Roads and Maritime Services
Lansdowne Bridge Replacement
Noise and vibration assessment

May 2014
Executive summary

This noise and vibration impact assessment has been undertaken for the Roads and Maritime Services of NSW as part of the Review of Environmental Factors for the replacement of Lansdowne Bridge. It is proposed to replace Lansdowne Bridge, a timber truss bridge on Bungonia Road across Mulwaree Ponds, Goulburn NSW. The new bridge will be of three-span concrete construction, along the same alignment, with the road geometry being modified to suit.

Two noise sensitive receivers along the proposed route have been identified in order to undertake the noise and vibration assessment and determine appropriate mitigation measures.

Noise monitoring was undertaken at two locations along the proposed route to determine existing background noise levels and current road traffic noise levels.

No residential receivers are predicted to exceed the road traffic assessment operational noise criteria. Additionally, no residential receivers are predicted to exceed the relative increase criteria or the acute noise levels. Therefore no residential receivers are predicted to require mitigation treatments for operational noise.

Construction works during standard construction hours and outside standard construction hours are predicted to exceed the construction noise criteria at both residential receivers. Feasible and reasonable noise mitigation measures have been recommended for implementation. Mitigation measures will minimise impacts at the surrounding residential receivers. However, it is unlikely that implementation of all reasonable and feasible noise mitigation measures would reduce noise levels to below the construction noise criteria under all circumstances. A construction noise and vibration management plan should be developed by the construction contractor to implement the construction noise and vibration mitigation measures and reduce the noise impacts to the surrounding residences.

Vibration is potentially perceptible at 2 Bungonia Road for pavement breaking, rolling and compacting activities. These would be considered intermittent and short-term and likely to be tolerated if prior warning is given to the resident. Therefore the residents at 2 Bungonia Road should be informed of the nature of the works, expected vibration levels, duration of works and a method of contact. With consideration to the building damage vibration criteria, the expected magnitude of ground vibrations at 2 Bungonia Road is potentially sufficient to cause building damage. Therefore the construction contractor should undertake a dilapidation survey for any buildings at this location and compliance vibration monitoring should be undertaken to ensure building damage vibration criteria are not exceeded.
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Appendix A - Noise level charts
Appendix B - RTA flowchart for selecting mitigation treatments
# Glossary of acoustic terms

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>dB</td>
<td>Decibel is the logarithmic unit used for expressing the sound pressure level (SPL) or power level (SWL) in acoustics.</td>
</tr>
<tr>
<td>dB(A)</td>
<td>Frequency weighting filter used to measure ‘A-weighted’ sound pressure levels, which conforms approximately to the human ear response, as our hearing is less sensitive at very low and very high frequencies.</td>
</tr>
<tr>
<td>$L_{Aeq(period)}$</td>
<td>Equivalent sound pressure level: the steady sound level that, over a specified period of time, would produce the same energy equivalence as the fluctuating sound level actually occurring.</td>
</tr>
<tr>
<td>$L_{A90(period)}$</td>
<td>The sound pressure level exceeded for 90% of the measurement period.</td>
</tr>
<tr>
<td>$L_{Amax}$</td>
<td>The maximum sound level recorded during the measurement period.</td>
</tr>
<tr>
<td>$L_{Aeq(15hr)}$</td>
<td>The $L_{Aeq}$ noise level for the period 7 am to 10 pm.</td>
</tr>
<tr>
<td>$L_{Aeq(9hr)}$</td>
<td>The $L_{Aeq}$ noise level for the period 10 pm to 7 am.</td>
</tr>
<tr>
<td>$L_{Aeq(1hr)}$</td>
<td>The highest hourly $L_{Aeq}$ noise level during the day and night periods.</td>
</tr>
</tbody>
</table>

**Noise sensitive receiver**  
An area or place potentially affected by noise could include:
- Residential dwelling.
- Educational institution, library, childcare centre, hospital, place of worship.
- Active (eg sports field) or passive (eg park) recreational areas.
- Commercial or industrial premises.

**Rating background level (RBL)**  
The overall single-figure background level representing each assessment period (day/evening/night) over the whole monitoring period.

**Feasible and reasonable (Office of Environment and Heritage definition)**  
Feasibility relates to engineering considerations and what is practical to build; reasonableness relates to the application of judgement in arriving at a decision, taking into account the following factors:
- Noise mitigation benefits (amount of noise reduction provided, number of people protected).
- Cost of mitigation (cost of mitigation versus benefit provided).
- Community views (aesthetics impacts and community wishes).
- Noise level for affected land use (existing and future levels, and changes in noise levels).
1. Introduction

1.1 Overview

GHD Pty Ltd has been commissioned by the Roads and Maritime Services (RMS) to undertake a noise and vibration assessment for the proposed replacement of the Lansdowne Bridge and realignment of Bungonia Road, NSW (hereafter ‘the proposal’). This assessment forms part of the Review of Environmental Factors (REF) undertaken under Part 5 of the Environmental Planning and Assessment Act 1979 (EP&A Act). The proposal is located in Goulburn, about a kilometre to the north of the Hume Highway.

This operational noise assessment and construction noise and vibration assessment has been prepared with consideration to the Environmental Noise Management Manual (RTA, 2001) and the following Office of Environment and Heritage publications:

- Road Noise Policy (DECCW, 2011).

1.2 Proposal description

RMS proposes to replace the Lansdowne Bridge over Mulwarree Ponds on Bungonia Road, with a new three span concrete bridge. The existing bridge was not designed for either the mass and speed of current day vehicles, nor the traffic densities that currently use the bridge. In particular it has been identified that the bridge conveys a substantial volume of stock movement by articulated vehicles, which contribute to the impact and fatigue and consequentially high maintenance costs required for bridge upkeep.

The new bridge would be constructed on the same alignment as the existing bridge, comprising a channel crossing of about 20 metres. It is noted that the entire area to the west of the site is prone to flooding.

A realignment of the geometry of the approaches to the bridge would also be provided to accommodate the new structure.

The proposal is shown in Figure 1.

1.3 Scope of works and limitations

Set out below is our scope of work for the noise and vibration assessment:

- Identify noise sensitive receivers in the study area.
- Undertake noise monitoring at two locations and simultaneous traffic counts in two directions.
- Establish road traffic noise assessment criteria with consideration to the Road Noise Policy (DECCW, 2011).
- Prepare the following noise models:
  - A ‘no-build option’ traffic noise model to predict road traffic noise in the vicinity of the proposal for the current year, year opening and 10 years after opening.
  - A ‘build option’ traffic noise model to predict road traffic noise in the vicinity of the proposal for the year opening and 10 years after opening.
- Undertake a qualitative assessment of maximum noise levels.
Assess predicted noise levels against the road traffic noise assessment criteria. If the noise assessment criteria are exceeded, discuss potential mitigation measures with consideration to the *Environmental Noise Management Manual* (RTA, 2001).

Establish the construction noise management levels with consideration to the *Interim Construction Noise Guideline* (DECC, 2009).

Predict noise associated with construction works assessed against the construction noise management levels.

Predict vibration from construction plant and equipment and assessed with consideration to the vibration criteria.

If the noise levels are predicted to exceed the construction noise management levels then appropriate construction noise and vibration mitigation measures as well as best practice measures will be recommended in order to minimise construction noise and vibration impacts.

### 1.3.1 Limitations

This report: has been prepared by GHD for Roads and Maritime Services and may only be used and relied on by Roads and Maritime Services for the purpose agreed between GHD and the Roads and Maritime Services.

GHD otherwise disclaims responsibility to any person other than Roads and Maritime Services arising in connection with this report. GHD also excludes implied warranties and conditions, to the extent legally permissible.

The services undertaken by GHD in connection with preparing this report were limited to those specifically detailed in the report and are subject to the scope limitations set out in the report.

The opinions, conclusions and any recommendations in this report are based on conditions encountered and information reviewed at the date of preparation of the report. GHD has no responsibility or obligation to update this report to account for events or changes occurring subsequent to the date that the report was prepared.

The opinions, conclusions and any recommendations in this Report are based on assumptions made by GHD when undertaking services and preparing the Report (“Assumptions”), including (but not limited to):

- Measurement methodology assumptions detailed in Section 2.2.
- Operational noise modelling assumption detailed in Section 4.1.
- Construction noise and vibration level prediction assumptions detailed in Section 5.1.

The findings of the noise assessment represent the findings apparent at the date and time of the monitoring and the conditions of the area at that time. It is the nature of environmental monitoring that all variations in environmental conditions cannot be assessed and all uncertainty concerning the conditions of the ambient noise environment cannot be eliminated. Professional judgment must be exercised in the investigation and interpretation of observations.

