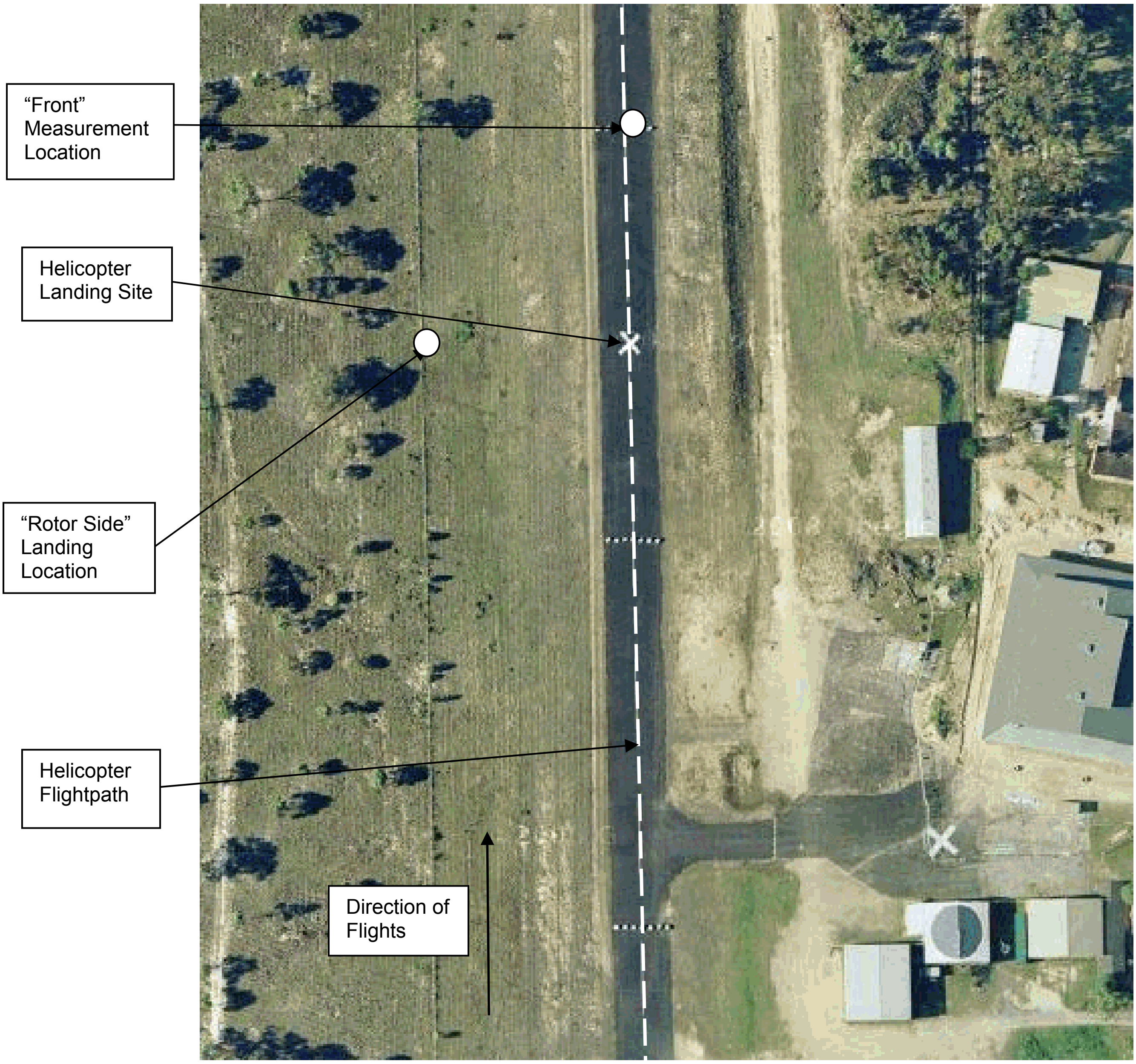


**Figure 6:** Site Plan of Cooranbong Airfield, showing Measurement Locations

| Flight Mode | Measurement Side | Sound Exposure Level $L_{AE}$ at 100 m | Maximum Noise Level $L_{Amax}$ at 100 m |
|---|---|---|---|
| Approach | Rotor | 95-98 | 83-87 |
| | Front | 87-91 | 84-88 |
| Flyover | Rotor | 84-89 | 79-86 |
| | Front | 87-90 | 81-87 |
| Hover | All | 102-103 | 93 |
| Idle | Rotor | 80-83 | 69-71 |
| | Front | 79-83 | 69-70 |
| Takeoff | Rotor | 89-90 | 82-84 |
| | Front | 89-96 | 76-87 |

