MARSHALL DAY Acoustics

GAP BLUFF AND CAMP COVE PRECINCTS CONSTRUCTION NOISE ASSESSMENT, REVISED EXHIBITION DRAFT

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Project: **GAP BLUFF DEVELOPMENT**

CONSTRUCTION NOISE ASSESSMENT

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EXECUTIVE SUMMARY

Marshall Day Acoustics Pty Ltd (MDA) has been engaged to carry out a Construction Noise impact assessment of the proposed construction works. The works will comprise:

- Excavation at the rear of the existing Armoury Building Bulk within the Gap Bluff Precinct;
- Excavation allowing the levelling of the driveway at 33 Cliff Street within the Camp Cove Precinct
- Substructure works for 33 Cliff Street and Armoury Building
- Structural and building modifications to Officers Mess and the Armoury Buildings
- Internal refurbishment and conservation works to Gap Bluff Cottage, Constables cottage and Green Point cottage

This report is an indicative assessment based on the projected construction works, establishing the likely impacts to surrounding residential receivers and potential mitigation measures that can be considered. The impact assessment has been in accordance with;

- *Interim Construction Noise Guideline*, NSW Environment Protection Authority.
- *Assessing Vibration: A Technical Guide*, Department of Environment and Conservation, NSW.

Detailed information on construction methodologies and construction equipment are not yet available. We have however carried out preliminary noise level calculations based on major construction activities likely to be associated with the proposed alterations.

Noise levels from construction activities have been calculated at the nearest noise sensitive receivers for the various locations near the construction works. Predicted levels indicate that average noise from typical construction activities may exceed the “noise affected” goals from the EPA criteria. Noise levels at most exposed residential receivers, particularly for excavation works at 33 Cliff Street, potentially exceed the EPA “highly noise affected” management levels.

From the assessment it is predicted there is the potential for exceeding the “highly noise affected” management level during worst case operations, for example during excavation at of the existing driveway at 33 Cliff Street.

A Construction Noise and Vibration Management Plan (CNVMP) will be required to be developed in co-ordination with the construction team prior to the issue of the Construction Certificate with details of construction programming, construction plant and equipment and specific mitigation measures. Potential mitigation measures and construction management practices that should be considered in the CNVMP have been outlined in this review.

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1.0 INTRODUCTION

As part of the Gap Bluff and Camp Cove Precinct development, Expertise Building and Construction Pty Ltd) are proposing to carried out modifications to some of the existing buildings and structures on site.

An acoustic assessment of the operation phase of the project has been carried and reported in Marshall Day Acoustics (MDA) document Rp 001 r01 20161667. This document assesses the noise impacts during the construction phase.

The proposed construction methodologies have been described in a Construction Management Plan prepared by Expertise Building and Construction Pty Ltd (EBCPL).

The works will comprise:

- Hoarding;
- Site establishment;
- Construction Management including proposed site access and construction traffic management;
- Excavation at the rear of the existing Armoury Building Bulk within the Gap Bluff Precinct;
- Excavation allowing the levelling of the driveway at 33 Cliff Street within the Camp Cove Precinct
- Substructure works for 33 Cliff Street and Armoury Building
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MDA has been engaged to carry out a Construction Noise impact assessment of the construction works according to;

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This report is an indicative assessment based on the projected construction works, establishing the likely impacts to surrounding residential receivers and potential mitigation measures that can be considered.

A Construction Noise and Vibration Management Plan (CNVMP) will be required to be developed in co-ordination with the construction team prior to the issue of the Construction Certificate with details of construction programming, construction plant and equipment and specific mitigation measures.

This report is based on calculations conducted by MDA in addition to:

- Construction Management Plan, Gap Bluff Precinct / Camp Cove Precinct Revision 02, dated 16/12/2016
- Acoustic report prepared by Marshall Day Acoustics RP001 20161667 *Gap Bluff and Camp Cove Precincts, Review of Environmental Factors - Acoustics*
- Information on typical construction methodology, demolition activities, plant details formulated based on past project experience. Acoustic terminology used throughout this report is detailed in Appendix A.

