Transport for NSW

Construction Noise and Vibration Guideline (Roads)

(For public transport infrastructure projects use EMF-NV-GD-0060)

December 2024

NSW GOVERNMENT

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Acknowledgement of Country

Transport for NSW acknowledges the traditional custodians of the land on which we work and live.

We pay our respects to Elders past and present and celebrate the diversity of Aboriginal people and their ongoing cultures and connections to the lands and waters of NSW.

Many of the transport routes we use today – from rail lines, to roads, to water crossings – follow the traditional Songlines, trade routes and ceremonial paths in Country that our nation's First Peoples followed for tens of thousands of years.

Transport for NSW is committed to honouring Aboriginal peoples' cultural and spiritual connections to the land, waters and seas and their rich contribution to society.

Document control

Document owner	Senior Specialist (Noise)
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Superseded documents	Construction Noise and Vibration Guideline version 1.0 Section 5 and Practice Note (vii) of the Environmental Noise Management Manual (2001)

Versions

Version	Date	Amendment notes
1.0	Aug 2016	First issue
1.1	Jun 2022	Rebranded from Roads & Maritime to Transport for NSW
1.2	Jul 2023	Minor updates and naming change
1.3	Nov 2024	Minor updates resolving noise level ranges applicable for mitigation
1.4	Dec 2024	Update to resolve omission of two entries in Table 6 from previous version

Related policy and supporting information

- Transport Environment and Sustainability Policy
- Environment & Sustainability Management Framework
- EPA's Interim Construction Noise Guideline
- EPA's Assessing Vibration: a technical guideline
- EPA's NSW Road Noise Policy
- Transport's EMF-NV-PR-0083 Noise and vibration assessment procedure (road traffic and construction)
- Transport's EMF-NV-GD-0060 Construction noise and vibration (public transport infrastructure)
- Transport's EMF-NV-GD-0025 Road Noise Criteria Guideline
- Transport's EMF-NV-GD-0024 Road Noise Mitigation Guideline

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1. Overview

1.1 Why is this guideline required?

This guideline outlines the approach Transport for NSW ('Transport') takes to the assessing and mitigating construction noise. For the purposes of this guideline construction noise and vibration also includes noise and vibration from minor works maintenance activities.

This policy should be read in conjunction with the documents nominated above.

1.2 Policy statement

Transport is committed to effectively managing impacts from its activities in an environmentally-responsible manner. Transport is committed to avoiding or minimising noise and vibration impacts from construction noise on projects under our control.

Transport recognises that considering noise at the outset of a project can minimise or avoid noise impacts and the cost of mitigating them.

Transport will assess and provide feasible and reasonable noise mitigation measures for:

- Maintenance works.
- Construction.
- Construction traffic including diversions.
- Ancillary sites.

Transport prefers noise and vibration mitigation measures to be applied within the road corridor or site boundary wherever practicable. Measures that need to be applied outside the road corridor or site boundary, such as at-property treatment of building facades, will be limited to the circumstances described in this guideline.

1.3 Context

The EPA Interim Construction Noise Guideline calls for the application of feasible and reasonable measures to mitigate construction noise and vibration.

This guideline provides the detail needed to identify feasible and reasonable noise mitigation measures for construction, minor works and maintenance projects.

This guideline will need to be considered for all construction, minor works and maintenance projects.

Construction noise impacts and mitigation measures need to be evaluated at various stages of a project to inform the concept design, environmental impact assessment, detail design and construction process.

When identifying feasible and reasonable noise mitigation the noise level from construction sites is considered in isolation from road traffic or operational noise. This is because construction noise is different in character operational noise. This is reflected by EPA's construction criteria which relate mostly to how noisy construction is relative to background noise levels.

Construction vehicle traffic and traffic diversions are assessed and mitigated using standard road traffic noise processes.

1.4 Construction hours

Construction activities (including the delivery of plant and equipment) should be limited to within hours described in Table 1 below wherever feasible and reasonable. This helps to reduce noise and vibration impacts by limiting potentially noisy and vibration causing construction activities to the day time, where background noise levels are higher, and by providing respite from construction noise and vibration during the evening, overnight and on weekends.

Table 1: Construction hours

Construction hours	Monday to Friday	Saturday	Sunday / Public Holiday
Standard construction hours	7:00 am to 6:00 pm	8:00 am to 1:00 pm	No work
Construction activities with impulsive or tonal noise emissions	8:00 am to 5:00 pm[1]	9:00 am to 1:00 pm[1]	No work
Blasting	9:00 am to 5:00 pm	9:00 am to 1:00 pm	No blasting

Note [1]: Works may be carried out in continuous blocks not exceeding three hours each with a minimum respite from those activities and works of not less than one hour between each block. 'Continuous' includes any period during which there is less than one-hour respite between ceasing and recommencing any of the work the subject of this condition.

1.5 Scope

This guideline provides a consistent approach to the evaluation, selection and design of the most appropriate noise and vibration control options during maintenance and construction. This guideline is most relevant for:

- Project managers
- Environmental staff
- Project implementation managers
- Acoustical consultants

This guideline will apply to:

- All projects managed by Transport:
  - in the final stages of project concept design development and in the environmental impact assessment (including any Review of Environmental Factors (REF))
  - during the project's detailed design
  - during the actual process of construction
- Minor works
- Maintenance
- Construction traffic and diversions

This guideline does not apply to:

- Emergency works

2. Principles for managing construction noise and vibration

This guideline describes the principles to be applied when reviewing and assessing construction noise, vibration and construction traffic. It also describes procedures to assist in reviewing noise and vibration mitigation.

The intention is to meet the following principles in all situations. Should circumstances arise where the procedures in this document do not appear to meet the principles below, then the procedures may be varied through consultation with Transport's noise specialists. Note that the use of the procedures in this guideline does not guarantee that the principles will always be met and in cases where there is doubt, then it is the principles rather than the procedures that take precedence.

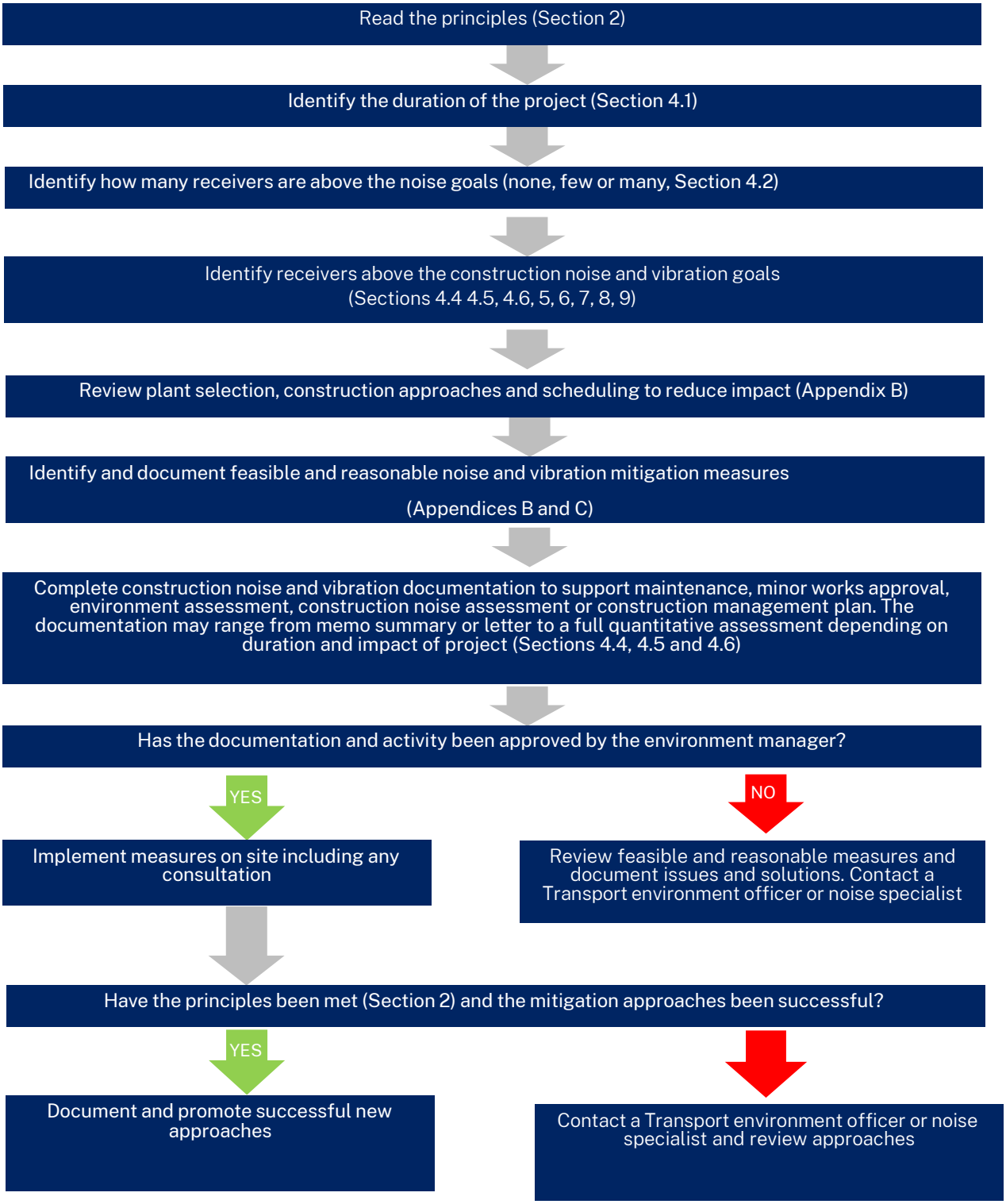
These principles are:

1. Good engagement with the community will be maintained to facilitate effective project delivery with balanced community impacts.
2. Construction noise and vibration levels for sensitive receivers will be minimised where feasible and reasonable.
3. Feasible and reasonable mitigation will reflect the time of day, and the degree and duration of the impact.
4. The community will be informed of the dates for the intended works, sequencing and timing of noisy events. Where possible, this will include an indicative schedule over a 24-hour period.
5. Minimising construction noise and vibration will be viewed as a continuous improvement exercise that is inclusive of stakeholders where no idea is too small to be considered.
6. Staff and community will be informed of the effort and methods undertaken to reduce noise and vibration for the works.
7. Any operational noise and vibration improvements resulting from the works will be promoted to the community.

3. How do I use this guideline?

The following flow chart provides an overview of how to use this guideline. Key aspects to note are that the guideline principles must be met and that each step in the flow chart is applicable at each project stage.

Figure 1: Overall approach for management of noise and vibration impacts



The following section describes in detail the process for construction noise and vibration assessments.

4. Identifying the required assessment type

4.1 Project duration and level of impact

Projects including maintenance have the potential to affect the community due to noise and vibration. The overall effect of a project and the likelihood of adverse community reaction depend on both duration of the works and level of noise and vibration. This needs to be recognised for each activity without creating an overly-onerous process that is out of proportion with the scale of the project, potential impacts or number of receivers.

The following approach has been developed to reflect the different impact (number of receivers potentially affected) and timelines from inception to delivery of various projects. The aim is to achieve consistent outcomes across all projects while providing an amount of input to noise management that reflects the project timelines and resources.

The approach also recognises that much work is routine and provides for the use of standardised assessments which may be reused for similar tasks in similar situations.

- The following key tasks must be completed. Note for ease of implementation the methods and tables in this guideline have been implemented in Construction and Maintenance Noise Estimator (Roads) (Section 5.1).
- Identify appropriate background noise levels from AS1055, short-term measurement or noise logging.
- Identify the Noise Management Level. Noise Management Levels are defined by the EPA's Interim Construction Noise Guideline goals.
- Identify safe working distances for vibration and blasting.
- Identify the noise and vibration impact and feasible and reasonable mitigation measures. The measures and level of engagement will vary depending on the duration and impact of the project.
- Complete an assessment documenting the noise and vibration impact for the project and measures undertaken to mitigate the impact. For shorter duration or minimal impact projects this will be a brief memo or letter summary ranging to a full quantitative assessment report for longer-term projects with greater impact.
- Obtain approval from an Environment Manager with appropriate delegation.
- Implement community consultation or notification measures.
- Apply and review feasible and reasonable noise mitigation.
- Review measures taken to reduce noise and vibration and promote successful new approaches.

4.2 Identifying the assessment type

The project duration and number of receivers identify the type of construction noise assessment to be carried out for the project. Different assessment types require different amounts of modelling detail and reporting. There are three tiers of approaches based on the number of receivers:

- No receivers with noise levels above the NML (Section 4.4).
- Few receivers above the NML (Section 4.5).
- Many receivers above the NML (Section 4.6).

And three tiers of noise assessment which reflects the project duration:

- Projects less than three weeks duration.
- Projects three to six weeks duration.
- Projects greater than six weeks duration.

The noise assessments with shorter duration and fewer receivers are quicker to complete and are based on the distance between the project and receivers. The distances are to be used as a guide and are intended to be conservative compared with detailed calculations of noise levels. In all instances detailed calculations or assessments may be completed if this is the preferred approach.

All steps below requiring the use of lookup tables in Appendices C to E, other than full quantitative approaches with modelling and noise logging, may be instead implemented with Section 5.1 Construction and Maintenance Noise Estimator (Roads).

4.3 Number of affected receivers

The first task in completing any assessment is to estimate whether the project may affect many receivers, few receivers or no receivers. The following steps may be used for guidance.

a) Use the Construction and Maintenance Noise Estimator (Roads) to identify an appropriate background noise level and Noise Management Level (NML) for each time period (implemented from Appendix D, table D1). Where needed noise measurement may provide guidance on the background noise level to select in the Estimator.

b) Confirm what equipment is likely to be used for the works and identify and implement standard mitigation measures as described in Appendix B. These standard measures will include scheduling noisy works to occur in standard hours where possible or before 11pm where possible.

c) Using either the individual item or scenario calculation sheets in the Construction and Maintenance Noise Estimator (Roads) (Section 5.1) select appropriate items that represent the equipment that will be used during the works. Also include any shielding implemented as part of the standard mitigation measures in Appendix B. The Estimator will then display the Affected Distance where receivers will be impacted to different degrees.

d) Broadly identify the number of receivers within the NML Affected Distance and minimum working distances for vibration from Section 6 and for blasting refer to Section 7.

4.4 No affected receivers

Where there are no receivers within the NML affected Distance or minimum vibration or blasting distance:

4.4.1 Projects with less than three weeks impact duration

For projects of less than three weeks duration, document the background noise levels, noise management levels and the affected distance in an internal memo or letter.

4.4.2 Projects with greater than three weeks impact duration

For projects of less than three weeks duration, document the background noise levels, noise management levels and the affected distance in an internal memo or letter.

- Use the Construction and Maintenance Noise Estimator (Roads) (Section 5.1) to calculate the noise levels at the worst-affected receiver.
- Document the background noise level and predicted noise level from the works at the worst-affected receiver in an internal Transport memo or letter.

- Notify the worst-affected receiver where noise levels from the construction or maintenance are predicted to be greater than 30dBA at their property boundary (or 30 metres from the receiver on large properties). The purpose of this it to ensure the nearest receiver is aware of the works where there is a chance noise may be noticeable.

4.5 Few affected receivers

Where there are few receivers within the affected distance, it may be possible to meet with all receivers to discuss the project and any noise impacts during the works. These meetings could assist in scheduling works to minimise impacts on the community. In instances where the resident cannot be contacted a letter may be hand delivered to their door outlining the works details with contact information should they have any questions.

However, the emphasis should be on meeting the receivers for the process to qualify as few receivers. Where a bulk postal letterbox drop (or equivalent) is required, the number of receivers would be considered to be many.

4.5.1 Projects with less than three weeks impact duration

For projects with less than three weeks impact duration complete a distance-based noise assessment to inform the community and establish feasible and reasonable noise mitigation.

- Use the Construction and Maintenance Noise Estimator (Roads) (Section 5.1) to identify an appropriate background noise level and Noise Management Level (NML) for each time period (implemented from Appendix D, table D1). Noise measurement may give guidance on the background level to select in the Estimator.
- Confirm what equipment is likely to be used for the works and identify and implement standard mitigation measures as described in Appendix B. These standard measures will include scheduling noisy works to occur in standard hours where possible or before 11pm where possible.
- Using either the individual item or scenario calculation sheets in the Construction and Maintenance Noise Estimator (Roads) (Section 5.1) select appropriate items that represent the equipment that will be used during the works. Also include any shielding implemented as part of the standard mitigation measures in Appendix B. The Estimator will then display distances where receivers are impacted to different degrees (implemented from Appendix D, table D2).
- For each distance, the Estimator will identify recommended additional feasible ad reasonable mitigation for consideration using Appendix C, table C1.
- Where the works will generate additional traffic movements, then use the Estimator to assess traffic noise (implemented from Appendix C). For example, traffic may be generated by spoil movement or temporary reroutes of roads.
- Where night works are involved, use Appendix E to identify sleep disturbance distances.
- For vibration Section 6 and for blasting refer to Section 7.
- Obtain approval from Environment Manager with appropriate delegation.
- Identify the team member who is responsible for implementing measures and managing noise and vibration.
- For out-of-hours works, engage with the affected receivers using the additional feasible and reasonable mitigation measures identified from Appendix C for guidance.
- Implement the measures on site in accordance with the principles.
- Document the outcomes of these steps.

4.5.2 Projects with greater than three weeks impact duration

If the project impact duration is between three to six weeks, noise calculations should be completed at each receiver and the details of the work documented in more detail.