Subject to the paragraphs in this section of the Report, the opinions, conclusions and any recommendations in this Report are based on conditions encountered and information reviewed at the time of preparation of this Report.

GHD has prepared this Report on the basis of information provided by the RMS, which GHD has not independently verified or checked (“Unverified Information”) beyond the agreed scope of work.

GHD expressly disclaims responsibility in connection with the Unverified Information, including (but not limited to) errors in, or omissions from, the Report, which were caused or contributed to by errors in, or omissions from, the Unverified Information.
1:12,000 (at A4)

100 200 300 400 500

Metres

Map Projection: Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia (GDA)
Grid: Map Grid of Australia 1994, Zone 56

Legend

Community and recreation
Sport and recreation
Education
Tourism
Goulburn Golf Club

The proposal

Roads and Maritime Services
REF for replacement of Lansdowne Bridge

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2. **Existing ambient noise environment**

2.1 **Noise sensitive receivers**

The proposal study area is located in a semi-rural environment with existing intermittent road traffic noise from Bungonia Road. Distant road traffic noise from the Hume Highway bypass is just audible at the receiver locations at low levels and does not significantly contribute to the ambient noise environment. The topography of the proposal study area is undulating terrain.

Sensitive receivers in the vicinity of the proposal include the following:

- Residence at 2 Bungonia Road.
- Residence at 33 Bungonia Road including the Historic Lansdowne Park (holiday camping accommodation).

2.2 **Noise monitoring methodology**

Noise monitoring was undertaken from 6 December to 13 December 2012 at the two locations shown in Figure 2 and Table 1.

Noise monitoring was undertaken to determine background noise levels for the construction noise assessment and existing road traffic noise levels for the operational noise assessment noise modelling verification process.

Noise monitoring was undertaken using Rion NL-21 environmental noise loggers within calibration. The instruments were programmed to accumulate environmental noise data continuously over sampling periods of 15 minutes for the entire monitoring period.

Field calibration checks were undertaken immediately before and after the monitoring period using an acoustic calibrator.

Logged data was reviewed and filtered to exclude any extraneous data and data potentially affected by adverse weather conditions during the monitoring period. Meteorological data for the monitoring period was sourced from the nearest Bureau of Meteorology Weather Station to the site, at Goulburn Airport, station number 70330, set to record 30-minute averages.

2.3 **Summary of noise monitoring results**

Logger data results, including rating background level (RBL) and road traffic noise descriptors are summarised in Table 2 and Table 3 with monitoring charts presented in Appendix A. A detailed description of the acoustic terms can be found in the Glossary at the start of this report.

The noise monitoring results at location 1 are typical of areas influenced by road traffic noise, which is expected due to the close proximity to Bungonia Road.

Monitoring location 2 is set back approximately 120 metres from Bungonia Road and due to the low traffic volumes on Bungonia Road, road traffic noise at this location is not a dominant feature of the ambient noise environment.
Figure 2

Legend

- Noise Monitoring Locations

Metres

Map Projection: Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia (GDA)
Grid: Map Grid of Australia 1994, Zone 56

Residential receivers and noise monitoring locations

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Table 1  Noise monitoring locations

<table>
<thead>
<tr>
<th>Location</th>
<th>Distance to Bungonia Road (m)</th>
<th>Site photo</th>
</tr>
</thead>
<tbody>
<tr>
<td>2 Bungonia Road</td>
<td>8 m</td>
<td><img src="image1" alt="Location 1 photo" /></td>
</tr>
<tr>
<td>Location 1$^1$</td>
<td></td>
<td></td>
</tr>
<tr>
<td>33 Bungonia Road</td>
<td>120 m</td>
<td><img src="image2" alt="Location 2 photo" /></td>
</tr>
<tr>
<td>Location 2$^2$</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note 1: Noise monitoring location 1 was located in free-field therefore a 2.5 dB(A) facade correction was applied to the road traffic noise levels.

Note 2: Noise monitoring location 2 was located one metre from the building façade therefore a 2.5 dB(A) facade correction was subtracted from the background noise levels.
### Table 2  Location 1 noise monitoring results (2 Bungonia Road); dB(A)

<table>
<thead>
<tr>
<th>Period</th>
<th>Background noise descriptors</th>
<th>Road traffic noise descriptors ¹</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td><strong>LA90(Day)</strong></td>
<td><strong>LA90(Evening)</strong></td>
</tr>
<tr>
<td>7 am to 6 pm, Monday to Saturday; 8 am to 6 pm Sundays &amp; Public Holidays</td>
<td>35.8</td>
<td>42.1</td>
</tr>
<tr>
<td>6 pm to 10 pm, Monday to Sunday &amp; Public Holidays</td>
<td>38.3</td>
<td>37.3</td>
</tr>
<tr>
<td>10 pm to 7 am, Monday to Saturday; 10 pm to 8 am Sundays &amp; Public Holidays</td>
<td>35.9</td>
<td>34.7</td>
</tr>
<tr>
<td>7 am to 10 pm weekdays</td>
<td>41.1</td>
<td>39.4</td>
</tr>
<tr>
<td>10 pm to 7 am weekdays</td>
<td>44.3</td>
<td>41.8</td>
</tr>
<tr>
<td>6 am to 12 am weekdays</td>
<td>41.5</td>
<td>40.2</td>
</tr>
<tr>
<td>Overall</td>
<td>40.2</td>
<td>34.5</td>
</tr>
</tbody>
</table>

Note 1: Includes a +2.5 dB(A) facade correction

### Table 3  Location 2 noise monitoring results (33 Bungonia Road); dB(A)

<table>
<thead>
<tr>
<th>Period</th>
<th>Background noise descriptors ¹</th>
<th>Road traffic noise descriptors</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td><strong>LA90(Day)</strong></td>
<td><strong>LA90(Evening)</strong></td>
</tr>
<tr>
<td>7 am to 6 pm, Monday to Saturday; 8 am to 6 pm Sundays &amp; Public Holidays</td>
<td>34.8</td>
<td>39.7</td>
</tr>
<tr>
<td>6 pm to 10 pm, Monday to Sunday &amp; Public Holidays</td>
<td>34.2</td>
<td>30.6</td>
</tr>
<tr>
<td>Period</td>
<td>Background noise descriptors¹</td>
<td>Road traffic noise descriptors</td>
</tr>
<tr>
<td>-------------------</td>
<td>-------------------------------</td>
<td>-----------------------------------------------------</td>
</tr>
<tr>
<td></td>
<td>LA90(Day)</td>
<td>LAeq(15hr)</td>
</tr>
<tr>
<td></td>
<td>7 am to 6 pm, Monday to</td>
<td>7 am to 10 pm,</td>
</tr>
<tr>
<td></td>
<td>Saturday; 8 am to 6 pm</td>
<td>10 pm to 7 am, Monday to Saturday; 10 pm to 8 am</td>
</tr>
<tr>
<td></td>
<td>Sundays &amp; Public Holidays</td>
<td>am Sundays &amp; Public Holidays</td>
</tr>
<tr>
<td></td>
<td>LA90(Evening)</td>
<td>LAeq(9hr)</td>
</tr>
<tr>
<td></td>
<td>6 pm to 10 pm, Monday to</td>
<td>10 pm to 7 am,</td>
</tr>
<tr>
<td></td>
<td>Sunday to Sunday; 10 pm to</td>
<td>9 am Sundays &amp; Public Holidays</td>
</tr>
<tr>
<td></td>
<td>8 am Sundays &amp; Public Holidays</td>
<td></td>
</tr>
<tr>
<td></td>
<td>LA90(Night)</td>
<td>LA10(18hr)</td>
</tr>
<tr>
<td></td>
<td>10 pm to 7 am, Monday to</td>
<td>6 am to 12 am</td>
</tr>
<tr>
<td></td>
<td>Saturday; 10 pm to 8 am</td>
<td>week days</td>
</tr>
<tr>
<td></td>
<td>Sundays &amp; Public Holidays</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Saturday-8-Dec-12</td>
<td>29.8</td>
<td>45.9</td>
</tr>
<tr>
<td></td>
<td>28.7</td>
<td>38.4</td>
</tr>
<tr>
<td></td>
<td>25.2</td>
<td>44.8</td>
</tr>
<tr>
<td>Sunday-9-Dec-12</td>
<td>34.0</td>
<td>44.5</td>
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<tr>
<td></td>
<td>36.3</td>
<td>43.2</td>
</tr>
<tr>
<td></td>
<td>30.0</td>
<td>46.6</td>
</tr>
<tr>
<td>Monday-10-Dec-12</td>
<td>38.2</td>
<td>45.9</td>
</tr>
<tr>
<td></td>
<td>38.7</td>
<td>44.5</td>
</tr>
<tr>
<td></td>
<td>33.8</td>
<td>48.1</td>
</tr>
<tr>
<td>Tuesday-11-Dec-12</td>
<td>35.6</td>
<td>44.2</td>
</tr>
<tr>
<td></td>
<td>36.2</td>
<td>42.7</td>
</tr>
<tr>
<td></td>
<td>31.3</td>
<td>46.4</td>
</tr>
<tr>
<td>Wednesday-12-Dec-12</td>
<td>32.4</td>
<td>45.1</td>
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<tr>
<td></td>
<td>35.2</td>
<td>44.8</td>
</tr>
<tr>
<td></td>
<td>29.8</td>
<td>45.4</td>
</tr>
<tr>
<td>Overall</td>
<td>34.2</td>
<td>45.1</td>
</tr>
<tr>
<td></td>
<td>36.2</td>
<td>45.0</td>
</tr>
<tr>
<td></td>
<td>30.0</td>
<td>46.4</td>
</tr>
</tbody>
</table>