2.0 PROPOSED WORKS

The proposed works are described within the Construction Management plan, reproduced in the following paragraphs.

2.1 Officers' Mess

Removing hipped roof extension to below adjacent parapet height and roof repairs generally

Accessibility measures including constructing an internal passenger lift

New wall openings

Partition removal

Conversion of kitchens and bathrooms

Reinstatement of original detailing and general conservation works

2.2 Armoury

New enclosed veranda to level 1

New kitchen and bathrooms

Expansion of building to the North-East

Internal partition removal

2.3 Gap Bluff Cottage

Rearrangement of the interior Layout to provide one bedroom, one bathroom, kitchen and living/dining room

Reinstatement of original detailing and general conservation works

Reinstatement of landscaping

2.4 Constable's Cottage, 32 Cliff Street

Minor Internal changes including a new bathroom

Construction of a new bay window

Reinstatement of original detailing and general conservation works

Landscaping works including boundary fencing and lawn and garden reinstatement

2.5 33 Cliff Street

Rationalisation of the interiors planning to a more open – plan layout

Replacing the western wall with glazed bi-fold doors

Excavation of the driveway for a road-level garage and a trafficable terrace above

Landscaping works would comprise replacement of existing plantings with native coastal species to the east of the house, and planting of a fast-growing screening hedge along the property's western boundary.

The existing path and clothesline to the east of the house would be removed and a new lawn established.

2.6 Green Point Cottage

Removal of part of the wall between the veranda and the living areas

Conversion of the existing laundry into a bathroom.

Relocation of the building entrance to the south and the current entrance infilled and made good.

The existing enclosed veranda windows would be replaced and the external deck would be extended and raised to be flush with the internal floor level.

Proposed landscaping works comprise establishment of garden beds with low plantings along the southern and western boundaries of the property.

2.7 Surrounding Noise Sensitive Receivers

For the proposed construction works, the nearest affected receivers are detailed in Table 1 and Figure 1 selected to be representative for the purpose of the assessment and calculations.

Figure 1: Gap Bluff precinct buildings and receivers, unattended logger location (L), photo source: SixMaps

Table 1: Noise sensitive receivers

Receiver	Location	Description
1	Officers Mess Building	Main Gap Bluff Precinct Building
2	Armoury Building	Main Gap Bluff Precinct Building
3	Watson Bay Boutique Hotel	Hotel accommodation
4	Area bounded by Cliff Street and Short Street	Residences
5	Area bounded by Cliff Street and Cove Street	Residences
6	Pacific Street	Residences
7	HMAS Watson	Accommodation
8	Military Road	Residential
9	Clovelly Street	Residential

For Camp Cove precinct buildings, the closest residential properties to the Constable Cottage building and 33 Cliff Street are those to the south west of Cliff Street, at approximately 15-25 metres distance. Closest receivers to the Green Point cottage are on Pacific Street, approximately 35-40m away.

3.0 ENVIRONMENTAL NOISE SURVEY

The baseline noise level data has been obtained from the MDA report assessing the operational noise from the proposed development. Detailed data is included with the operational noise report; however, it has been summarised in sections 3.1 and 3.2 of this report.

3.1 Gap Bluff Precinct

For the purposes of the assessment a new logger survey has been conducted in the Gap Bluff Precinct to establish baseline noise levels. A new logger assessment was conducted to;

- Confirm that there has not been any change to existing ambient noise levels, and
- Obtain a more detailed ambient noise level survey. The deployed logger has the capability of overall and octave band measurements, providing a longer octave band survey period than the 24-hour octave band survey conducted in the PKA assessment.

As a cross-check, a comparison to previous logging conducted as detailed in the PKA assessment is detailed below.

The logger is located adjacent to the sealed road overflow carpark adjacent near the Armoury building, adjacent to residences at 26 Cliff Street as shown in Figure 1 and in detail in Figure 2. The logger location is considered to be representative of the ambient background noise level of most affected noise sensitive dwellings from function activities in the Officers Mess and Armoury buildings.