- Use the Construction and Maintenance Noise Estimator (Roads) (Section 5.1) to predict noise levels and mitigation measures at all receivers to inform the consultation using the Individual Receiver and Traffic Noise calculation sheets. Include any shielding implemented under the standard measures from Appendix B. Measured background noise levels may be entered into the spreadsheet.
- The Estimator will identify any additional feasible and reasonable mitigation measures from Appendix C.
- Where night works are involved use Appendix E to identify sleep disturbance distances.
- For vibration Section 6 and for blasting refer to Section 7.
- Prepare a summary report detailing:
  - background noise levels
  - noise management levels
  - estimated noise and vibration levels for each time period.
  - sleep disturbance for night time works
  - noise and vibration mitigation measures
  - team member responsible for implementing mitigation measures and managing noise and vibration
  - obtain approval from Environment Manager with appropriate delegation.
- Engage with the affected receivers to discuss noise and vibration impacts and implement remaining additional mitigation measures using the additional mitigation measures in Appendix C as guidance.
- Implement the measures on site in accordance with the principles.
- Document the outcomes of these steps.

4.5.3 Projects with greater than three weeks impact duration

- For projects greater than six weeks a detailed noise assessment should be undertaken with at least seven days of noise logging (Further detail is given in Section 5.2). For blasting see Section 7 and for vibration Section 6.
- Obtain approval from the Environment Manager with appropriate delegation.
- Engage with the affected receivers on noise and vibration impacts and implement remaining additional mitigation measures using the additional mitigation measures in Appendix C as guidance.
- Implement the measures on site in accordance with the principles.
- Document the outcomes of these steps.

4.6 Many affected receivers

Where there are many receivers within the affected distance, it may not be possible to meet with all receivers. In this situation bulk letterbox drops (or equivalent) may be required to notify the community. Project resources should be sufficient to meet or engage with the worst affected receivers.

In instances where one of the worst-affected residents cannot be contacted an option may be a letter hand delivered to their door outlining the works details and contact information should they

have any questions. However, the emphasis should be on meeting or engaging the worst-affected receivers.

4.6.1 Projects with less than three weeks impact duration

For projects with less than three weeks impact duration complete a distance-based noise assessment to inform the community and establish feasible and reasonable noise mitigation.

- Use the Construction and Maintenance Noise Estimator (Roads) (Section 5.1) to identify an appropriate background noise level and Noise Management Level (NML) for each time period (implemented from Appendix D, table D1). Where needed noise measurement may provide guidance on the background noise level to select in the Estimator.
- Confirm what equipment is likely to be used for the works and identify and implement standard mitigation measures as described in Appendix B. These standard measures will include scheduling noisy works to occur in standard hours where possible or before 11pm where possible.
- Using either the individual item or scenario calculation sheets in the Construction and Maintenance Noise Estimator (Roads) (Section 5.1) select appropriate items that represent the equipment that will be used during the works. Include any shielding implemented as part of the standard mitigation measures in Appendix B. The Estimator will then display distances where receivers are impacted to different degrees (implemented from Appendix D, table D3).
- For each distance the Estimator will identify recommended additional feasible and reasonable mitigation for consideration using Appendix C, Table C1.
- Where the works will generate additional traffic movements then use the Estimator to assess traffic noise (implemented from Appendix C). For example, traffic may be generated by spoil movement or temporary reroutes of roads.
- Where night works are involved use Appendix E to identify sleep disturbance distances.
- For vibration Section 6 and for blasting refer to Section 7.
- Document the outcomes of the steps above.
- Obtain approval from the Environment Manager with appropriate delegation.
- For any noise-sensitive receiver within each identified distance, implement the corresponding noise mitigation.
- Meet or engage with the worst-affected receivers.
- Implement the measures on site in accordance with the principles.
- Document the outcomes of the steps above.

4.6.2 Projects with greater than three weeks impact duration

For projects greater than three weeks a detailed noise assessment should be undertaken.

- Complete a detailed assessment, see Section 5.2. For blasting see Section 7 and for vibration Section 6.
- Obtain approval from Environment Manager with appropriate delegation.
- Engage with the affected receivers on noise and vibration impacts and implement remaining additional mitigation measures using the additional mitigation measures in Appendix C.
- Implement the measures on site in accordance with the principles.
- Document the outcomes of these steps.

5. Quantitative assessment of construction noise

5.1 Construction and Maintenance Noise Estimator (Roads)

Transport has an Excel spreadsheet titled Construction and Maintenance Noise Estimator (Roads). Please see our Reducing road traffic noise - Roads and waterways - Transport for NSW for the latest version.

The Estimator works in two ways. The first allows the user to enter plant items or activities and the tool outputs distances at which receivers may be impacted. It also allows the user to enter the distances between plant and a receiver, background noise levels and to select whether acoustic shielding has been provided. The output also provides a list of additional mitigation measures from Appendix C.

The Estimator also provides estimates of noise from construction traffic.

5.2 Detailed assessment

For higher-impact projects with many receivers or a longer duration, a detailed quantitative assessment should be completed.

As part of the environmental impact assessment process, the impacts on nearby receivers of airborne noise, ground-borne noise and ground-borne vibration generated during the construction of a project are evaluated. This assessment shall form part of the environmental impact assessment documentation (e.g., Review of Environmental Factors (REF)). The noise and vibration construction assessment should:

- Be based on the design, scope and construction methodology for the project.
- Identify sensitive receivers, the existing noise environment and complete an assessment against relevant criteria for the project. Appendix A lists references with suitable criteria for the assessment of construction noise and vibration.
- Appendices B provides standard measures and Appendix C provides further feasible and reasonable noise and vibration mitigation measures (including any project specific measures1) to meet or mitigate any predicted exceedances of the construction noise and vibration objectives at the nearest receivers.

Where the noise and vibration assessment is placed on public display with an environmental assessment, comments received from the community and stakeholders should be considered. Where feasible and reasonable, changes should be made to mitigation and management procedures to accommodate the local community and stakeholders.

Further details on completing quantitative assessments for Transport projects are provided in the Transport's EMF-NV-PR-0083-Preparing an operational traffic and construction noise and vibration assessment report.

The construction noise and vibration objectives for the project and any accompanying mitigation measures in the environmental impact assessment documentation are based on an initial design

[1] The construction noise and vibration objectives for the project and any accompanying mitigation measures in the environmental impact assessment documentation are based on an initial design and construction

and construction methodology. Typically, as the design of a project is further developed following its approval, the construction methodology and staging is also altered.

Where sufficient detail was not available about the construction activities or timing of works near specific receivers during the environmental assessment, an additional Construction Noise and Vibration Impact Assessment (CNIA) may be required for each major construction stage or key activity. This additional detail will be included or referenced in the Construction Noise and Vibration Management Plan (CNVMP). The CNIA should be used as the basis on which to develop or implement the CNVMP[2] for that activity.

5.3 Noise catchment areas

While not a Transport nor EPA requirement it is common for receivers to be grouped into catchment areas for construction noise during an environmental assessment. A Noise Catchment Area (NCA) can provide a logical grouping of receivers affected by the same works to assist with assessment, consultation or notification.

Noise logging should be completed in a location that is representative of the worst-case impact (exceedance of background level by construction noise) to determine the background noise level and criteria. Additional spot check measurements should be completed to understand the range in background noise levels and associated criteria within the catchment which may vary between receiver locations or between alternate facades with different exposure.

The spot checks should be used to provide greater certainty that the mitigation measures designed to manage the impact at the assumed worst case receiver address the noise impact across the catchment. While it may not be possible to accurately identify the background noise level at each receiver, noise levels should be predicted for all receivers within the catchment.

6. Construction vibration

6.1 Ground vibration-minimum working distances from sensitive receivers

As a guide, minimum working distances from sensitive receivers for typical items of vibration intensive plant are listed in Table 2. The minimum distances are quoted for both “cosmetic” damage (refer BS 7385) for light-framed residential type structures and human comfort (refer Assessing Vibration: a technical guideline (EPA 2006)). The minimum working distances for cosmetic damage must be complied with at all times, unless otherwise approved by Transport or under the environmental license as relevant.

Note that in the case of heritage structures, DIN 4150 has criteria of particular relevance in relation to damage.

[2] NB: Any changes to the project must be consistent with the environmental assessment documentation and project approval and cannot cause significant additional impacts on the environment or community.

Table 2: Recommended minimum working distances for vibration intensive plant from sensitive receivers

Plant item	Rating / Description	Minimum working distance	
		Cosmetic damage (BS 7385)	Human response (OH&E Vibration guideline)
Vibratory Roller	< 50 kN (Typically 1-2 tonnes)	5 m	15 m to 20 m
	< 100 kN (Typically 2-4 tonnes)	6 m	20 m
	< 200 kN (Typically 4-6 tonnes)	12 m	40 m
	< 300 kN (Typically 7-13 tonnes)	15 m	100 m
	> 300 kN (Typically 13-18 tonnes)	20 m	100 m
	> 300 kN (>18 tonnes)	25m	100 m
Small Hydraulic Hammer	(300 kg - 5 to 12t excavator)	2 m	7 m
Medium Hydraulic Hammer	(900 kg –12 to 18t excavator)	7 m	23 m
Large Hydraulic Hammer	(1600 kg –18 to 34t excavator)	22 m	73 m
Vibratory Pile Driver	Sheet piles	2 m to 20 m	20 m
Pile Boring	≤ 800 mm	2 m (nominal)	4 m
Jackhammer	Hand held	1 m (nominal)	2 m
Small Hydraulic Hammer	(300 kg - 5 to 12t excavator)	2 m	7 m
Medium Hydraulic Hammer	(900 kg –12 to 18t excavator)	7 m	23 m

Note: Note that more stringent screening criteria may be applicable to heritage or other sensitive structures

The minimum working distances are indicative and will vary depending on the particular item of plant, local geotechnical conditions and the dominant frequency of the construction vibration levels. They apply to cosmetic damage of typical light-framed residential buildings under typical geotechnical conditions and assume that construction vibration could include low frequency content with associated increased risk of cosmetic damage. Vibration monitoring is recommended to confirm the minimum working distances at specific sites.