Note 1: 2.5 dB(A) facade correction subtracted from the background noise descriptors
3. **Project criteria**

3.1 **Operational noise criteria**

The *Road Noise Policy* (DECCW, 2011) provides non-mandatory traffic noise assessment criteria for residential receivers and sensitive land uses near new roads and redevelopments of existing roads. The target levels should aim to be achieved 10 years after project opening.

Bungonia Road has been considered a sub-arterial road with consideration to the *Road Noise Policy* (DECCW, 2011). The proposal is considered a road redevelopment for all sensitive receivers due to the existing noise exposure and proposed road alignment location.

The *Road Noise Policy* (DECCW, 2011) road traffic noise assessment criteria are presented in Table 4.

The *Road Noise Policy* (DECCW, 2011) relative increase criterion assesses any increase in the total traffic noise level at a receiver due to the proposal. The relative increase criteria is exceeded if the ‘build option’ noise levels increase by more than 12 dB(A) above the ‘no-build option’ noise levels.

Residences experiencing exceedances to the road traffic noise assessment criteria or the relative increase criteria should be considered for mitigation measures with consideration to the *Environmental Noise Management Manual* (RTA, 2001).

### Table 4  Road traffic noise assessment criteria for sub-arterial roads, $L_{Aeq(period)}$ dB(A)

<table>
<thead>
<tr>
<th>Road category</th>
<th>Type of project</th>
<th>Assessment criteria (external)</th>
<th>Receivers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Arterial</td>
<td>Existing residences affected by noise from redevelopment of an existing sub-arterial road</td>
<td>$L_{Aeq(15hr)}$ 60&lt;sup&gt;1&lt;/sup&gt;</td>
<td>All sensitive receivers</td>
</tr>
</tbody>
</table>

---

Note: Section 3.4 of the *Road Noise Policy* (DECCW 2011) states that “Where existing traffic noise levels are above the noise assessment criteria, the primary objective is to reduce these through feasible and reasonable measures to meet the assessment criteria. A secondary objective is to protect against excessive decreases in amenity as the result of a project by applying the relative increase criteria.”
3.1.1 Sleep disturbance

The *Road Noise Policy* (DECCW, 2011) provides a literature review for the assessment of sleep arousal due to traffic noise however does not set a sleep disturbance assessment criterion.

Sleep disturbance impacts are likely to be dependent on the following:

- Maximum noise level of an event.
- Number of occurrences.
- Duration of the event.
- Level above background or ambient noise levels.

For continuous rather than intermittent traffic flow, the *Environmental Noise Management Manual* (RTA, 2001) recommends $L_{\text{Amax}}$ noise pass-by events should not exceed $L_{\text{Aeq (1hr)}}$ noise levels by more than 15 dB(A). The *Environmental Noise Management Manual* (RTA, 2001) advises that maximum noise levels can be used as a tool to prioritise and rank mitigation strategies, but should not be applied as a decisive criterion in itself.

3.2 Construction noise criteria

The *Interim Construction Noise Guideline* (DECC, 2009) provides guidance for assessment of construction noise. The guideline recommends standard hours for construction activities as Monday to Friday: 7 am to 6 pm, Saturday: 8 am to 1 pm and no work on Sundays or Public Holidays.

Construction activities are proposed to be undertaken during the recommended standard hours. However there is always the potential that some night-time works would be required outside of the recommended standard hours to minimise traffic delays and disruption associated with road closures.

The *Interim Construction Noise Guideline* (DECC, 2009) acknowledges that the following activities have justification to be undertaken outside the recommended construction hours assuming all reasonable and feasible mitigation measures are implemented to minimise the impacts to the surrounding community:

- The delivery of oversized plant or structure.
- Emergency work.
- Works for which it can be demonstrated that there is a need to operate outside the recommended standard hours.
- Works which maintain noise levels at receivers to below the night-time noise affected construction noise management levels.

Table 5 and Table 6 detail the noise management levels at sensitive residences and land uses respectively. The noise management levels for each sensitive receiver are summarised in Table 7. The assessment point is 30 metres from the residence, or the resident boundary, whichever is the closest.

The *Interim Construction Noise Guideline* states that where construction works are planned to extend over more than two consecutive nights, the analysis should include maximum noise levels and the extent and number of times the maximum exceeds the rating background levels. The *Industrial Noise Policy* application notes regarding sleep disturbance recommend that where the $L_{1\text{minute}}$ exceeds the $L_{A90 \text{15minute}}$ by more than 15dB(A), a more detailed analysis is required. Further guidance for sleep disturbance is provided in the *Road Noise Policy* which concludes, based on the research to date, that:
• Maximum internal noise levels below 50 -55 dB(A) are unlikely to awaken people from sleep.

• One or two noise events per night, with maximum internal noise levels of 65 – 70 dB(A), are not likely to affect health and wellbeing significantly.

For sleep disturbance the assessment point is inside the residence’s bedroom where as the assessment point for the construction noise management levels is 30 metres from the residence, or the residence boundary, whichever is the closest.
### Table 5  Noise management levels at residences

<table>
<thead>
<tr>
<th>Time of day</th>
<th>Management level</th>
<th>How to apply</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Recommended standard hours:</strong></td>
<td></td>
<td>The noise affected level represents the point above which there may be some community reaction to noise. Where the predicted or measured $L_{Aeq(15min)}$ is greater than the noise affected level, the proponent should apply all feasible and reasonable work practices to meet the noise affected level. The proponent should also inform all potentially impacted residents of the nature of works to be carried out, the expected noise levels and duration, as well as contact details.</td>
</tr>
<tr>
<td>Monday to Friday 7 am to 6 pm</td>
<td>Noise affected</td>
<td></td>
</tr>
<tr>
<td>Saturday 8 am to 1 pm</td>
<td>Rating background level $+10\text{ dB(A)}$</td>
<td></td>
</tr>
<tr>
<td>No work on Sundays or public holidays</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Highly noise Affected</td>
<td></td>
<td>The highly noise affected level represents the point above which there may be strong community reaction to noise. Where noise is above this level, the relevant authority (consent, determining or regulatory) may require respite periods by restricting the hours that the very noisy activities can occur, taking into account: Times identified by the community when they are less sensitive to noise (such as before and after school for works near schools, or mid-morning or mid-afternoon for works near residences. If the community is prepared to accept a longer period of construction in exchange for restrictions on construction times.</td>
</tr>
<tr>
<td>$75\text{ dB(A)}$</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Outside recommended standard hours</strong></td>
<td>Noise affected</td>
<td>A strong justification would typically be required for works outside the recommended standard hours. The proponent should apply all feasible and reasonable work practices to meet the noise affected level. Where all feasible and reasonable practices have been applied and noise is more than $5\text{ dB(A)}$ above the noise affected level, the proponent should negotiate with the community.</td>
</tr>
<tr>
<td>Rating background level $+5\text{ dB(A)}$</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Table 6  Noise management levels at sensitive land uses

<table>
<thead>
<tr>
<th>Land use</th>
<th>Management level, $L_{Aeq(15min)}$ (applies when properties are being used)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Classrooms at schools and other educational institutions</td>
<td>Internal noise level 45 dB(A)</td>
</tr>
<tr>
<td>Hospital wards and operating theatres</td>
<td>Internal noise level 45 dB(A)</td>
</tr>
<tr>
<td>Places of worship</td>
<td>Internal noise level 45 dB(A)</td>
</tr>
<tr>
<td>Active recreation areas (characterised by sporting activities and activities which generate their own noise or focus for participants, making them less sensitive to external noise intrusion)</td>
<td>External noise level 65 dB(A)</td>
</tr>
<tr>
<td>Passive recreation areas (characterised by contemplative activities that generate little noise and where benefits are compromised by external noise intrusion, for example, reading, meditation)</td>
<td>External noise level 60 dB(A)</td>
</tr>
</tbody>
</table>