Figure 2: Logger Location, L Gap Bluff precinct

Logging was conducted with a 01dB Duo noise logger Serial number 10419. The logger was calibrated immediately before and after deployment and found to be acceptable, the calibration certificate is provided in Appendix E.

Baseline noise levels were recorded from Tuesday 29th November to Monday 5th December 2016 inclusive. Measurements were recorded continuously over this period and grouped to 15 minute intervals. The survey results are summarised in Appendix B.

In determining existing noise levels, any data affected by extraneous noise events in addition to rainfall were excluded in accordance with EPA INP guidance. A weather station was installed adjacent to the noise logger to measure wind and rain conditions to establish periods to be excluded from the

weather data. Exclusions were made for the Evening and Night period for the 2nd December and the Night period for 5th December.

The results of the unattended monitoring are provided in Table 2. As there is no proposal for construction outside normal daytime hours, the results for the evening and night times have not been reported.

Table 2: Ambient and background noise level survey

Period	Time Period	RBL, L_{A90} dB	L_{Aeq} dB
Day	0700-1800 hours	44	56

For comparison, results from the noise survey conducted by PKA are summarised in Table 3 as overall levels. The location of the logger for the current assessment and the PKA assessment are considered to be equivalent for the purposes of the noise survey.

Table 3: Ambient Noise Level Survey Summary (PKA Report 215 043 R01 V2.4 Gap Bluff Precinct Acoustic Report)

Period	Time Period	RBL, L_{A90} dB	L_{Aeq} dB
Day	0700-1800 hours	40.5	51

Overall the PKA measurements were in the order of 3dBA less in each period. Octave band measurements reported in the PKA assessment for the Night period did not record the 4kHz peak as measured in the current logging survey. It is noted the PKA noise survey was conducted in late March early April, suggesting potential seasonal variations from local wildlife activity.

As the reason for the discrepancy between the site surveys has not been able to have been identified, for the purposes of establishing site noise criteria, site survey conditions as documented in the PKA report are utilised for the assessment. Utilising the PKA site survey establishes a lower site background conditions, which is more restrictive to activities in the Gap Bluff precinct.

3.2 Camp Cove Precinct

The PKA assessment included details of logging conducted at the far end of Cliff Street, close to the 33 Cliff Street building. In the PKA report it was noted that logging was considered to be representative of conditions at 1 Victoria Street. A summary of logging results is shown in Table 4.

For the purposes of establishing the existing noise environment, logging measurements conducted in the previous PKA assessment are considered to be appropriate for quantifying the noise environment for residences in the vicinity of Constables Cottage and 33 Cliff Street. In addition, the surveyed ambient noise levels are considered to be appropriate for residential receivers in the vicinity of Green Point Cottage. It is noted that in the OEH review of the PKA report that surveys conducted at 1 Victoria Street are representative of receivers in the vicinity of Green Point Cottage.

Table 4: Ambient Noise Level Survey Summary (PKA Report 215 043 R01 V2.4 Gap Bluff Precinct Acoustic Report)

Location		Existing Noise Levels	
		L_{Aeq}	L_{90} RBL
1 Victoria Street	Day	52.5	39.5

4.0 CONSTRUCTION NOISE & VIBRATION CRITERIA

4.1 Construction Noise Criteria

Construction noise criteria have been derived based on the measured background noise level presented in Section 3.0. The noise criteria for the permitted hours of construction are summarised in Table 5 below with a full derivation of the criteria set out in Appendix C.

Table 5: Construction noise management levels

Receiver	Type	Time of Day	"Noise Affected" management level, dB $L_{Aeq, 15min}$[1]	"Highly noise affected" management level, dB $L_{Aeq, 15min}$
Gap Bluff Precinct	Residential	Mon-Fri 0700-1800hrs Sat 0800-1300hrs	50.5	75

Note 1: As per the EPA Interim Construction Noise Guideline, noise levels apply at the property boundary that is most exposed to the construction noise at a height of 1.5m above ground level. Noise levels may be higher at upper floors of the residences.