Operational aspects of some receivers may be highly sensitive to noise and vibration over and above typical noise and vibration allowances based on annoyance and human comfort. For highly-sensitive receivers (e.g. high-technology facilities with sensitive equipment, recording studios and cinemas),

specific assessment is required to ensure satisfactory operation of the facility and determine if any mitigation or management measures are required to minimise the potential impacts. Some guidance where building contents contain sensitive equipment may be found in these additional references:

- Australian Standard 2834-1995 Computer Accommodation, Chapter 2.9 Vibration, p16
- Gordon CG Generic Vibration Criteria for Vibration Sensitive Equipment Proceedings of International Society for Optical Engineering (SPIE), Vol. 1619, San Jose, CA, November 4-6, 1991, pp. 71-85
- ASHRAE Applications Handbook (SI) 2003, Chapter 47 Sound and Vibration Control, pp47.39-47.40
- ISO 8569 1996 Measurement and evaluation of shock and vibration effects on sensitive equipment in buildings

In relation to human comfort (response), the minimum working distances in Table 2 relate to continuous vibration. For most construction activities, vibration emissions are intermittent in nature and for this reason, higher vibration levels, occurring over shorter periods are allowed (see Assessing Vibration: a technical guideline (EPA 2006)). Where the predicted vibration levels exceed the human comfort objectives, the procedures Appendix C are to be followed in order to mitigate the potential impacts at sensitive receivers.

If the predicted ground-borne vibration levels exceed the cosmetic damage screening levels, a different construction method with lower-source vibration levels must be used where feasible and reasonable otherwise construction works should not proceed unless attended vibration measurements are undertaken at the commencement of the works to verify the site-specific minimum working distances and/or confirm that damage screening criteria are not exceeded. If there is any risk of exceedance of the cosmetic damage objective, a permanent vibration monitoring system should be installed, to warn plant operators (via flashing light, audible alarm, SMS, etc) when vibration levels are approaching the cosmetic damage objective.

6.2 Ground-borne noise

Underground vibration intensive works may be transmitted through the ground into a building structure creating noise. This may also occur when works are completed in a different floor or occupancy of a building. Ground-borne noise becomes apparent where typical noise paths through the air are blocked.

Estimates should be made for ground-borne noise where it may be apparent and noise levels monitored during construction.

Table 3: Construction hours

Time of day		Ground-borne noise objectives $L_{Aeq(15minute)}$
Daytime	1:00am to 6:00pm	Human comfort vibration objectives only
Evening	6:00pm to 10:00pm	40 dBA – internal
Night-time	10:00 pm to &:00am	35 dBA – internal

7. Blasting

For works where blasting is required, an assessment of ground vibration and blast over pressure should be undertaken. During the environmental assessment this should include estimates at

affected receivers for a given maximum instantaneous charge (MIC). Guidance on vibration and overpressure blasting limits should be based on:

- Australian Standard™ AS 2187.2-2006 Explosives - Storage and use.
- British Standard BS 6472, British Standard BS 7385-2.

Prior to works beginning, the assessment should be revised with the blasting contractor and trial blasts completed to verify predicted noise and vibration levels.

8. Construction traffic

The EPA Interim Construction Noise Guideline references the EPA NSW Road Noise Policy for the assessment of construction traffic on public roads.

For Transport projects, an initial screening test should first be applied by evaluating whether noise levels will increase by more than 2dBA due to construction traffic or a temporary reroute due to a road closure. Where increases are 2dBA or less then no further assessment is required.

Where noise levels increase by more than 2dBA (2.1dBA) further assessment is required based upon Transport's Road Noise Criteria Guideline. This documents Transport's approach to implementing the EPA NSW Road Noise Policy. Consideration should also be given under the Road Noise Criteria Guideline as to whether the construction traffic or temporary reroute triggers new road criteria due to changes in road category.

Noise mitigation should be considered using Appendices B and C. However, since noise from construction traffic is temporary, guidance to feasible and reasonable noise mitigation differs from operational traffic noise.

9. Occupational health and safety

In addition to potential noise and vibration impacts on the community and structures, construction noise and vibration can also have an adverse impact upon the health of workers.

The main adverse impacts of hazardous noise are permanent noise-induced hearing loss and interference with clearly hearing instructions and/or audible warning signals. Excessive vibration from hand-held power tools (such as jack hammers) and whole-body vibration (from mobile plant) can lead to adverse impacts such as white-finger disease, damage to tendons and nerves, and lower back pain.

For the above reasons, it is important that contractors adopt noise management strategies to prevent or minimise worker exposure to excessive noise and vibration and comply with all relevant health and safety requirements. Such measures will also assist in reducing noise and vibration impacts on the surrounding community.

The series of Standards, AS/NZS 1269 Parts 0 to 4, sets out procedures to assess, control, manage and review noise hazards, and Regulation 56 of the Work Health and Safety Regulation 2017 which defines the applicable noise limits that are applicable in NSW.

The *National Code of Practice for Prevention of Musculoskeletal Disorders from Performing Manual* Tasks at Work (2007) contains guidance on assessing and controlling vibration risks.

10. Approval delegations

This guideline covers a broad range of construction, minor works and maintenance activities. As such, the appropriate delegation level to approve the documentation and activity will vary depending on the type of activity and planning approval pathway.

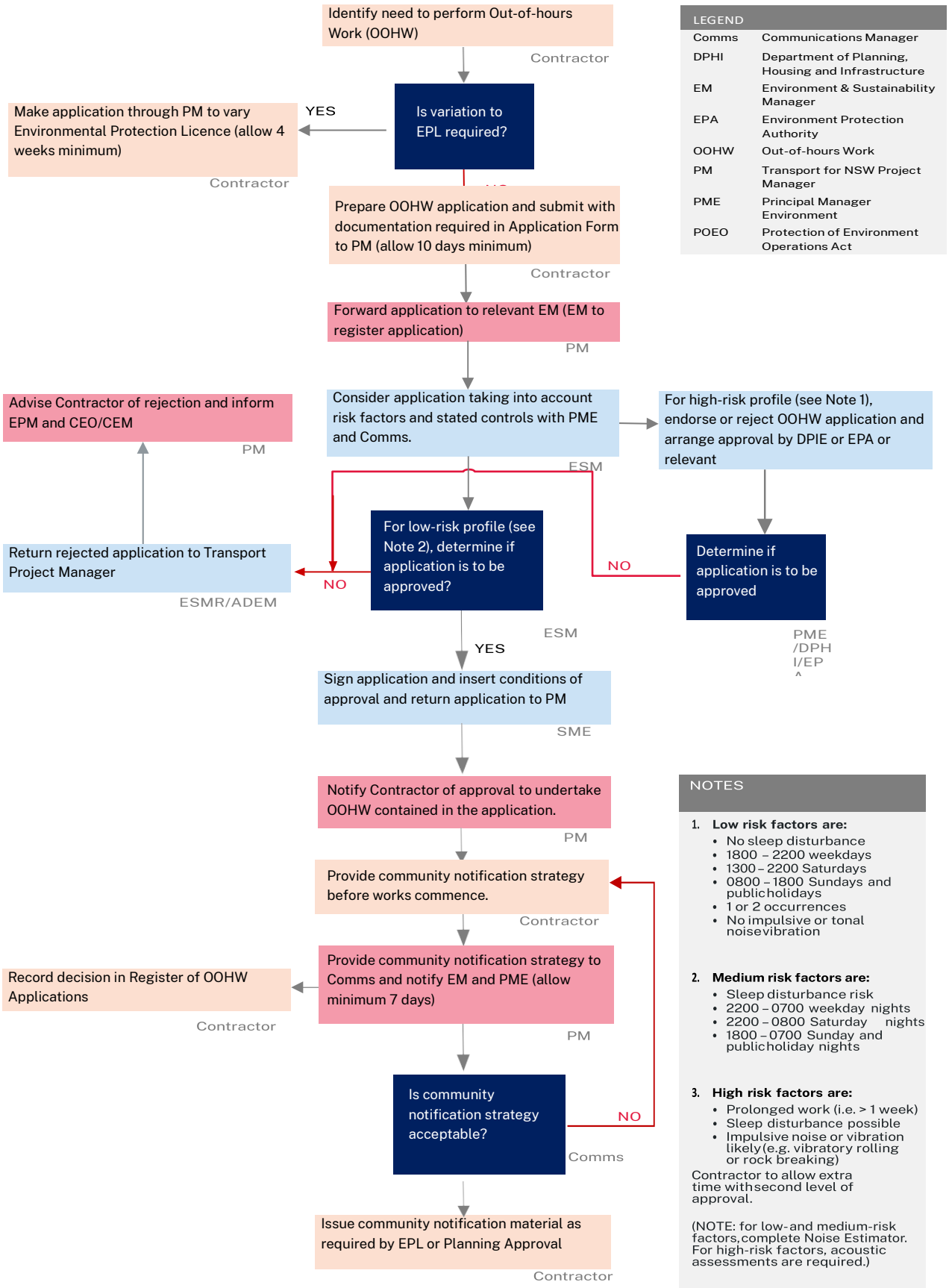
For some projects the appropriate delegation will also depend on project specific Environmental Protection Licences and conditions placed through the Department of Planning.