Table 7  Summary of noise management levels at sensitive receivers, dB(A)

<table>
<thead>
<tr>
<th>Address</th>
<th>Noise affected noise management level $L_{Aeq(15min)}$ during standard recommended hours</th>
<th>Outside of standard recommended hours</th>
<th>During standard recommended hours</th>
<th>Evening 6 pm to 10 pm Monday to Sunday &amp; Public Holidays</th>
<th>Night 10 pm to 7 am, Monday to Friday; 10 pm to 8 am Saturday, Sunday &amp; Public Holidays</th>
</tr>
</thead>
<tbody>
<tr>
<td>2 Bungonia Road</td>
<td>50</td>
<td>45</td>
<td>45</td>
<td>40</td>
<td></td>
</tr>
<tr>
<td>33 Bungonia Road and Historic Lansdowne Park</td>
<td>44</td>
<td>39</td>
<td>41</td>
<td>35</td>
<td></td>
</tr>
</tbody>
</table>

3.3  Construction vibration criteria

3.3.1  Human comfort

Vibration criteria have been set with consideration to *Assessing Vibration: a technical guideline* (DEC, 2006). *British Standard BS 6472 – 1992, Guide to Evaluation of Human Exposure to Vibration in Buildings (1 Hz to 80 Hz)* is recognised by the guideline as the preferred standard for assessing the ‘human comfort criteria’.
Typically, construction activities generate ground vibration of an intermittent nature. Intermittent vibration is assessed using the vibration dose value. Acceptable values of vibration dose are presented in Table 8 for sensitive receivers.

Whilst the assessment of response to vibration in BS 6472-1:1992 is based on vibration dose value and weighted acceleration, for construction related vibration, it is considered more appropriate to provide guidance in terms of a peak value, since this parameter is likely to be more routinely measured based on the more usual concern over potential building damage.

Humans are capable of detecting vibration at levels which are well below those causing risk of damage to a building. The degrees of perception for humans are suggested by the vibration level categories given in British Standard, BS 5228.2 – 2009, Code of Practice Part 2 Vibration for noise and vibration on construction and open sites – Part 2: Vibration and are shown below in Table 9.

### Table 8  Human comfort intermittent vibration limits (BS 6472-1992)

<table>
<thead>
<tr>
<th>Receiver type</th>
<th>Period</th>
<th>Intermittent vibration dose value (m/s(^{1.75}))</th>
<th>Preferred value</th>
<th>Maximum value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Residential</td>
<td>Day</td>
<td>0.2</td>
<td>0.2</td>
<td>0.4</td>
</tr>
<tr>
<td></td>
<td>(7 am and 10 pm)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Night</td>
<td>0.13</td>
<td>0.26</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(10 pm and 7 am)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Offices, schools, educational institutes and places of worship</td>
<td>When in use</td>
<td>0.4</td>
<td>0.8</td>
<td></td>
</tr>
</tbody>
</table>

### Table 9  Guidance on effects of vibration levels for human comfort (BS 5228.2 – 2009)

<table>
<thead>
<tr>
<th>Vibration level</th>
<th>Effect</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.14 mm/s</td>
<td>Vibration might be just perceptible in the most sensitive situations for most vibration frequencies associated with construction.</td>
</tr>
<tr>
<td>0.3 mm/s</td>
<td>Vibration might be just perceptible in residential environments.</td>
</tr>
<tr>
<td>1.0 mm/s</td>
<td>It is likely that vibration at this level in residential environments will cause complaints, but can be tolerated if prior warning and explanation has been given to residents.</td>
</tr>
<tr>
<td>10 mm/s</td>
<td>Vibration is likely to be intolerable for any more than a very brief exposure.</td>
</tr>
</tbody>
</table>

### 3.3.2 Structural damage

Currently, there is no Australian Standard that sets criteria for the assessment of building damage caused by vibration. Guidance of limiting vibration values is attained from reference to German Standard DIN 4150-3: 1999 Structural Vibration – Part 3: Effects of vibration on structures.

Table 10 presents guideline values for the maximum absolute value of the velocity,
“at the foundation of various types of building. Experience has shown that if these values are complied with, damage that reduces the serviceability of the building will not occur. If damage nevertheless occurs, it is to be assumed that other causes are responsible.”

Measured values exceeding those listed in Table 10,

“does not necessarily lead to damage; should they be significantly exceeded, however, further investigations are necessary.”

**Table 10  Guideline values for short term vibration on structures**

<table>
<thead>
<tr>
<th>Line</th>
<th>Type of structure</th>
<th>Guideline values for velocity, (mm/s)</th>
<th>1 Hz to 10 Hz</th>
<th>10 Hz to 50 Hz</th>
<th>50 Hz to 100 Hz²</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Buildings used for commercial purposes, industrial buildings, and buildings of similar design</td>
<td>20</td>
<td>20 to 40</td>
<td>40 to 50</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Dwellings and buildings of similar design and/or occupancy</td>
<td>5</td>
<td>5 to 15</td>
<td>15 to 20</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Structures that, because of their particular sensitivity to vibration, cannot be classified under lines 1 and 2 and are of great intrinsic value (for example listed buildings under preservation order)</td>
<td>3</td>
<td>3 to 8</td>
<td>8 to 10</td>
<td></td>
</tr>
</tbody>
</table>

Note 1: At frequencies above 100 Hz the values given in this column may be used as minimum values.
4. Operational noise assessment

4.1 Noise modelling methodology

Road traffic noise predictions were undertaken using the United Kingdom Department of Transport Calculation of Road Traffic Noise (CoRTN) algorithm. CoRTN is recognised and accepted by the Office of Environment and Heritage and adapted to Australian conditions through research undertaken by the Australian Road Research Board. The CoRTN algorithm is implemented in CadnaA V4.3 noise modelling software.

Noise predictions were undertaken for the following cases:
- Year 2014 ‘no build option’ (Traffic flow on the existing alignment for year opening).
- Year 2024 ‘no build option’ (Traffic flow on the existing alignment 10 years after opening).
- Year 2014 ‘build option’ (Proposed design for year opening).
- Year 2024 ‘build option’ (Proposed design 10 years after opening).

4.1.1 Traffic data

The daily traffic volumes on Bungonia Road are shown in Table 11. The forecast traffic volumes have been extrapolated using a traffic growth factor of five per cent per annum (Townsend pers. comm. 2013).

Table 11 Daily traffic volumes on Bungonia Road

<table>
<thead>
<tr>
<th>Year</th>
<th>Data source</th>
<th>Daily traffic volume</th>
</tr>
</thead>
<tbody>
<tr>
<td>2012</td>
<td>Traffic counts undertaken as part of the noise assessment</td>
<td>2190</td>
</tr>
<tr>
<td>2014</td>
<td>Year opening forecast assuming a growth factor of 5% per annum</td>
<td>2415</td>
</tr>
<tr>
<td>2024</td>
<td>10 years after opening forecast assuming a growth factor of 5% per annum</td>
<td>3933</td>
</tr>
</tbody>
</table>

4.1.2 Modelling inputs and assumptions

The noise model inputs and assumptions are presented in Table 12.

Table 12 Noise model inputs and assumptions

<table>
<thead>
<tr>
<th>Inputs / assumption</th>
<th>Data incorporated into noise model</th>
</tr>
</thead>
<tbody>
<tr>
<td>Traffic speeds</td>
<td>60 km/h (posted)</td>
</tr>
<tr>
<td>Austroads road surfaces corrections</td>
<td>Spray Seal</td>
</tr>
<tr>
<td></td>
<td>No build – worn spray seal +2 dB(A)</td>
</tr>
<tr>
<td></td>
<td>Build year opening – fresh spray seal +4 dB(A)</td>
</tr>
<tr>
<td></td>
<td>Build 10 years after opening – worn spray seal +2 dB(A)</td>
</tr>
<tr>
<td>Australian Road Research Board</td>
<td>-1.7 dB(A) for ‘façade’</td>
</tr>
<tr>
<td>correction</td>
<td>-0.7 dB(A) for ‘free-field’</td>
</tr>
<tr>
<td>Road gradient</td>
<td>Taken into account based on the road design model.</td>
</tr>
<tr>
<td>Façade correction</td>
<td>+2.5 dB(A) to account for sound reflected from the façade.</td>
</tr>
<tr>
<td>Source height</td>
<td>Cars - 0.5 m.</td>
</tr>
<tr>
<td></td>
<td>Truck engines - 1.5 m.</td>
</tr>
<tr>
<td></td>
<td>Truck exhausts - 3.6 m.</td>
</tr>
</tbody>
</table>
4.1.3 Noise modelling verification

The CoRTN algorithm and noise modelling process was validated against the road traffic noise monitoring data and simultaneous traffic counts and average vehicle speed undertaken for the proposal in December 2012.