The "noise affected" level is the point above which there may be some community reaction to noise". The "highly noise affected" level represents the point above which there may be a strong community reaction to noise. Where the "Noise Affected" management level is predicted to be exceeded the CNG requires that all feasible and reasonable work practices be employed.

Where it is predicted that the "highly noise affected" management level will be exceeded respite periods may need to be considered.

4.2 Construction vibration criteria

The EPA *Interim Construction Noise Guideline* refers assessment of vibration effects on people to the EPA document *Assessing vibration: A technical guideline*. For assessment of vibration effects on structures the German standard DIN 4150 is used.

4.2.1 Vibration limits - Effects on structures

The German Standard DIN 4150 provides short-term vibration limits below which any cosmetic damage to buildings is unlikely. The vibration limits are detailed in Table 6.

Table 6: Vibration limits according to DIN 4150

Line	Type of structure	Guideline values for velocity, in mm/s of vibration in horizontal plane of highest floor, at all frequencies
I	Buildings used for commercial purposes, industrial buildings, and buildings of similar design	40
II	Dwellings and buildings of similar design and/or occupancy	15
III	Structures that, because of their particular sensitivity to vibration, cannot be classified under lines I and II and are of great intrinsic value (e.g. listed buildings under preservation order)	8

4.2.2 Vibration limits - Effects on people

The EPA document *Assessing vibration: A technical guideline,* provides a Vibration Dose Value (VDV) criteria to assess the severity of intermittent vibration, such as that experienced from construction

activities including rock breaking and piling. The VDV criteria for residential receivers as detailed in the guideline are provided in Table 7 below.

Table 7: Acceptable vibration dose values for intermittent vibration (m/s$^{1.75}$)

Receiver Type	Daytime[1]	
	Preferred Value	Maximum Value
Residences	0.20	0.40
Offices	0.40	0.80

Note 1: Day-time 0700-2200hrs.

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

5.0 CONSTRUCTION NOISE AND VIBRATION IMPACT ASSESSMENT

As the project development is in its early stages, a schedule of proposed demolition and construction activities has not been finalised and a full Construction Noise and Vibration Management Plan is not achievable. In lieu of this, concept level considerations of demolition and construction noise and associated vibration impacts are described below.

5.1 Construction Activities

Detailed information on construction methodologies and construction equipment are not yet available. We have however carried out preliminary noise level calculations based on major construction activities likely to be associated with the proposed alterations.

There are several noise sources associated with the difference phases of construction that have the potential to increase noise at the nearest noise sensitive receivers. A preliminary schedule of anticipated activities and equipment for each construction stage is provided in Table 8.

Table 8: Anticipated activities and equipment schedule

Works Location	Major Construction Activities	Major Equipment Expected	Truck Delivery / Exit Gate
Officers Mess	• Establish site • Install sheds, fences and gates • Demolish existing roof • Construct new roof • Internal modifications and refurbishment	• 1x Mobile Crane • 1x Truck • Electric Handtools • Compressor • Cherry picker • Jackhammer	Entry and Exit , Military Road Gate
Armoury	• Establish site • Install sheds, fences and gates • Demolish existing roof • Excavate for extension • Construction of building extensions • Construct new roof • Internal modifications and refurbishment	• 1x Mobile Crane • 1x Truck • Electric Handtools • Compressor • Cherry picker • Jackhammer • Concrete Trucks and pumps	Entry and Exit, Military Road Gate

Works Location	Major Construction Activities	Major Equipment Expected	Truck Delivery / Exit Gate
Gap Bluff Cottage	• Internal Rearrangement and refurbishment • Conservation works	• 1x Truck • Electric Handtools •	Entry and Exit, Military Road Gate
Constables Cottage	• Internal Rearrangement and refurbishment • Conservation works	• 1x Truck • Electric Handtools	Entry and Exit, Cliff Road
33 Cliff Street	• Internal Rearrangement and refurbishment • Excavation of driveway • Construction of Terrace	• 1x Truck • Electric Handtools • Jackhammer • Compressor • Concrete Trucks and pumps	Entry and Exit, Cliff Road
Green Point Cottage	• Internal Rearrangement and refurbishment • Deck extension • Conservation works	• 1x Truck • Electric Handtools	Entry and Exit, Pacific Street

5.2 Assessment

5.2.1 Predicted Noise Levels - Gap Bluff Precinct

Noise levels due to typical activities on site have been estimated by allowing for typical noise levels generated by construction activities and plant. There is no allowance for screening or shielding or absorption by land features

Within guidance hours (Monday – Friday: 0700-1700hrs, Saturday 0800-1300hrs) the estimated typical $L_{Aa,vmax}$ noise levels from typical operations are set out in Table 9 for the residential locations described in Table 1 .