**Table 25:** Helicopter Noise Measurements, Cooranbong Airfield, Bell 407 Helicopter 1 October 2008, dB(A) re 20 μPa

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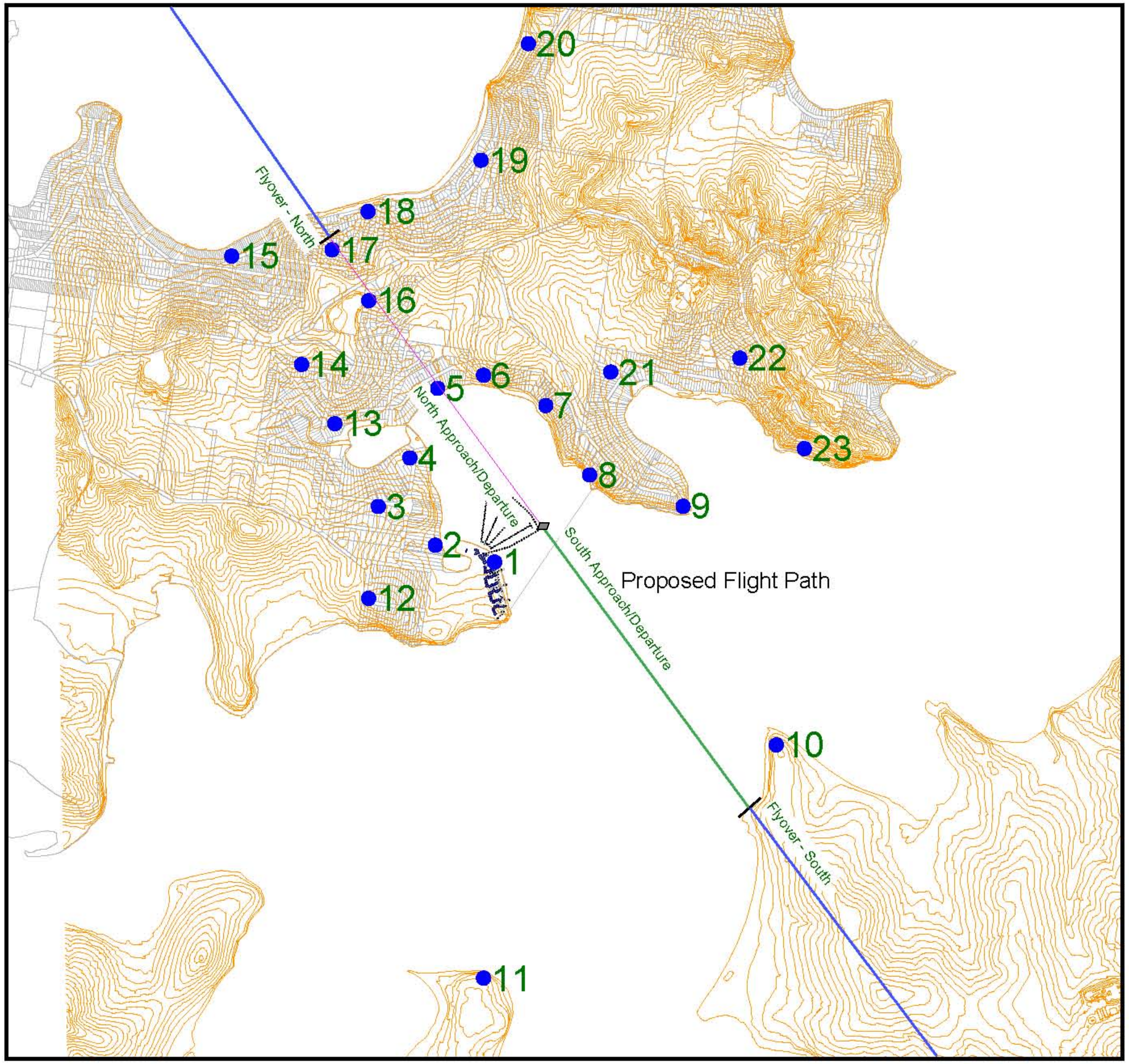
Appendix D