The model is deemed to be verified if the average difference between the measured and calculated values of the descriptors is within +/-2 dB(A).

A comparison of the modelling and monitoring results is shown in Table 13. The predicted results and measured results have an acceptable variance of within 2 dB(A).

Monitoring location 2 was set back approximately 120 metres from Bungonia Road and due to the low traffic volumes on Bungonia Road, road traffic noise is not a significant feature of the ambient noise environment at this location; therefore measured noise results from location 2 have not been used in the noise modelling verification.

<table>
<thead>
<tr>
<th>Location</th>
<th>Day $L_{Aeq}$(15hr)</th>
<th>Night $L_{Aeq}$(9hr)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Measured</td>
<td>Modelled</td>
</tr>
<tr>
<td>Noise monitoring location 1</td>
<td>59.0</td>
<td>61.0</td>
</tr>
</tbody>
</table>

4.2 Predicted noise levels

The day and night-time predicted receiver noise levels for the ‘no-build option’ and ‘build option’ for year 2014 and year 2024 are detailed in Table 14. Day and night-time noise contour plots for each scenario are shown in Figure 3 to Figure 10. All road traffic noise levels include a +2.5 dB(A) façade correction. All receivers are predicted to comply with the road traffic noise criteria.
**Table 14 Predicted road traffic noise levels, dB(A)**

<table>
<thead>
<tr>
<th>Receiver</th>
<th>‘No build option’</th>
<th>‘Build option’</th>
<th>Exceedance to RNP road traffic noise assessment criteria</th>
<th>Exceedance to road traffic noise criteria by &gt; 2 dB(A) or exceedance to the ‘Acute’ 65 dB(A) noise criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Year 2014</td>
<td>Year 2024</td>
<td>Year 2014</td>
<td>Year 2024</td>
</tr>
<tr>
<td>2 Bungonia Road</td>
<td>63</td>
<td>55</td>
<td>65</td>
<td>59</td>
</tr>
<tr>
<td>33 Bungonia Road</td>
<td>46</td>
<td>38</td>
<td>48</td>
<td>42</td>
</tr>
</tbody>
</table>

Note 1: *Environmental Noise Management Manual* (RTA 2001)
4.3 Maximum noise level / sleep disturbance assessment

The Road Noise Policy provides a literature review for the assessment of sleep arousal due to traffic noise however does not set a sleep disturbance assessment criterion. Sleep disturbance impacts are likely to be dependent on the following:

- Maximum noise level of an event.
- Number of occurrences.
- Duration of the event.
- Level above background or ambient noise levels.

For continuous rather than intermittent traffic flow, the Environmental Noise Management Manual recommends $L_{\text{Amax}}$ noise pass-by events may lead to sleep disturbance if the $L_{\text{Amax}}$ noise levels exceeds the $L_{\text{Aeq}}$ noise level by more than 15 dB(A) when the $L_{\text{Amax}}$ noise levels is greater than 65. The Environmental Noise Management Manual advises that the maximum noise level can be used as a tool to prioritise and rank mitigation strategies, but should not be applied as a decisive noise criterion for selection of mitigation treatments.

The $L_{\text{Amax}}$ and $L_{\text{Aeq(9hr)}}$ noise levels during the night-time period (10:00 pm to 7:00 am) at noise monitoring location 1 are summarised in Table 15. Note that there was no significant existing road traffic noise exposure at noise monitoring location 2 therefore the results have not been presented.

### Table 15 Summary of maximum noise levels; dB(A)

<table>
<thead>
<tr>
<th>Noise monitoring location</th>
<th>$L_{\text{Amax}}$ range</th>
<th>$L_{\text{Aeq(9hr)}}$</th>
<th>Highest $L_{\text{Amax}}$ minus $L_{\text{Aeq(9hr)}}$</th>
<th>$L_{\text{Amax}}$ minus $L_{\text{Aeq(9hr)}}$ average</th>
<th>Number of $L_{\text{Amax}}$ events $&gt; 65$ dB(A) and $15$ dB(A) above $L_{\text{Aeq(9hr)}}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Location 1 2 Bungonia Road</td>
<td>49 to 91</td>
<td>54</td>
<td>37</td>
<td>21</td>
<td>153</td>
</tr>
</tbody>
</table>

The current maximum noise levels exceed the $L_{\text{Aeq(9hr)}}$ noise levels by more than 15 dB(A) and are above 65 dB(A) on several occasions per night at the noise monitoring location 1 (2 Bungonia Road).

Maximum noise levels are expected to decrease as well as the number of the $L_{\text{Amax}}$ events higher 65 dB(A) and 15 dB(A) above $L_{\text{Aeq(9hr)}}$ since the distance between the most affected residential receivers (2 Bungonia Road) the Bungonia Road is proposed to be increased.

Additionally the road design is likely to reduce the maximum noise levels for all residential receivers due to an improved road surface which is likely to reduce road irregularities and associated maximum noise level events.

4.4 Assessment of impacts

The Environmental Noise Management Manual (RTA, 2001) considers it reasonable to consider noise mitigation options when:

- There is existing road traffic noise exposure above the noise assessment criteria and the ‘build option’ noise levels are 2 dB(A) above the ‘no-build option’ noise levels.
- When there is existing road traffic noise exposure and the ‘build option’ noise levels are above the acute 65 $L_{\text{Aeq(15hr)}}$ Day and 60 $L_{\text{Aeq(9hr)}}$ night noise levels.
No residential receivers are predicted to exceed the road traffic assessment criteria. Additionally, no residential receivers are predicted to exceed the relative increase criteria or the acute noise levels.

33 Bungonia Road may be exposed to an increase of 2 to 4 dB(A) for year opening (2014). However, the predicted noise levels at this receiver remain below the road traffic noise criteria and the relative increase criteria. Hence, no residential receivers are predicted to require mitigation treatments.

It is predicted that the residence at 2 Bungonia Road will benefit from the proposed alignment. The alignment is proposed to be located about 35 metres away from the existing road and the benefit is expected to be a decrease of 5 to 6 dB(A) in 2014 if the proposed road is built. Additionally, maximum noise levels are expected to decrease at 2 Bungonia Road which will reduce sleep disturbance at this location.

It is noted that the predicted noise levels for the build option in 2024 are similar to the build option in 2014 when traffic flows are assumed to grow by 5 per cent every year. This is caused by wearing of the spray seal road surface as it ages. The correction applied for spray seal (see Table 12) as recommended by Austroads\(^2\) is +2 dB(A) in 2024 for worn surfaces and +4 dB(A) in 2014 for new surfaces. Therefore, the predicted noise levels are similar in 2024 compared to year opening.

The process for assessing road redevelopments for mitigation treatments is provided in Appendix B (Memo 9M4507 RTA, 2012).

---

\(^2\) Austroads Research Report, *Modelling, Measuring and Mitigating Road Traffic Noise*, 2005 (AP-R277/05)
4.5 Post-construction noise monitoring program

To confirm that the noise level targets are achieved the *Environmental Noise Management Manual* (RTA 2001) Practice note (viii) recommends that a post-construction noise monitoring program be undertaken.

The noise monitoring program (including simultaneous traffic counts) should be undertaken within 12 months of opening once traffic flows have stabilised. Monitoring locations should be selected along the route at the most affected residential receiver locations.