The estimated levels in Table 9 do not show allowance for simultaneous work at the Officers Mess, Armoury or Gap Bluff Cottage site. The intermittent that variable nature of the works means that maximum noise levels are unlikely to combine in a conventional manner, although we have included this in our discussions.

Table 9: Estimated construction Noise Levels - Gap Bluff Precinct

Receptor Location		Noise levels due to work at Officers Mess site $L_{Aa,vmax}$	Noise levels due to work at Armoury site $L_{Aa,vmax}$	Noise levels due to work at Gap Bluff Cottage site $L_{Aa,vmax}$
3	Watson Bay Hotel	66	65	52
4	Cliff/Short Street Residential	63	67	50
5	Cliff/Cove Street Residential	58	61	45
6	Pacific Street Residential	57	58	44
7	HMAS Watson accommodation	63	68	52
8	27 Military Road Residential	64	60	49
9	Clovelly Street Residential	62	59	47

We conclude from Table 9 the following estimated outcomes:

- Location 3: Construction activities are estimated to be up to 16dB(A) (approximately 18 dB(A) as a combined level) above the "noise affected" goals, but less than "highly noise affected" management levels at receivers;
- Location 4: Construction activities are estimated to be up to 17dB(A) (approximately 18 dB(A) as a combined level) above the "noise affected" goals, but less than "highly noise affected" management levels at receivers;
- Location 5: Construction activities are estimated to be up to 11dB(A) (approximately 13 dB(A) as a combined level) above the "noise affected" goals, but less than "highly noise affected" management levels at receivers;
- Location 6: Construction activities are estimated to be up to 8 dB(A) (approximately 10 dB(A) as a combined level) above the "noise affected" goals, but less than "highly noise affected" management levels at receivers;
- Location 7: Construction activities are estimated to be up to 18 dB(A) (approximately 19 dB(A) as a combined level) above the "noise affected" goals, but less than "highly noise affected" management levels at receivers;
- Location 8: Construction activities are estimated to be up to 14 dB(A) (approximately 16 dB(A) as a combined level) above the "noise affected" goals, but less than "highly noise affected" management levels at receivers;
- Location 9: Construction activities are estimated to be up to 12 dB(A) (approximately 14 dB(A) as a combined level) above the "noise affected" goals, but less than "highly noise affected" management levels at receivers;

The predicted $L_{Aa,vmax}$ levels from the proposed construction activities indicates the that there is the potential for exceeding the "highly noise affected" management level during worst case operations. This may occur, for example where multiple noisy plant items are operated simultaneously at the site boundary directly adjacent a receiver.

We do note that the existing noise levels for residences exposed to Olympic Drive are significant. Existing traffic noise levels at receivers exposed to Olympic Drive are likely to be higher than the "noise affected" management levels and will mask the construction noise to some extent.

It is possible that many of the nominated residences will already have mitigation measures in place (e.g. glazing and alternative ventilation) to address traffic noise. This would in turn also assist in reducing construction noise intrusion.

Predicted exceedances are typical of large construction sites in urban residential areas and on the basis construction works are restricted to take place only during the daytime, noise impacts will not be experienced during the most sensitive time period i.e. night-time.

Exceedance of the "noise affected" management construction noise criteria indicates that all reasonable and feasible mitigation measures will need to be considered to minimise impact from construction noise on the nearest sensitive occupancies.

5.2.2 Predicted Noise Levels – Camp Cove Precinct

The proposed refurbishment works at Constables Cottage, 33 Cliff Street and Green Point cottage are within the Camp Cove Precinct. While major construction works are not proposed at these locations, the nearest residential boundaries are in close proximity at around 15-35 metres.