However, the overall process will be similar:

- A proposed work activity will either be already approved or require approval.
- Works that require approval shall be assessed and documented using this guideline and be sent for approval to an Environment Manager and Project Manager. In some instances, these may be approved either internally by the contractor or Transport subject to project specific contractual arrangements. In other instances, external approval may be required by another agency.
- Where works require external approval the Environment Manager and Project Manager shall first review the proposal and provide it for external review to the external agency.

An out-of-hours work assessment and approval procedure is given as an example in Figure 2. Project specific procedures that include specific licence conditions and contractual arrangements may be developed subject to approval by the Transport Environment and Sustainability Manager and relevant agencies.

Figure 2: Example Out-of-hours work and assessment procedure



11. Documentation

11.1 Overview

Projects shall maintain a record of all complaints received and the subsequent action taken, in accordance with any determination and licence conditions.

- Contractors are to retain records of the following:
- Complaint records (time and nature of complaint).
- Complaint responses and close out actions.
- Correspondence.
- Monitoring results.
- Verification results.
- Mitigation measures.
- Noise and Vibration Management Plans.

11.2 Documentation and correspondence

11.2.1 General

All written communication should include plain English description of events and impacts aligned with the Transport Editorial Style Guide. Communication templates should be obtained from the Transport communication and stakeholder engagement electronic toolkit. Guidance on engagement activities can be sought from Transport Communication and Stakeholder Engagement.

11.2.2 Project information line or equivalent

A 24-hour contact telephone number for community enquiries and complaints is required for all construction works. All enquiries require a verbal response within 24 hours during standard construction hours, or on the next working day during out-of-hours work (unless the enquirer agrees otherwise). All complaints require a verbal response within two hours.

11.2.3 Email distribution list

Email distribution lists are used on some projects to disseminate project information to interested stakeholders. Advanced warning of audible activities can assist to reduce the impact of projects experienced by the community.

11.2.4 Signage

Signage is used on projects to notify stakeholders of project details and enquiry contact information. Where possible and when appropriate, the full community notification, detailing likely audible construction noise will be on display at the work site.

12. Definitions

Term	Definition
Affected distance	Distance up to which noise levels are expected to exceed the Noise Management Level as defined by the EPA's Interim Construction Noise Guideline (ICNG).
a_{rms}	Root mean squared weighted acceleration, a vibration parameter used to assess human response to continuous or intermittent vibration
At-receiver treatments	Includes building treatments and courtyard walls. Building treatments may include but are not limited to ventilation, glazing, window and door seals, sealing of vents and underfloor areas.
Equitable	Receivers and communities exposed to road project noise receive consistent outcomes.
Feasibility	Relates to engineering considerations (what can be practically built). These engineering considerations may include: • The inherent limitations of different techniques to reduce noise emissions from road traffic noise sources. • Safety issues such as restrictions on road vision. • Road corridor site constraints such as space limitations. • Floodway and stormwater flow obstruction. • Access requirements. • Maintenance requirements. The suitability of building conditions for at receiver treatments.
Highly sensitive receiver	Receiver where standard annoyance and human comfort criteria do not provide sufficient guidance on the impact. Some examples include buildings with sensitive equipment, recording studios and cinemas.
L_{Amax}	The Maximum Noise Level for an event used in the assessment of potential sleep disturbance during night-time periods. The subscript 'A' indicates that the noise levels are filtered to match normal human hearing characteristics (i.e., A-weighted). 'Fast' time constant is used for this measurement.
$L_{Aeq(15\ minute)}$	The Energy Average Noise Level during construction activities, evaluated over a measurement period of 15 minutes. This is the main parameter used to assess the construction noise impacts.
L_{A90}	The Background Noise Level in the absence of construction activities. This parameter represents the average minimum noise level during the daytime, evening and night-time periods respectively. The $L_{Aeq(15\ minute)}$ construction noise objectives are based on an allowance margin above the L_{A90} background noise levels.

Number of affected receivers	The number of receivers that may be considered to be few or many will depend on the project resources and the number of receivers.
	Few receivers -Where the project resources are sufficient to meet with affected receivers, then the number of receivers is considered to be few. Note that in some instances it may not be possible to meet with all receivers due to circumstances associated with a particular receiver.
	Many receivers -Where the project resources are unable to meet with all affected receivers, then the number of receivers is considered to be many. Project resources should be sufficient to meet with the worst-affected receivers. Where letter-box drops are necessary to communicate with the community, then this would be considered to be many receivers.
PPV	Peak Particle Velocity, the peak vector vibration velocity used to assess the risk of damage to structures from ground-borne vibration. This is generally evaluated at the building footings.
Project	For the purposes of this guideline, project includes maintenance works, minor works and new roads or redeveloped upgrades.
Reasonable	Selecting reasonable measures from those that are feasible involves judging whether the overall noise benefits provide significant social, economic or environmental benefits. The factors to be considered are: • The noise reduction provided and the overall number of people that benefit from the mitigation. • Existing and future noise levels including changes in noise levels in the build and design year and the extent of any exceedance of the noise criteria. • Potential for a mitigation measure to reduce noise during construction as well as from road traffic after the project is complete. • The cost of mitigation including the cost of noise mitigation measures as a percentage of the total project cost and the ongoing maintenance and operational costs. • Community views and preferences (typically gathered during the community consultation process following the noise assessment). • Visual impacts for the community surrounding the road project and for road users. These are typically identified in the Environmental Assessment. • The wider community benefits arising from noise mitigation of the proposed road or road redevelopment. Relative weighting of treatments with respect to protection of outdoor areas or only internal living spaces.

Appendix A: NSW construction noise and vibration goals and management levels

This appendix provides a brief overview of construction noise and vibration and its potential effects on people, buildings and their contents. It also provides guidance on how to establish construction noise and vibration objectives during the environmental assessment phase.

A.1 Construction noise objectives

Where a quantitative noise assessment is to be undertaken, the construction airborne and ground-borne noise objectives are based on the EPA Interim Construction Noise Guideline. The interim guideline contains noise management levels for sensitive land uses including commercial and industrial receivers.

A.2 Effects of vibration on structures

The levels of vibration required to cause cosmetic damage to buildings tend to be at least an order of magnitude (10 times) higher than those at which people may consider the vibration to be intrusive. Guidance may be found in:

- Australian Standard™ AS 2187.2-2006 Explosives - Storage and use.
- British Standard BS 7385 Part 2-1993 Evaluation and measurement for vibration in buildings Part 2.
- DIN 4150 has criteria for heritage structures.

A.3 Human perception of vibration

Guidance in relation to acceptable vibration levels for human comfort are provided in Assessing Vibration: a technical guideline (EPA 2006). This document is based on the guidelines contained in BS 6472-1992.

A.4 Effects on building contents

People can perceive floor vibration at levels well below those likely to cause damage to building contents or affect their operation. For most receivers, the controlling vibration criterion is therefore the human comfort criterion and separate objectives are not normally required in relation to the effect of construction vibration on building contents.

Some scientific equipment (e.g. electron microscopes and microelectronics manufacturing equipment) can require more stringent objectives than those applicable to human comfort. Where appropriate, objectives for the satisfactory operation of critical instruments or manufacturing processes should be sourced from manufacturer's data and/or other published objectives.

A.5 Construction vibration on sensitive equipment

- Australian Standard 2834-1995 Computer Accommodation, Chapter 2.9 Vibration, p16.
- Gordon CG Generic Vibration Criteria for Vibration Sensitive Equipment Proceedings of International Society for Optical Engineering (SPIE), Vol. 1619, San Jose, CA, November 4-6, 1991, pp. 71-85.
- ASHRAE Applications Handbook (SI) 2003, Chapter 47, Sound and Vibration Control, pp47.39-47.40.
- ISO 8569 1996 Measurement & Evaluation of Shock & Vibration Effects on Sensitive Equipment in buildings.