The measured noise levels should be compared to the noise level assessment targets. If the noise level targets are exceeded the *Environmental Noise Management Manual* (RTA, 2001) recommends the following action:

- If the exceedance is less than 2 dB(A), “the prediction methodology and suitability of noise mitigation measures should be reassessed and the reasons for the marginal exceedance should be identified in the report.”
- If the exceedance is greater than 2 dB(A), “the adequacy of the noise mitigation measures needs to be reviewed, and if problems are identified steps need to be taken to rectify the situation. Additional noise treatments may be required to achieve the design noise level, where this is feasible and reasonable.”
FORBES STREET

Noise Level dB(A)

- 55
- 60
- 65

Metres

Map Projection: Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia (GDA)
Grid: Map Grid of Australia 1994, Zone 56

Year 2014 'no-build option'
day-time noise levels

Figure 3
Figure 4

Year 2014 ‘no-build option’

night-time noise levels

- Map Projection: Transverse Mercator
- Horizontal Datum: Geocentric Datum of Australia (GDA)
- Grid: Map Grid of Australia 1994, Zone 56
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Noise Level dB(A)

- 55
- 60
- 65

Map Projection: Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia (GDA)
Grid: Map Grid of Australia 1994, Zone 56

Year 2024 ‘no-build option’
day-time noise levels

Figure 5
Noise Level dB(A)

- 50
- 55
- 60

Figure 6

Year 2024 ‘no-build option’

night-time noise levels
Noise Level dB(A)

- 55
- 60
- 65

Day-time noise levels

Figure 7

Year 2014 ‘build option’

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Figure 8

Year 2014 ‘build option’
night-time noise levels

Noise Level dB(A)

- 50
- 55
- 60

Metres

Map Projection: Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia (GDA)
Grid: Map Grid of Australia 1994, Zone 56

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Year 2024 ‘build option’
day-time noise levels

Noise Level dB(A)

- 55
- 60
- 65

Metres

Map Projection: Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia (GDA)
Grid: Map Grid of Australia 1994, Zone 56

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Figure 10

Year 2024 ‘build option’
night-time noise levels

Roads and Maritime Services
REF for replacement of Lansdowne Bridge

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Map Projection: Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia (GDA)
Grid: Map Grid of Australia 1994, Zone 56

Metres

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5. Construction noise and vibration assessment

5.1 Construction noise assessment

The noise emissions from construction have been assessed at the surrounding potentially affected receivers during the standard construction hours as well as outside the standard construction hours. A quantitative assessment has been undertaken with consideration to the *Interim Construction Noise Guideline* (DECC, 2009).

5.1.1 Construction program summary

Construction is expected to involve the following work methodology (the final work methodology would be determined during detailed design):

- Seed collection prior to construction for rehabilitation works where practicable.
- Progressive installation of temporary erosion, sedimentation and drainage controls.
- Utility adjustment (electricity and telecommunications) as required.
- Establishing site compounds.
- Establishing stockpile sites.
- Removal and mulching of vegetation, and grubbing along the new section of the alignment and along the section of the highway to be widened.
- Demolition of existing bridge.
- Drainage works.
- Piling works followed by bridge construction.
- Preparation of surface using graders, dozers, scrapers and other equipment.
- Recycling of suitable excavated material and incorporation of suitable material in earthworks.
- Compaction of the resultant surface using compaction equipment.
- Installation of roadside drainage structures.
- Construction of roadside batters.
- Construction of roadside gutters and berms.
- Application of flexible asphalt pavement using pavers and rollers.
- Landscaping and revegetation of the proposal site.
- Installation of line marking, signs and guide posts.
- Decommissioning of temporary facilities eg site compounds.
- Site clean-up and disposal of all surplus waste materials.

It is anticipated that work for the proposal would be undertaken during recommended standard hours for construction work according to the *Interim Construction Noise Guideline* (DECC, 2009):

- Monday to Friday: 7 am to 6 pm.
- Saturday: 8 am to 1 pm.
- Sundays and public holidays: no work.

Should any out of hours work be required, works would be undertaken in line with procedures contained in Environmental Noise Management Manual (RTA, 2001), Practice Notes vii – Roadworks Outside of Normal Working Hours.

5.1.2 Noise generating equipment

Plant and equipment needed for the proposal would be determined during the construction planning phase. The anticipated plant and equipment used for the proposal is shown in Table 16 with the corresponding noise emission sound power levels. Noise level data has been obtained from AS2436[^3] and the Environmental Noise Management Manual (RTA, 2001). Other equipment may be used however it is anticipated that they would produce similar noise emissions.

The magnitude of off-site noise impact associated with construction will be dependent upon a number of factors:

- The intensity and location of construction activities.
- The type of equipment used.
- Existing background noise levels.
- Intervening terrain and structures.
- The prevailing weather conditions.

Construction machinery would likely move about the study area altering noise impacts with respect to individual receivers. During any given period, the machinery items to be used in the study area would operate at maximum sound power levels for only brief stages. At other times, the machinery may produce lower sound levels while carrying out activities not requiring full power. It is highly unlikely that all construction equipment would be operating at their maximum sound power levels at any one time and certain types of construction machinery would be present in the study area for only brief periods during construction. Therefore noise predictions are considered conservative.

[^3]: Australian Standard, AS2436 – 2010, Guide to noise and vibration control on construction, demolition and maintenance sites
## Table 16  Construction plant and equipment sound pressure levels at 10 m, dB(A)

<table>
<thead>
<tr>
<th>Plant and equipment</th>
<th>Sound pressure level at 10 m</th>
</tr>
</thead>
<tbody>
<tr>
<td>Excavator with rock breaker attachment (20 tonne)</td>
<td>90</td>
</tr>
<tr>
<td>Light vehicle</td>
<td>78</td>
</tr>
<tr>
<td>Trucks</td>
<td>79</td>
</tr>
<tr>
<td>Concrete pump truck</td>
<td>80</td>
</tr>
<tr>
<td>Water carts</td>
<td>79</td>
</tr>
<tr>
<td>Grader</td>
<td>82</td>
</tr>
<tr>
<td>Asphalt paver</td>
<td>80</td>
</tr>
<tr>
<td>Bobcat (small front end loader)</td>
<td>82</td>
</tr>
<tr>
<td>Backhoe</td>
<td>76</td>
</tr>
<tr>
<td>Concrete vibrators</td>
<td>75</td>
</tr>
<tr>
<td>Smooth drum roller (15 tonne)</td>
<td>80</td>
</tr>
<tr>
<td>Pad foot roller (18 tonne)</td>
<td>80</td>
</tr>
<tr>
<td>Compactor</td>
<td>85</td>
</tr>
<tr>
<td>Road sweeper</td>
<td>79</td>
</tr>
<tr>
<td>Chainsaw</td>
<td>85</td>
</tr>
<tr>
<td>Stump grinder</td>
<td>85</td>
</tr>
<tr>
<td>Line marking vehicle</td>
<td>79</td>
</tr>
<tr>
<td>Crane (80 tonne)</td>
<td>77</td>
</tr>
</tbody>
</table>

### 5.1.3 Predicted construction noise impacts

For each item of equipment, the potential noise impacts on the surrounding sensitive receivers have been predicted. Noise modelling was undertaken using Computer Aided Noise Abatement (CadnaA). CadnaA is a computer program designed for the calculation, assessment and prognosis of noise exposure. CadnaA calculates environmental noise propagation according to ISO 9613-2 *Acoustics – Attenuation of sound during propagation outdoors.*

The following assumptions and calculation parameters were used in the noise model:

- Surrounding land was modelled assuming a ground absorption coefficient of 0.5.
- The noise model was used to predict noise levels during a typical worst case 15 minute period of operation where the specified item of equipment is running at full power.
- Atmospheric absorption was based on an average temperature of 10 degrees Celsius and an average humidity of 70 per cent.
- The noise source was located at the centre of either the existing or proposed alignment (whichever is closest to the receiver). In practice the equipment would move either side of these positions.
The predicted noise levels at each receiver are shown in Table 17 indicating the potential exceedances to the construction noise management levels during standard construction hours. Both residential receivers have the potential to experience an exceedance of the construction noise management levels during recommended standard construction hours. There is also the potential that the highly noise affected construction noise management level of 75 dB(A) could be exceeded at 2 Bungonia Road due to the close proximity to the existing alignment, which is anticipated to be removed. It is recommended that the noise mitigation measures detailed in Section 5.3 be implemented where feasible and reasonable and all potentially impacted residents should be informed of the nature of the works, expected noise levels, duration of works and a method of contact. Construction activities during recommended standard construction hours have the potential to exceed the highly noise affected construction noise management level at 2 Bungonia Road.

Activities that are going to occur during the night-time period have not been identified at this stage of the project and would be managed in the Construction Noise and Vibration Management Plan which would be prepared by the construction contractor. The consultation and procedural requirements of the *Environmental Noise Management Manual* (RTA, 2001) Practice Note (vii) should be implemented and are summarised in Section 5.3 to minimise and manage impacts. The construction contractor should also prepare an Out of Hours Works Procedure as part of the construction noise and vibration management plan for the project.