Noise levels due to typical activities on site have been estimated by allowing for typical noise levels generated by construction activities and plant. There is no allowance for screening or shielding or absorption by land features

Within guidance hours (Monday – Friday: 0700-1700hrs, Saturday 0800-1300hrs) the estimated typical $L_{Aa,vmax}$ noise levels from typical operations are set out in Table 9 for the residential locations described in Table 1 .

The estimated levels in Table 10 do not show allowance for simultaneous work at the Constables Cottage, 33 Cliff Street and Green Point cottage sites. The intermittent and variable nature of the works means that maximum noise levels are unlikely to combine in a conventional manner, although we have included this in our discussions.

Table 10: Estimated construction noise levels - Camp Cove Precinct

Receptor Location		Noise levels due to work at Constables Cottage site $L_{Aa,vmax}$	Noise levels due to work at 33 Cliff Street site $L_{Aa,vmax}$	Noise levels due to work at Green Point Cottage site $L_{Aa,vmax}$
10	1 Victoria Street	67	85	
11	Pacific Street		64	64

We conclude from Table 10 the following estimates outcomes:

- Location 10: Construction activities are estimated to be up to 85dB(A) as a combined level from both the Constables Cottage and the 33 Cliff Street work sites. This would be above the highly noise affected" management levels at receivers during period of excavation work associated with levelling the driveway at 33 Cliff Street. At other times, the combed noise level would be above the "noise affected" goals, but less than "highly noise affected" management levels at receivers;
- Location 11: Construction activities are calculated to be up to 14dB(A) (approximately 17 dB(A) as a combined level) above the "noise affected" goals, but less than "highly noise affected" management levels at receivers;

5.2.3 Potential Mitigation Measures

Table 11 outlines potential mitigation measures that should be considered for the various construction stages to minimise the construction noise impacts to affected receivers. Due to the predicted exceedances, construction activities should be restricted to the daytime period (except for exceptional circumstances, to be confirmed in the CNVMP).

Table 11: Comment and review of potential mitigation measures

Work Location	Mitigation Measures to be Considered / Comments
Gap Bluff Precinct	• Limit noise levels from work site radios • Where there is a need to break rock in excavation, consider lower noise impact sawing and ripping methods; • Work only within the recommended construction hours
Camp Cove Precinct	• Limit noise levels from work site radios • Where there is a need to break rock in excavation, consider lower noise impact sawing and ripping methods; • Work only within the recommended construction hours • Investigate options for shielding noisy excavation of existing driveway from residences across Victoria Street, e.g. temporary screens, storage of materials; • Noise and vibration monitoring is recommended to identify activities at 33 Cliff Street with vibratory impact and to monitor noise level exceedances to receivers to assist in planning, management and notification of noise exceedances.

Vibration generating activity will need to be minimised through the construction methodologies and selection of appropriate construction equipment.

Apart from that at 33 Cliff Street recommended in Table 11, vibration and noise monitoring should be considered and may be required if complaints are received. Management practices relating to community consultation and construction noise control measures that should be considered are detailed in Section 6 below.

6.0 CONSIDERATIONS FOR THE CONSTRUCTION NOISE AND VIBRATION MANAGEMENT PLAN

The Construction Noise and Vibration Management Plan (CNVMP) will need to consider the following aspects to minimise and manage the impact to nearby noise sensitive receivers.

6.1 Community consultation

It is recommended that the following practices relating to community consultation be considered in the CNVMP:

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

6.2 Scheduling of activities and providing respite periods

It is recommended that the following practices relating to scheduling of activities be considered:

- Scheduling high noise-generating activities to be undertaken when background noise, including local road traffic, is high to provide masking to construction noise;
- It is recommended high noise generating activities should be to the Interim Construction Noise Guidelines or Development Application restricted hours as appropriate;
- Scheduling any deliveries to the site and removal of waste material from the site to occur during proposed construction hours only, and restricting particularly noisy activity to Monday to Friday (7:30am to 5:00pm) and with a 45 minute respite break between 12 noon and 1pm.