# Noise Sensitive Receiver and Helicopter Flightpath Diagrams




Johnson Property Group
Trinity Point Marina and
Mixed-Use Development

Helicopter Flight Path

Noise Sensitive Receiver Locations

Worst-Case Flighpath Options

Plot

**1**

Helicopter Noise Prediction Geometry
Noise Receiver Height = 1.5 m above ground level

4 helicopter movements/day
(Maximum 30 movements per week)

Bell 407 helicopter

**Legend**

- Building
- Elevation Line
- Cadastre
- Flight Path
- Receiver

N

0 0.2 0.4 0.8 1.2 1.6 km

ARUP

| | | | |
|---|---|---|---|
| To | Bryan Garland, Johnson Property Group | Reference number | 86790/01/CMH |
| cc | Sandra Hutton, ADW Johnson<br>Frank Butera, Arup | File reference | M01 |
| From | Cameron Hough x 467 (Sydney) | Date | 8 December 2008 |
| Subject | Trinity Point - Operational Noise Contours | | |

Bryan,

Please find attached a plot of operational noise contours for the Trinity Point Marina and Mixed-Use Development, Lake Macquarie NSW. The attached plot should be read in conjunction with this memorandum and the Arup Acoustics *Acoustic Assessment Report* for the Trinity Point Marina and Mixed-Use Development (Revision E, dated 14 November 2008) (hereafter referred to as the "Arup Acoustics report").

We have predicted preliminary operational noise levels resulting from marina operation at the Trinity Point site. As instructed by JPG, we have predicted noise levels for the following noise sources:

- Vessels manoeuvring within the marina area itself
- Operation of the boat travel lift, hardstand and workshop

All other noise sources associated with the development are specifically excluded from the accompanying noise contour plot.

Source sound power levels used for prediction are the same as those documented in Sections 5.2 and 5.4 of the Arup Acoustics report. Predictions were made using the CONCAWE noise propagation model, in accordance with the prediction methodology used in Sections 5.2 and 5.4 of the Arup Acoustics report.

The project-specific noise criterion is 39 dB $LAeq_{,15min}$, which is derived from the "Intrusiveness" criterion of the NSW Industrial Noise Policy. A derivation of the criteria is provided in Section 4.2 of the Arup Acoustics report. This criterion has been indicated by an unbroken blue line on the noise contour plots.

Noise levels have been predicted for typical "worst-case" operation of the marina, with operation of the workshop, hardstand, boat travel-lift and marina vessels occurring simultaneously. Each of these noise sources has been assessed individually in the Arup Acoustics report, and compliance with the project-specific noise criteria was assessed for each source in isolation.

The situation with all noise sources operating simultaneously is expected to be a "worst-case" condition, as in normal operation of the marina, not all sources are likely to operate over a complete 15-minute period, for example the travel lift.