**Table 17  Construction plant and equipment noise levels at residential receivers, dB(A)**

<table>
<thead>
<tr>
<th>Plant and equipment</th>
<th>Sensitive receiver noise level</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2 Bungonia Road</td>
</tr>
<tr>
<td>Excavator with rock breaker attachment (20 tonne)</td>
<td>84</td>
</tr>
<tr>
<td>Light vehicle</td>
<td>72</td>
</tr>
<tr>
<td>Trucks</td>
<td>73</td>
</tr>
<tr>
<td>Concrete pump truck</td>
<td>74</td>
</tr>
<tr>
<td>Water carts</td>
<td>73</td>
</tr>
<tr>
<td>Grader</td>
<td>76</td>
</tr>
<tr>
<td>Asphalt paver</td>
<td>74</td>
</tr>
<tr>
<td>Bobcat (small front end loader)</td>
<td>76</td>
</tr>
<tr>
<td>Backhoe</td>
<td>70</td>
</tr>
<tr>
<td>Concrete vibrators</td>
<td>69</td>
</tr>
<tr>
<td>Smooth drum roller (15 tonne)</td>
<td>74</td>
</tr>
<tr>
<td>Pad foot roller (18 tonne)</td>
<td>74</td>
</tr>
<tr>
<td>Compactor</td>
<td>79</td>
</tr>
<tr>
<td>Road sweeper</td>
<td>73</td>
</tr>
<tr>
<td>Chainsaw</td>
<td>79</td>
</tr>
</tbody>
</table>
Plant and equipment | Sensitive receiver noise level
--- | ---
2 Bungonia Road | 33 Bungonia Road and Historic Lansdowne Park
Stump grinder | 79 | 55
Line marking vehicle | 73 | 49
Crane (80 tonne) | 71 | 47

Note: **Bold text** indicates exceedances to the noise management levels during standard construction hours

### 5.1.4 Sleep disturbance impacts

The *Interim Construction Noise Guideline* states that “where construction works are planned to extend over more than two consecutive nights, the impact assessment should cover the maximum noise level from the proposed works”.

Typically, \( L_{A1(1\text{minute})} \) noise levels are around 5 dB to 10 dB greater than the \( L_{Aeq(15\text{minute})} \) noise levels. Typically a window will provide a 10 dB reduction when open and a 20 dB reduction when closed. To be conservative, it is assumed that windows would be kept open during night-time construction activities.

The Office of Environment and Heritage publications acknowledges that based on the current level of understanding no absolute noise level criteria have been established that correlate to an acceptable level of sleep disturbance. However, the *Road Noise Policy* provides that maximum internal noise levels below 50 dB(A) to 55 dB(A) are unlikely to cause awakening reactions and one or two events per night, with maximum internal noise levels of 65 dB(A) to 70 dB(A) (inside dwellings) are not likely to significantly affect health and wellbeing. There is the potential for sleep disturbance impacts, with consideration to the *Road Noise Policy* sleep disturbance levels, if construction activities occur during the night-time period.

The construction contractor would prepare an Out of Hours Works Procedure as part of the Construction Noise and Vibration Management Plan for the project which includes how activities outside of the recommended standard construction hours are managed.
5.2 Construction vibration assessment

Energy from construction equipment is transmitted into the ground and transformed into vibrations, which attenuates with distance. The magnitude and attenuation of ground vibration is dependent on the following:

- The efficiency of the energy transfer mechanism of the equipment (i.e., impulsive; reciprocating, rolling or rotating equipment).
- The frequency content.
- The impact medium stiffness.
- The type of wave (surface or body).
- The ground type and topography.

Due to the above factors, there is inherent variability in ground vibration predictions without site-specific measurement data. The *Environmental Noise Management Manual* (RTA, 2001) provides typical construction equipment ground vibration levels at 10 metres. The rate of vibration attenuation can be calculated from the following regression analysis formula:

\[ V = D^{-n} \]

where

- \( V \) = Peak Particle Velocity
- \( D \) = Distance
- \( n \) = attenuation exponent. The value of \( n \) generally lies between 0.8 and 1.6 with a relatively common value of 1.0.

The predicted ground vibrations at various distances are shown in Table 18 for typical equipment that may be used based on data from the *Environmental Noise Management Manual* (RTA 2001).

**Table 18 Typical vibration levels at distances (mm/s Peak)**

<table>
<thead>
<tr>
<th>Plant item</th>
<th>Distance from source</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>10 m</td>
</tr>
<tr>
<td>Roller (15 tonne)</td>
<td>7 to 8</td>
</tr>
<tr>
<td>Compactor (7 tonne)</td>
<td>5 to 7</td>
</tr>
<tr>
<td>Dozer</td>
<td>2.5 to 4</td>
</tr>
<tr>
<td>Backhoe</td>
<td>1.0</td>
</tr>
<tr>
<td>Pavement breaker</td>
<td>4.5 to 6</td>
</tr>
</tbody>
</table>

5.2.1 Predicted construction vibration impacts

The nearest residential receiver to construction activities is the dwelling and buildings at 2 Bungonia Road which is located as close as eight metres from the existing road and 40 metres from the proposed road. All other residential receivers are located over 100 metres from the construction area and are not expected to be impacted by vibration from construction works.

Vibration is potentially perceptible at 2 Bungonia Road for pavement breaking, rolling and compacting activities. These would be considered intermittent and short-term and likely to be tolerated if prior warning is given to the resident. Therefore, the residents at 2 Bungonia Road should be informed of the nature of the works, expected vibration levels, duration of works and a method of contact.
With consideration to the building damage vibration criteria, the expected magnitude of ground vibrations at 2 Bungonia Road is potentially sufficient to cause building damage. Therefore the construction contractor should undertake a dilapidation survey for any buildings at this location and compliance vibration monitoring should be undertaken to ensure building damage vibration criteria are not exceeded.

### 5.3 Construction mitigation measures

There is the potential that construction activities could exceed the construction noise and vibration management levels for the proposal. Recommended construction noise and vibration mitigation measures are listed below. As part of the detailed design stage of the project a construction noise and vibration management plan should be developed by the construction contractor to implement the construction noise and vibration mitigation measures and minimise the impacts to the surrounding residences.

#### 5.3.1 Noise mitigation measures

The *Interim Construction Noise Guideline* (DECC, 2009) provides a summary of potential noise mitigation measures. It is recommended that the following construction noise mitigation measures be implemented to reduce the impact on the surrounding residences:

- The site configuration should be designed to minimise noise impacts to the surrounding community. The following should be considered in the design:
  - Construction compounds should be laid-out in such a way that the primary noise sources are at a maximum distance from residences, with solid structures (sheds, containers, etc) placed between residences and noise sources (and as close to the noise sources as is practical).
  - Compressors, generators, pumps and any other fixed plant should be located as far away from residences as possible and behind site structures.
  - Material dumps, loading and unloading areas should be located as far as practical from the nearest residences.

- All equipment should be selected to minimise noise emissions. Equipment should be fitted with appropriate silencers and be in good working order. Machines found to produce excessive noise compared to normal industry expectations should be removed from the site or stood down until repairs or modifications can be made.

- To reduce the annoyance associated with reversing alarms, broadband reversing alarms (audible movement alarms) should be used for all site equipment. Satisfactory compliance with occupational health and safety requirements will need to be achieved and a safety risk assessment may need to be undertaken to determine that safety is not compromised. Refer to Appendix C of the *Interim Construction Noise Guideline* (DECC, 2009) for more information.

- General construction activities should be limited to the recommended construction hours where feasible and reasonable.

- The final selection and design of noise mitigation measures should be undertaken with consideration to best management and economically achievable practice during the development of the construction noise and vibration management plan.

- The construction noise and vibration management plan should be reviewed in response to complaints and amended where practical throughout the construction phase of the project.
If works are planned outside of the recommended standard construction hours the construction contractor would also prepare an Out of Hours Works Procedure as part of the construction noise and vibration management plan for the project. *Environmental Noise Management Manual* Practice Note (vii) requires that Out of hours work should not affect residences on more than two consecutive nights, or on more than a total of six nights over a period of one calendar month. When night work is programmed in stages to comply with this requirement, the periods of work should be separated by not less than one week.

### 5.3.2 Work ethics

All site workers should be sensitised to the potential for noise and vibration impacts on local residents and encouraged to take practical and reasonable measures to minimise the impact during the course of their activities. This should include:

- Avoid the use of loud radios.
- Avoid shouting and slamming doors.
- Where practical, machines should be operated at low speed or power and switched off when not being used rather than left idling for prolonged periods.
- Keep truck drivers informed of designated vehicle routes, parking locations and delivery hours.
- Minimise reversing.
- Avoid dropping materials from height.
- Avoid metal to metal contact on material.
- All engine covers should be kept closed while equipment is operating.