6.3 Management work practices

It is recommended that the following practices relating to management of work practices be considered:

- Planning deliveries and access to the site to occur quietly and efficiently. Truck drivers must be kept informed of designated entry and egress points, parking locations and acceptable delivery hours. Vehicle movements outside standard construction hours should be avoided where possible;
- Scheduling vehicle deliveries so that where practicable, delivery vehicles are switched off during loading and unloading activities where close to residences;
- It is recommended vehicles are fitted with broadband reversing alarms ('quackers') instead of tonal reversing beepers.

6.4 Construction noise control measures

Practical noise control measures that should be considered include:

- Using existing structures and temporary site structures and material stockpiles as noise barriers;
- Reducing the line-of sight from noise source to receiver through erection of barriers as necessary around static, high noise items such as compressors and preferentially locating on-site to use the retained building as shielding;

- Where practicable, installing broadband noise reversing alarms as an alternative to common 'beeper' alarms for on-site vehicles and vehicles that regularly visit the construction site;
- Siting of noisy plant as far away from sensitive properties as permitted by site constraints.

6.5 Complaint handling procedure

- The site representative responsible for matters relating to noise will be responsible for handling complaints and will need to be readily accessible to give complaints a fair hearing should they arise;
- All feasible and reasonable measures will need to be applied to address the source of complaint.

A register of all complaints will need to be maintained documenting the nature of complaints and the procedures applied to resolve the complaint. All complaints should be responded to and a record kept of actions taken to address the issues. All complaints should be followed up after the implementation of any controls to identify whether the complaint has been adequately resolved.

6.6 Vibration Monitoring

Due to the proximity of the neighbouring structures to the excavation works at 33 Cliff Street , permanent monitoring of ground vibration levels at the boundary of residents should be considered to ascertain the impact of construction activities and ensure that vibration levels remain below the levels at which cosmetic damage to buildings becomes likely (provided in Table 6). Attention should be made to construction periods with piling nearby residences, nearby truck movements and / or impact demolition works.

For vibration monitoring, the following should be considered in the CNVMP;

- Any exceedances of pre-determined trigger levels should be investigated before works are allowed to continue on-site. The vibration monitoring system would need to provide an instant warning of trigger levels which can either be visually or audibly communicated, or otherwise transmitted via email or SMS alerting the site representative of encroaching exceedances.
- All vibration monitoring data should be recorded and the results should be maintained to assess compliance with the criteria.
- If complaints are received from residents regarding vibration levels, a monitoring system to measure vibration and assess the levels against the criteria for human comfort should be implemented. This will likely need to be a separate system to the one used to monitor vibration levels for building damage.

6.7 Noise monitoring

Monitoring of construction noise is recommended in the construction staging to ascertain the impact of construction noise on the nearest affected receivers once construction activities commence. The measured noise level data can be used to determine the effectiveness of the recommended noise control measures and management practices.

The following noise monitoring methodology is recommended:

- Attended noise monitoring conducted for a representative period during each of the construction phases identified in Table 5. The contractor must ascertain the noisiest period during each construction phase which will be chosen for monitoring.
- The results of the monitoring to be compiled in a report, comparing the measured noise levels at each identified noise affected receiver with the predicted construction noise levels identified for each Stage in the CNVMP. Any exceedances over and above those predicted shall be commented on, and if particular works are identified as creating excessive noise, further noise mitigation

options shall be explored and employed if possible. This report should be presented to Council at their request.

- Records of all monitoring will be maintained and kept readily available.

Additional noise monitoring is recommended on an as-required basis in response to receipt of any complaints. Typically investigations and monitoring should occur following receipt of 2 or more complaints.

APPENDIX A GLOSSARY OF TERMINOLOGY

SWL or L_W Sound Power Level
A logarithmic ratio of the acoustic power output of a source relative to 10^{-12} watts and expressed in decibels. Sound power level is calculated from measured sound pressure levels and represents the level of total sound power radiated by a sound source.

dB Decibel
The unit of sound level.