A.6 Construction-related traffic noise goals

Where traffic noise levels increase by more than 2dBA from construction traffic, or a temporary reroute due to a road closure, further assessment is required using Transport's approach to implementing the Road Noise Policy.

This is assessment is addressed in the Transport:

- Road Noise Criteria Guideline (RNCG).
- Road Noise Mitigation Guideline (RNMG).

In any instance the only trigger for noise mitigation under the RNMG shall be due to noise level increase. Further detail is in Appendix C.

A.7 Blasting limits

Guidance on vibration and overpressure blasting limits should be based on:

- Australian Standard™ AS 2187.2-2006 Explosives - Storage and use.
- British Standard BS 6472 British Standard BS 7385-2

Appendix B: Standard mitigation measures

The following standard actions and mitigation measures should be implemented on all construction projects. Assistance from Transport Communication and Stakeholder Engagement is available to coordinate and deliver community consultation and notification. The team also has the latest noise fact sheets and letter templates.

Action required	Applies to	Details
Management measures		
Implementation of any project specific mitigation measures required.	Airborne noise	Implementation of any project specific mitigation measures required.
Implement community consultation or notification measures (refer to Appendix C for further details of each measure).	Airborne noise Ground-borne noise and vibration	Notification detailing work activities, dates and hours, impacts and mitigation measures, indication of work schedule over the night-time period, any operational noise benefits from the works (where applicable) and contact telephone number. Notification should be a minimum of seven calendar days prior to the start of works. For projects other than maintenance works more advanced consultation or notification may be required. Contact Transport Communication and Stakeholder Engagement for guidance. Website (If required). Contact telephone number for community. Email distribution list (if required). Community drop-in session (if required by approval conditions).
Site inductions	Airborne noise Ground-borne noise and vibration	All employees, contractors and subcontractors are to receive an environmental induction. The induction must at least include: • all project specific and relevant standard noise and vibration mitigation measures • relevant licence and approval conditions • permissible hours of work • any limitations on high noise generating activities • location of nearest sensitive receivers • construction employee parking areas • designated loading/unloading areas and procedures • site opening/closing times (including deliveries) • environmental incident procedures

Action required	Applies to	Details
Behavioural practices	Airborne noise	No swearing or unnecessary shouting or loud stereos/radios on site. No dropping of materials from height, throwing of metal items and slamming of doors.
Verification	Airborne noise Ground-borne noise and vibration	Where specified under Appendix C, a noise verification program is to be carried out for the duration of the works in accordance with the Construction Noise and Vibration Management Plan and any approval and licence conditions.
Attended vibration measurements	Ground-borne vibration	Where required attended vibration measurements should be undertaken at the commencement of vibration generating activities to confirm that vibration levels are within the acceptable range to prevent cosmetic building damage.
Update Construction Environmental Management Plans	Airborne noise Ground-borne noise and vibration	The CEMP must be regularly updated to account for changes in noise and vibration management issues and strategies.
Building condition surveys	Vibration Blasting	Undertake building dilapidation surveys on all buildings located within the buffer zone prior to commencement of activities with the potential to cause property damage
Source controls		
Construction hours and scheduling.	Airborne noise Ground-borne noise and vibration	Where feasible and reasonable, construction should be carried out during the standard daytime working hours. Work generating high noise and/or vibration levels should be scheduled during less sensitive time periods.
Construction respite period during normal hours and out-of-hours work	Airborne noise Ground-borne noise and vibration	Please refer to Appendix C for more details on the following respite measures: • Respite Offers (RO) • Respite Period 1 (R1) • Respite Period 2 (R2) • Duration Respite (DR)
Equipment selection.	Airborne noise Ground-borne noise and vibration	Use quieter and less vibration emitting construction methods where feasible and reasonable. For example, when piling is required, bored piles rather than impact-driven piles will minimise noise and vibration impacts. Similarly, diaphragm wall

Action required	Applies to	Details
		construction techniques, in lieu of sheet piling, will have significant noise and vibration benefits. Ensure plant including the silencer is well maintained.
Plant noise levels.	Airborne-noise	The noise levels of plant and equipment must have operating sound power or sound pressure levels compliant with the criteria in Appendix F. Implement a noise monitoring audit program to ensure equipment remains within the more stringent of the manufacturers specifications or Appendix F.
Rental plant and equipment.	Airborne-noise Ground-borne vibration	The noise levels of plant and equipment items are to be considered in rental decisions and in any case cannot be used on site unless compliant with the criteria in Table 2.
Use and siting of plant.	Airborne-noise	The offset distance between noisy plant and adjacent sensitive receivers is to be maximised. Plant used intermittently to be throttled down or shut down. Noise-emitting plant to be directed away from sensitive receivers. Only have necessary equipment on site.
Plan worksites and activities to minimise noise and vibration	Airborne noise Ground-borne vibration	Locate compounds away from sensitive receivers and discourage access from local roads. Plan traffic flow, parking and loading/unloading areas to minimise reversing movements within the site. Where additional activities or plant may only result in a marginal noise increase and speed up works, consider limiting duration of impact by concentrating noisy activities at one location and move to another as quickly as possible. Very noise activities should be scheduled for normal working hours. If the work cannot be undertaken during the day, it should be completed before 11:00pm. Where practicable, work should be scheduled to avoid major student examination periods when students are studying for examinations such as before or during Higher School Certificate and at the end of higher education semesters. If programmed night work is postponed the work should be re-programmed and the approaches in this guideline apply again.
Reduced equipment power	Airborne noise Ground-borne vibration	Use only the necessary size and power.

Action required	Applies to	Details
Non-tonal and ambient sensitive reversing alarms	Airborne-noise	Non-tonal reversing beepers (or an equivalent mechanism) must be fitted and used on all construction vehicles and mobile plant regularly used on site and for any out-of-hours work. Consider the use of ambient sensitive alarms that adjust output relative to the ambient noise level.
Minimise disturbance arising from delivery of goods to construction sites	Airborne-noise	Loading and unloading of materials/deliveries is to occur as far as possible from sensitive receivers. Select site access points and roads as far as possible away from sensitive receivers. Dedicated loading/unloading areas to be shielded if close to sensitive receivers. Delivery vehicles to be fitted with straps rather than chains for unloading, wherever possible. Avoid or minimise these out-of-hours movements where possible.
Blasting regime	Airborne noise Ground-borne vibration	The noise and vibration impacts of blasting operations can be minimised by: • Choosing the appropriate blast charge configurations • Ensuring appropriate blast-hole preparation • Optimising blast design, location, orientation and spacing • Selecting appropriate blast times, and • Utilising knowledge of prevailing meteorological conditions. • Australian Standard™ AS 2187.2-2006 Explosives -Storage and use, Part 2: Use of Explosives provides more detailed advice on ground vibration and air blast overpressure impact minimisation options.
Engine compression brakes	Construction vehicles	Limit the use of engine compression brakes at night and in residential areas. Ensure vehicles are fitted with a maintained original equipment manufacturer exhaust silencer or a silencer that complies with the National Transport Commission's National Stationary Exhaust Noise Test Procedures for In-service Motor Vehicles and any relevant reference standards.
Path controls		
Shield stationary noise sources such as pumps,	Airborne noise	Stationary noise sources should be enclosed or shielded where feasible and reasonable whilst ensuring that the occupational health and safety of

Action required	Applies to	Details
compressors, fans etc.		workers is maintained. Appendix D of AS 2436:2010 lists materials suitable for shielding.
Shield sensitive receivers from noisy activities	Airborne noise	Use structures to shield residential receivers from noise such as site shed placement, earth bunds, fencing, erection of operational stage noise barriers (where practicable), and consideration of site topography when situating plant.
Receptor controls		
Structural surveys and vibration monitoring	Ground-borne vibration	Pre-construction surveys of the structural integrity of vibration sensitive buildings may be warranted. At locations where there are high-risk receptors, vibration monitoring should be conducted during the activities causing vibration.
See Appendix C for additional measures	Airborne noise Ground-borne vibration	In some instances, additional mitigation measures may be required.

Appendix C: Additional mitigation measures

C.1 Overview of additional mitigation measures

After standard noise mitigation measures (Appendix B) have been applied noise levels may still exceed noise management levels. Where exceedances remain consider implementing the following approaches in Tables C.1 to C.3 where feasible and reasonable. Note that assistance from Transport Communication and Stakeholder Engagement is available to coordinate and deliver community consultation and notification. The team also has the latest noise fact sheets and letter templates.

The range of additional measures in Tables C.1 to C.3 are described below. Note in instances where there are many receivers above the NML it may not be practical to discuss the project with every receiver recommended below. Instead, the community should be proactively engaged so they have an incentive to participate in discussion. Support from the community may be demonstrated from surveys, online feedback, contact phone numbers and community events.

C.1.1 Notification (letterbox drop or equivalent)

Advanced warning of works and potential disruptions can assist in reducing the impact on the community. The notification may consist of a letterbox drop (or equivalent) detailing work activities, time periods over which these will occur, impacts and mitigation measures. Notification should be a minimum of five working days prior to the start of works. The approval conditions for projects may also specify requirements for notification to the community about works that may impact on them.