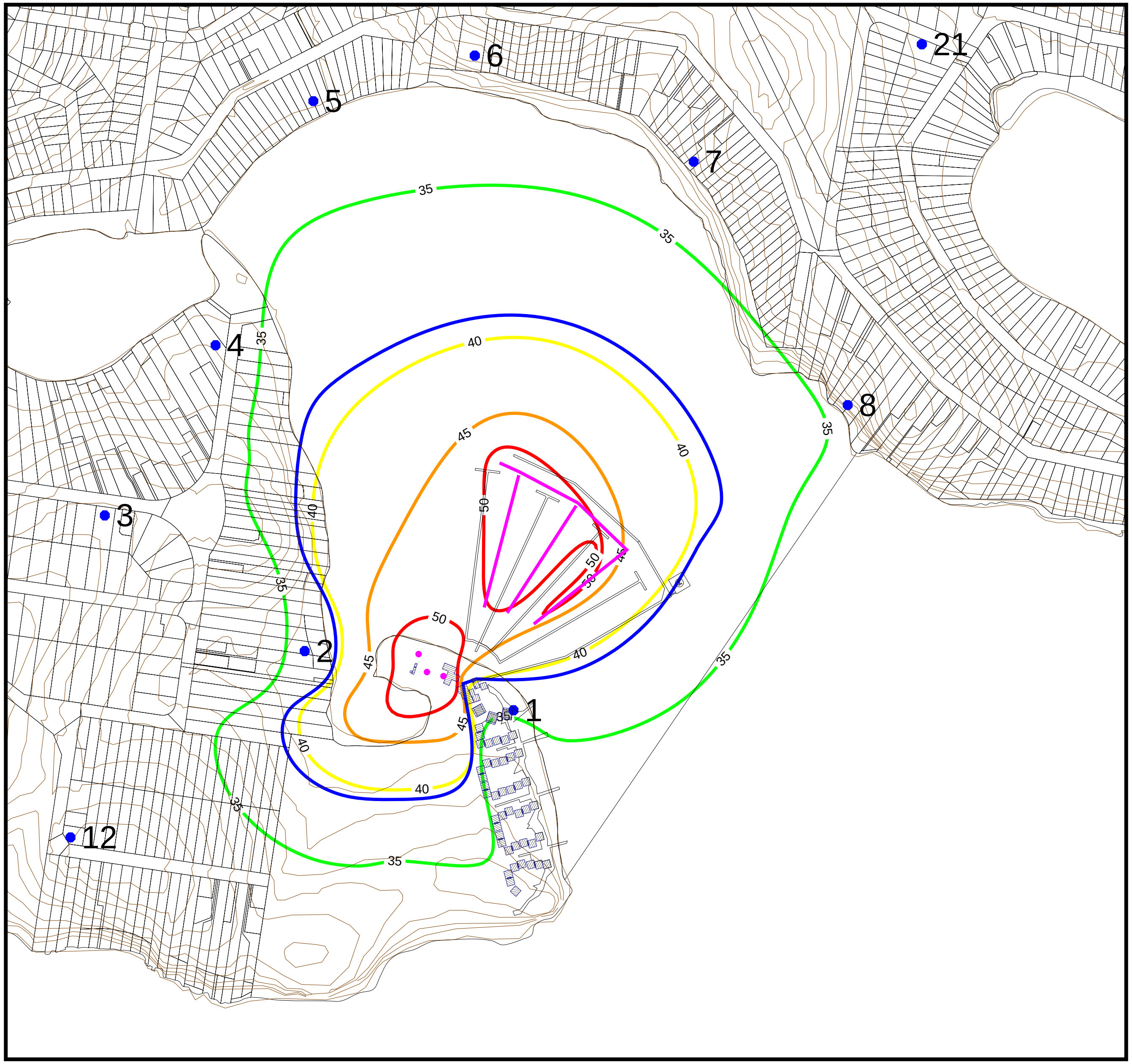
The noise levels from eleven vessels arriving/departing the marina area have been predicted as part of the noise contour plots, which corresponds to the maximum expected number of vessels to operate simultaneously within the marina area, as detailed in Section 5.4 of the Arup Acoustics report. A speed of 4 knots for vessels within the marina has been used for prediction. This is in accordance with the recommended mitigation measures for operational noise from the marina documented in Section 6.6 of the Arup Acoustics report.
A time correction was applied to account for the time each vessel would take to arrive/depart the marina at a speed of four knots.

Noise from the compressor (used to power maintenance operations at the hardstand) is predicted to be the dominant noise source at the nearest residential receivers along Lakeview Road, Morisset Park.
During the detailed design phase of this project, all workshop, hardstand and travel lift equipment will be selected, designed, managed or controlled as appropriate to ensure that the project-specific noise levels are met at all noise-sensitive receivers.

I trust that this memorandum is satisfactory. If you have any questions regarding this memorandum or the accompanying noise-contour plots, please do not hesitate to contact me.

Regards,

For Arup Acoustics
Cameron Hough




Johnson Property Group
Trinity Point Marina and
Mixed-Use Development

Marina Operational Noise Contours

To be read in conjunction with Arup Acoustics Memorandum 86790/01/M01 dated 8 Dec 08

**Plot**

# 2

Preliminary Operational Noise Predictions

Noise Contour plot at 1.5 m above ground level

Typical "Worst Case" Marina Operation

Noise Sources:
Boat Travel Lift Noise
Hardstand Maintenance Activity Noise
Workshop Noise
Marine Vessel Noise

**Noise levels day**
LAeq, 15min

| | |
|---|---|
| < | 35 |
| 35 - | 40 |
| 40 - | 45 |
| 45 - | 50 |
| >= | 50 |

**Legend**

- Building
- Elevation Line
- Workshop Noise Source
- Receiver
- Project Noise Criterion
- Marina Vessel Source

0 50 100 200 300 400 m

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