### 5.3.3 Vibration mitigation measures

When pavement breaking, rolling and compacting activities are required adjacent to 2 Bungonia Road, it is recommended that the resident be informed of the nature of the works, duration and contact details.

The construction contractor should undertake a dilapidation survey for any buildings at 2 Bungonia Road.

### 5.3.4 Community relations

Consultation and cooperation between the site and surrounding residents will assist in minimising uncertainty, misconceptions and adverse reactions to noise and vibration.

The *Environmental Noise Management Manual* (RTA, 2001) Practice Note (vii) provides community consultation procedures for road works outside normal working hours. This includes the following:

- Contact the local community potentially affected by the proposed works (outside of recommended construction hours) and inform them by letter of the proposed work, location, type of work days and dates of work and hours involved. The contact should be made five days prior to commencement of works.
- A suitable advertisement should be placed in local papers including a reference to night-time noise impacts.
- A community liaison phone number and permanent site contact should be provided so that complaints can be received and addressed in a timely manner.
• Upon receipt of a noise complaint monitoring should be undertaken and reported as soon as possible. If exceedances are detected, the situation should be reviewed in order to identify means to attempt to reduce the impact to acceptable levels.

5.3.5 Compliance noise and vibration monitoring

Attended compliance noise monitoring should be undertaken upon receipt of a complaint. Monitoring should be reported as soon as possible. In the case that exceedances are detected, the situation should be reviewed in order to identify means to minimise the impacts to residences.

Vibration monitoring should be undertaken at the commencement of activities near 2 Bungonia Road.
6. Conclusions

No residential receivers are predicted to exceed the road traffic assessment operational noise criteria. Additionally, no residential receivers are predicted to exceed the relative increase criteria or the acute noise levels. Therefore no residential receivers are predicted to require mitigation treatments for operational noise.

Construction works during standard construction hours are predicted to exceed the construction noise criteria at both residential receivers. Feasible and reasonable noise mitigation measures have been recommended for implementation. Mitigation measures will minimise impacts at the surrounding residential receivers. However, it is unlikely that implementation of all reasonable and feasible noise mitigation measures would reduce noise levels to below the construction noise criteria under all circumstances. A construction noise and vibration management plan should be developed by the construction contractor to implement the construction noise and vibration mitigation measures and reduce the noise impacts to the surrounding residences. If construction activities were to occur outside standard recommended hours, a strong justification would be required as well as the preparation of an Out of Hours Works Procedure as part of the construction noise and vibration management plan.

Vibration is potentially perceptible at 2 Bungonia Road for pavement breaking, rolling and compaction activities. These would be considered intermittent and short-term and likely to be tolerated if prior warning is given to the resident. Therefore the residents at 2 Bungonia Road should be informed of the nature of the works, expected vibration levels, duration of works and a method of contact. With consideration to the building damage vibration criteria, the expected magnitude of ground vibrations at 2 Bungonia Road is potentially sufficient to cause building damage. Therefore the construction contractor should undertake a dilapidation survey for any buildings at this location and compliance vibration monitoring should be undertaken to ensure building damage vibration criteria are not exceeded.
7. References


British Standards, 1992, *BS 6472 Guide to Evaluation of Human Exposure to Vibration in Buildings (1 Hz to 80 Hz)*.


Bureau of Meteorology’s Goulburn Airport Automatic Weather Station data from 6 December to 13 December 2012.

Townsend, P., 2013, Personal communication between Peter Townsend (RMS) and Lucy Bourne (GHD).
Appendix A - Noise level charts

Noise monitoring location 1 and location 2
Noise Level Charts
33 Bungonia Rd, Goulburn, NSW - Wednesday 12 December 2012

Noise Level Charts
33 Bungonia Rd, Goulburn, NSW - Thursday 13 December 2012
Appendix B - RTA flowchart for selecting mitigation treatments

Assessment of a road redevelopment
An assessment of a road redevelopment project is required to support an EA or RPE.

For an area within 600 metres of the road project:
- Conduct noise monitoring and traffic monitoring contemporaneously at sufficient monitoring points to verify the noise model predictions and calibrate the model where needed.
- Provide noise contour maps to show where $L_{Aeq}$ based noise criteria are exceeded.
- Conduct noise modelling for noise sensitive receivers (e.g., each facade of residences, schools, hospitals, places of worship, child care facilities and open space) to identify noise levels for “no build” and “build” scenarios and to determine where noise criteria are exceeded.
- Identify the change in noise levels and absolute level of traffic noise for the “build” scenario at locations and for facades where the noise criteria are exceeded.

Is the increase in total road traffic noise more than 12 dB at the design year?

- YES
- NO

Does total road traffic noise exceed RNP criteria at the design year?

- YES
- NO

Consideration of additional noise mitigation measures beyond those applied to the road design is not required.

EVALUATE & SELECT NOISE MITIGATION MEASURES

Evaluate noise mitigation measures in accordance with steps 4 to 6 of Practice note 4 of the ENMM noting the following:

1. Evaluate noise mitigation measures in following order of priority:
   - Road design & traffic management
   - Quieter pavement surfaces
   - In corridor noise barriers/mounds
   - At-property treatments or localized barriers/mounds

2. Evaluate noise mitigation measures where either:
   - The increase in noise level between the build and no build scenarios at year of opening or at the design year is more than 2 dB. Where the change in noise level is 2 dB or less then the impact is minor and assessment of mitigation measures is limited to road design & traffic management. An exception to this may be reasonable where the mitigation measure is relatively inexpensive for example small extensions to length or height of barriers or to length of pavement treatments already planned or the use of small barriers that are relatively cheap to install (such as “New Jersey”-style kerbs), or
   - The level of road traffic noise is at or above an acute level of noise at the design year regardless of any change in noise level between build and no build scenarios.

3. Where the barrier height achieves the RNP controlling criteria at the worst noise sensitive affected receiver no additional architectural treatment is needed.

4. Where a barrier height less than the height needed to meet the RNP controlling criteria at the worst affected noise sensitive receiver is selected (i.e., the “assessed” barrier) then additional mitigation using architectural treatment is limited to receivers above the RNP criteria that experience an increase of more than 2 dB or have an acute level of noise after the noise reduction due to the barrier is considered.

5. Architectural treatments may replace at-road mitigation only in the following circumstances:
   - Where isolated groups of dwellings occur in close groupings of 3 or less (in applying this condition take care that locations in medium density areas (e.g., urban and suburban areas) are not erroneously identified as isolated groups of 3 or less, particularly where other dwellings are located close-by), or
   - Where the affected community express a preference for architectural treatment and the cost is less than a combination of a barrier and architectural treatment, or
   - Where noise barriers cannot achieve the level of noise mitigation (insertion loss) required in Practice note 4, or
   - Where the applicable noise criteria are internal (e.g., schools, hospitals, child care facilities and places of worship).
OVERALL CONSIDERATION OF FEASIBLE & REASONABLE MEASURES

Issues of feasibility are listed in ENMM Practice note 4 and include safety, water management, access and maintenance, facade condition and ground conditions. Where issues of feasibility are identified that would prevent installation of a noise mitigation measure that had been identified for consideration it is important to provide a well supported and objective case to support the feasibility issues cited. Expert opinion in each particular area is helpful and for contentious locations the views of an independent expert are highly recommended. Quantitative information such as wind loading calculations, diagrams of site access, soil conditions, etc are needed to provide an objective basis. If there is insufficient detail available at this point to present a quantified and definitive case then the issues and extent of information known should be presented together with a clear commitment to provided the missing information once the detailed design of the project is known. It should also be clearly stated that it will only be at that stage (ie post detailed design) that a decision on what noise mitigation measures can be applied can be made.

The consideration of what is reasonable typically means looking at cost and equity considerations. There is no set monetary limit for noise mitigation provided for a road project however, there are some guiding principles to gauge whether costs are reasonable and equitable and the following points should be considered:

- Cost of mitigation measure
- Total cost of noise mitigation for the project
- Cost of mitigation measure as percentage of total project cost and total cost of noise mitigation measures as percentage of total project cost
- Have comparable noise mitigation measures been provided at other locations in the project or for other similar projects.

Use this and other salient information that may be available to build a cogent case based on cost and equity considerations to support any view that the mitigation measure is not reasonable.

It is only for individual property treatments that a limit of $30,000 is applied. The theme throughout the ENMM is to prefer at road noise mitigation measures over at property measures. Except where isolated groups of dwellings occur in close groupings of 3 or less there is no provision to select at property noise mitigation measures over at road noise mitigation measures based solely on cost.
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**Document Status**

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