C.1.2 Specific notification (SN)

Specific notifications are letterbox dropped (or equivalent) to identified stakeholders no later than seven calendar days ahead of construction activities that are likely to exceed the noise objectives. The specific notification provides additional information when relevant and informative to more highly-affected receivers than covered in general letterbox drops.

The exact conditions under which specific notifications would proceed are defined in the relevant Additional Mitigation Measures (Tables C.1 to C.3). This form of communication is used to support periodic notifications, or to advertise unscheduled works.

C.1.3 Phone calls (PC)

Phone calls detailing relevant information made to identified/affected stakeholders within seven calendar days of proposed work. Phone calls provide affected stakeholders with personalised contact and tailored advice, with the opportunity to provide comments on the proposed work and specific needs. Where the resident cannot be telephoned then an alternative form of engagement should be used.

C.1.4 Individual briefings (IB)

Individual briefings are used to inform stakeholders about the impacts of high noise activities and mitigation measures that will be implemented. Project representatives would visit identified stakeholders at least 48 hours ahead of potentially disturbing construction activities. Individual briefings provide affected stakeholders with personalised contact and tailored advice, with opportunity to comment on the project. Where the resident cannot be met with individually then an alternative form of engagement should be used.

C.1.5 Respite offers (RO)

Respite offers should be considered where there are high-noise and vibration-generating activities near receivers. As a guide, work should be carried out in continuous blocks that do not exceed three hours each with a minimum respite period of one hour between each block. The actual duration of each block of work and respite should be flexible to accommodate the usage of, and amenity at, nearby receivers.

The purpose of such an offer is to provide residents with respite from an ongoing impact. This measure is evaluated on a project-by-project basis and may not be applicable to all projects.

C.1.6 Respite period 1 (R1)

Out-of-hours construction noise in out-of-hours period 1 shall be limited to no more than three consecutive evenings per week except where there is a Duration Respite. Work during these periods should be separated by not less than one week and no more than six evenings per month.

C.1.7 Respite period 2 (R2)

Night-time construction noise in out-of-hours period 2 shall be limited to two consecutive nights except for where there is a Duration Respite. For night work, these periods of work should be separated by not less than one week and six nights per month. Where possible, high noise-generating works shall be completed before 11pm.

C.1.8 Duration reduction (DR)

Respite offers and respite periods 1 and 2 may be counterproductive in reducing the impact on the community for longer-duration projects. In this instance, and where it can be strongly justified, it may be beneficial to increase the work duration, number of evenings or nights worked through Duration Respite so that the project can be completed more quickly.

The project team should engage with the community where noise levels are expected to exceed the NML to demonstrate support for Duration Respite.

Where there are few receivers above the NML, each of these receivers should be visited to discuss the project to gain support for Duration Respite.

C.1.9 Alternative accommodation (AA)

Alternative accommodation options may be offered to residents living in close proximity to construction works that are likely to experience highly-intrusive noise levels (Tables C.1-C.3). The specifics of the offer will be identified on a project-by-project basis. Additional aspects for consideration shall include whether the highly-intrusive activities occur throughout the night or before midnight.

C.1.10 Verification (V)

Please see Appendix F for more details about verification of noise and vibration levels as part of routine checks of noise levels or following reasonable complaints. This verification should include measurement of the background noise level and construction noise. Note that this is not required for projects of less than three weeks unless to assist in managing complaints.

C.2 Overview of additional mitigation measures

Shorter-term impacts

For calculated noise levels, the tables show additional measures to be implemented for each receiver depending on how far above the background noise level or NML the impact is. These measures are most appropriate for shorter-term works.

For distance-based assessments, the distances where additional mitigation measures should be implemented are identified by cross referencing the mitigation levels in Table C.1 with the plant and mitigation levels in Tables D.2 and D.3. Note that this is automatically completed by the Estimator spreadsheet.

As an example, using distance-based methods, consider a NML of 45dBA in OOHW Period 1 in Table C1 below. Letter-box drops should be completed at mitigation levels greater than 50dBA (NML+5dBA). From Table D.2 this corresponds to receivers at distances equal to or less than 340 metres for a concrete saw.

Table C.1: Triggers for additional mitigation measures – airborne noise

Predicted airborne $L_{Aeq(15min)}$ noise level at receiver			Additional mitigation measures	
Perception	dB(A) above RBL	dB(A) above NML	Type[1]	Mitigations levels[2]
All hours				
75dBA or greater			N, V, PC, RO	HA
Standard hours: Mon - Fri (7am – 6pm), Sat (8am – 1pm), Sun/Public Holiday (Nil)				
Noticeable	5 to 10	0	-	NML
Clearly audible	>10 to 20	≤ 10	-	NML
Moderately intrusive	>20 to 30	>10 to 20	N, V	NML+10
Highly intrusive	> 30	> 20	N, V	NML+20
OOHW Period 1: Mon – Fri (6pm – 10pm), Sat (7am – 8am & 1pm – 10pm), Sun/Pub Holidays (8am – 6pm)				
Noticeable	5 to 10	≤ 5	-	NML
Clearly audible	>10 to 20	>5 to 15	N, R1, DR	NML+5
Moderately intrusive	>20 to 30	>15 to 25	V, N, R1, DR	NML+15
Highly intrusive	> 30	> 25	V, IB, N, R1, DR, PC, SN	NML+25
OOHW Period 2: Mon – Fri (10pm – 7am), Sat (10pm – 8am), Sun/Public Holiday (6pm – 7am)				
Noticeable	5 to 10	≤ 5	N	NML
Clearly Audible	>10 to 20	>5 to 15	V, N, R2, DR	NML+5
Moderately intrusive	>20 to 30	>15 to 25	V, IB, N, PC, SN, R2, DR	NML+15
Highly intrusive	> 30	> 25	AA, V, IB, N, PC, SN, R2, DR	NML+25

Notes[1] (refer to detailed descriptions in Table C1 above):

1. AA = Alternative accommodation R1 = Respite period 1

V	= Validation of predicted noise levels	R2	= Respite period 2
IB	= Individual briefings	DR	= Duration respite
N	= Notification box drops	RO	= Project specific respite offer
PC	= Phone calls	HA	= Highly affected
SN	= Specific notifications		

2. All affected receivers

C.3 Ground-borne noise

Table C.2: Triggers for additional mitigation measures – ground-borne noise

Predicted ground-borne $L_{Aeq(15min)}$ noise level at receiver		Additional mitigation measures	
Perception	dB(A) above GB NML	Type[1]	Apply to[2]
Standard Hours: Mon - Fri (7am – 6pm), Sat (8am – 1pm), Sun / Pub Holiday (Nil)			
N/A	Vibration only applicable during standardhours		
OOHW Period 1: Mon – Fri (6pm – 10pm), Sat (7am – 8am & 1pm – 10pm), Sun/Public Holidays (8am – 6pm)			
Clearly audible	≤10	N	All
Moderately intrusive	>10 to 20	V, N, R1, DR SN	All
Highly intrusive	> 20	V, IB, N, PC, SN, R1, DR	All
OOHW Period 2: Mon – Fri (10pm – 7am), Sat (10pm – 8am), Sun / Public Holiday (6pm – 7am)			
Clearly Audible	≤ 10	V, N, SN	All
Moderately intrusive	>10 to 20	AA, V, IB, N, PC, SN, R2,DR	All
Highly intrusive	> 20	AA, V, IB, N, PC, SN, R2,DR	All

Notes (refer to detailed descriptions in Table C1 above):

1. AA = Alternative accommodation
   V = Validation of predicted noise levels
   IB = Individual briefings
   N = Notification box drops
   PC = Phone calls
   SN = Specific notifications
   R1 = Respite period 1
   R2 = Respite period 2
   DR = Duration respite
2. All affected receivers

C.4 Vibration

Table C.3: Triggers for additional mitigation measures - vibration

Predicted ground-borne vibration level at receiver		Additional mitigation measures	
Perception		Type[1]	Apply to[2]
Standard Hours: Mon - Fri (7am – 6pm), Sat (8am – 1pm), Sun / Public Holiday (Nil)			
Predicted Vibration Exceeds Maximum Levels		V, N, RO	All
OOHW Period 1: Mon – Fri (6pm – 10pm), Sat (7am – 8am & 1pm – 10pm), Sun/Public Holidays (8am – 6pm)			

Predicted Vibration Exceeds Maximum Levels	V, IB, N, RO, PC, R1, SN	All
OOHW Period 2: Mon – Fri (10pm – 7am), Sat (10pm – 8am), Sun / Public Holiday (6pm – 7am)		
Predicted Vibration Exceeds Maximum Levels	AA, V, IB, N, PC, R2, SN	All

Notes:

1. AA = Alternative accommodation
   V = Validation of predicted noise levels
   IB = Individual briefings
   N = Notification box drops
   PC = Phone calls
   SN = Specific notifications
   R1 = Respite period 1
   R2 = Respite period 2
   DR = Duration respite
2. All affected receivers

C.5 Construction-related traffic noise

Management of construction related traffic or traffic reroutes noise should as a minimum include the following controls:

- Scheduling and routing of vehicle movements.
- Speed of vehicles.