Expressed as a logarithmic ratio of sound pressure P relative to a reference pressure of Pr=20 μPa i.e. dB = 20 x log(P/Pr)

dBA The unit of sound level which has its frequency characteristics modified by a filter (A-weighted) so as to more closely approximate the frequency bias of the human ear.

A-weighting The process by which noise levels are corrected to account for the non-linear frequency response of the human ear.

$L_{Aeq\ (t)}$ The equivalent continuous (time-averaged) A-weighted sound level. This is commonly referred to as the average noise level.

The suffix "t" represents the time period to which the noise level relates, e.g. (8 h) would represent a period of 8 hours, (15 min) would represent a period of 15 minutes and (2200-0700) would represent a measurement time between 10 pm and 7 am.

L_{A90} The A-weighted noise level equalled or exceeded for 90% of the measurement period. This is commonly referred to as the background noise level.

L_{Amax} The A-weighted maximum noise level. The highest noise level which occurs during the measurement period.

L_{Aavmax} The A-weighted sound pressure level obtained by arithmetically averaging the maximum levels measured during the time period considered.

Vibration When an object vibrates, it moves rapidly up and down or from side to side. The magnitude of the sensation when feeling a vibrating object is related to the vibration velocity.

Vibration can occur in any direction. When vibration velocities are described, it can be either the total vibration velocity, which includes all directions, or it can be separated into the vertical direction (up and down vibration), the horizontal transverse direction (side to side) and the horizontal longitudinal direction (front to back).

PPV Peak Particle Velocity
For Peak Particle Velocity (PPV) is the measure of the vibration aptitude, zero to maximum. Used for building structural damage assessment.

VDV Vibration Dose Value
Vibration Dose Value is based on British Standard BS 6472:1992 Guide to Evaluation of Human Exposure to Vibration in Buildings (1Hz to 80Hz) and provides guidelines for the evaluation of whole body exposure to intermittent vibration.

VDV can be used to take into account the weighted measured RMS vibration from many vibration sources including rail vehicles, construction equipment such as jackhammers and industry. VDV takes into account the duration of each event and the number of events per day, either at present or in the foreseeable future and calculates a single value index.

APPENDIX B CONSTRUCTION NOISE CRITERIA

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

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

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

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

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

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

Unattended background noise levels were measured on the site by Marshall Day Acoustics as detailed in Section 3.0.

The rating background level, RBL, during the day time period, 0700-1800hrs, was measured to be 49dB $L_{A90(period)}$. The construction noise management levels for residential receivers that will be impacted during the construction phases of this project are provided in Table C1 below.

Table C1: Construction noise management levels for residential receivers[1]

Receiver/Time of day	Time period	RBL, dB L_{A90}	"Noise affected" management level, dB $L_{Aeq,15mins}$	"Highly noise affected" management level, dB $L_{Aeq,15mins}$
Within recommended hours				
Monday to Friday	0700-1700hrs	49	59	75
Saturday	0800-1300hrs			
Outside recommended hours				
Saturday	1300-1700hrs	49	54	N/A

Where the Noise Affected management, level is predicted to be exceeded, the CNG requires that all feasible and reasonable work practices are employed and that all potentially impacted receivers should be informed.

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

APPENDIX C CONSTRUCTION EQUIPMENT

Noise levels during the demolition, excavation and construction phases have been calculated at the nominated occupancies during the demolition, excavation and general construction phases. These noise levels have been predicted under guidance from AS2436-2010 *Guide to noise control on construction, maintenance and demolition sites.*

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

Table D1: Equipment assumed to be operating simultaneously in a 15 minute period

Construction equipment	Officers Mess	Armoury	Gap Bluff Cottage	Constables Cottage	33 Cliff Street	Green Point Cottage
Jackhammer	✓	✓			✓	
Truck (concrete & pump)		✓			✓	
Electric Hand Tools	✓	✓	✓	✓	✓	✓
Mobile Crane	✓	✓				
Truck	✓	✓	✓	✓	✓	✓
Compressor	✓	✓			✓	
Cherry Picker	✓	✓				