Driver behaviour and avoidance of the use of engine compression brakes.

Ensuring vehicles are adequately silenced before allowing them to access the site. Consideration must be given to the following measures where feasible and reasonable:

- Temporary noise barriers.
- At-receiver noise mitigation.

Feasible and reasonable considerations should also include:

- Time of day of the noise increase and how far above the criteria the noise is expected to be.
- Time of use of affected receivers.
- How many decibels the noise levels are expected to increase above existing traffic noise.
- How long the mitigation will provide benefit to the receiver during the project.

Appendix D: Noise assessment using distance categories

D.1 Establishing background noise levels and distance categories

The following background noise levels from Australian Standard 1055 may be used as an estimate for projects less than three weeks in duration. However, existing data from other projects or short-term attended noise measurements should be used to assist in establishing noise management levels where possible.

Table D.1: Typical background noise levels and applicable Noise Management Levels (NMLs)

Area type	Description of area surrounding road project		Day 0700-1800	Evening 1800-2200	Night 2200-0700
Rural/ suburban	Areas with negligible transportation or very limited local traffic, typically light vehicles only. 100 metres or more from the road.	Background level (L_{A90})	40	35	*30*
		NML	50	40	35
Suburban/ urban	Areas with low density transportation. Typically, local traffic, light vehicles, intermittenttraffic flow	Background level (L_{A90})	45	40	35
		NML	55	45	40
Urban	Areas with medium density transportation or some commerce or industry. Typically, traffic is moving from one area to another (light and heavy vehicles) with heavy peak-hour traffic movement. May be on or close to bus route / light rail.	Background level (L_{A90})	50	45	40
		NML	60	50	45
Urban/ industrial	Areas with dense transportation with some commerce of industry. Typically, on or near an arterial or sub arterial road OR near rail line; 24-hour traffic movement.	Background level (L_{A90})	55	50	45
		NML	65	55	50
Non-residential receivers	Classrooms at schools and other educational institutions.	NML[1]	55	-	-
	Hospital wards and operating theatres.	NML[2]	65	65	65
	Place of worship	NML[1]	55	55	55
	Active recreation	NML	65	65	-
	Passive recreation	NML	60	60	-
	Industrial premise	NML	75	75	75
	Offices, retail outlets	NML	70	70	70

NML[1] = Assumed equivalent external noise level with windows open.

NML[2] = Assumed equivalent external noise level with windows shut.

D.2 Plant items, scenarios and noise-affected distances

Table D.2: Affected distances for individual plant items

Individual Plant Item[1]	No. Units	Affected Distance, metres[2]								
Mitigation Level (dBA)		35	40	45	50	55	60	65	70	75[3]
Rural community										
Power generator / concrete pump	1	390	270	185	130	85	50	30	25	15
Vibratory roller / concrete truck	1	525	365	250	175	120	75	45	25	20
Chainsaw / CMI SF400 paver / jack hammer / bored piling rig	1	760	525	365	250	175	120	75	45	25
Concrete saw / asphalt profiler / CAT D10	1	1010	705	490	340	235	160	110	70	40
Air-track drill / diamond grinding	1	1750	1250	875	610	420	290	200	140	95
Urban community										
Power generator / concrete pump	1	500	335	220	145	95	55	35	25	15
Vibratory Roller / concrete truck	1	690	460	305	200	135	85	50	30	20
Chainsaw / CMI SF400 paver / jack hammer / bored piling rig	1	1010	690	460	305	200	135	85	50	30
Concrete saw / asphalt profiler / CAT D10	1	1355	940	635	425	280	185	120	75	45
Air-track drill / diamond grinding	1	2425	1675	1175	805	545	360	240	155	105

Notes:

1. Typical plant items operating individually for road construction works.
2. Distances may be halved where there is no direct line of sight between the plant and receiver.
3. Highly noise affected.

Appendix E: Sleep disturbance

Table E.1: Sleep disturbance for the operation of individual plant items

Plant Item	Affected Distance	
	Open window	
	L_{Amax} 65 dB(A) external	
	Rural	Urban
Power generator / concrete pump	50	55
Vibratory roller / concrete truck	95	105
Chainsaw / CMI SF400 paver	120	135
Jack hammer / bored piling rig	175	200
Concrete saw / asphalt profiler	160	185
CAT D10	235	280
Air-track drill / diamond grinding	270	335

Table E.2: Sleep disturbance distance for the construction scenarios

Construction scenario	Affected Distance (open window)	
	L_{Amax} 65 dB(A) external	
	Rural	Urban
Site establishment / utility, property, service adjustment / drainage infrastructure / compound operation / road furniture installation	85	95
Compound site establishment	115	130
Re-surfacing works	155	180
Structural demolition / crushing plant / bridge works	170	200
Corridor clearing / bulk earthworks / local road works	230	280
Retaining walls / noise walls / paving / asphalting	270	330

Appendix F: Additional mitigation measures

This appendix describes the approaches to be used where additional noise mitigation measures have been applied that include noise-level verification.

The attended measurements will need to be carried out by an appropriately trained person in the measurement and assessment of construction noise and vibration, and familiar with the requirements of the relevant standards and procedures.

The attended measurements shall include evaluation of both construction noise and background noise levels compared with the predicted and estimated levels used in the assessment.

The results of the attended noise measurements shall be used to update the Construction Noise and Vibration Management Plan and other relevant environmental management documents.

F.1 Plant items, scenarios and noise-affected distances

All plant and equipment used for construction must have operating Sound Power or Sound Pressure Levels less than or equal to those in Table F1. For construction equipment not listed in Table F1, reference should be made to the typical noise levels in Australian Standard AS 2436-2010, British Standard BS 5228-1 or DEFRA noise database (2006).

The noise levels in Table F1 can also be used as a guide in the prediction of LAeq(15minute) construction noise. In doing so, the predicted LAeq(15minute) noise levels will be dependent on several factors including, but not limited to the duration of the construction activities, the number of plant items and their location on site in relation to the nearest receivers.

Attended measurements are to be undertaken within a period of 14 days of equipment arriving on site to confirm that the operating noise levels of all plant items comply with the maximum levels in Table F1. The attended measurements are to be repeated on a three-monthly basis to ensure that noise from individual plant items are still within the acceptable noise range.

F.2 Plant items, scenarios and noise-affected distances

Where additional mitigation measures require the spot check verification of noise levels, attended measurements are to be undertaken within a period of 14 days from the commencement of construction activities. The purpose of these measurements is to confirm that:

- Noise and vibration levels from construction in the adjacent community are consistent with the predictions in the noise assessment, approval and/or licence conditions.
- Mitigation is appropriate for the range of background noise levels at receivers affected by the works. Where the background noise levels differ from those assumed in the noise assessment then refinement of mitigation measures may be required and the CEMP amended.

The attended measurements must be undertaken at:

- The potentially most exposed receivers.
- Locations further from the works and existing noise sources which may have lower background noise levels.

Noise measurements shall be undertaken consistent with the procedures documented in AS1055.1-1997 Acoustics -Description and Measurement of Environmental Noise -General Procedures and NSW EPA's Approved methods for the measurement and analysis of environmental noise in NSW where appropriate. Vibration measurements shall be undertaken in accordance with the procedures

documented in Assessing Vibration: a technical guideline (EPA 2006) and BS7385 Part 2-1993 Evaluation and measurement for vibration in buildings.

For projects with a duration of greater than three months, the attended measurements are to be repeated on a three-monthly basis as part of the audit cycle to ensure that noise and vibration levels in the adjacent community remain consistent with the predicted levels in the noise assessment, approval and/or licence conditions. For projects with a duration of less than three months, or where out-of-hours works are required, the attended measurements must be undertaken at the time intervals described in the assessment, out-of-hours assessment, approval and/or licence conditions.

Table F.1: Highest allowable noise levels for construction equipment

Activity	Description of Activity	Plant/ Equipment	L_{Aeq} SWL	L_{Aeq} at 7m	Assumptions for quantitative assessment		
					No. Units	Activity total L_{eq} SWL	Activity total L_{A1} SWL
Mobilisation and Site Establishment	Installing construction boundary hoardings/ fences and traffic barriers	Truck (medium rigid)	103	78	4 per hour	115	116
		Road truck	108	83	4 per hour		
		Scissor lift	98	73	1		
		Franna crane	98	73	1		
Utility, property, service adjustment	Adjustment of property boundaries (where required); relocation of services	Excavator (tracked) 35t	110	85	1	116	116
		Dump truck	110	85	4 per hour		
		Franna crane 20t	98	73	1		
		Pneumatic hammer	113	88	-		
		Concrete saw	118	93	1		
		Vacuum truck	109	84	-		
		Backhoe	111	86	-		
		Power generator	103	78	1		
Corridor clearing	General land clearing, tree and stump removal, topsoil stripping, loading	Bulldozer D9	116	91	1	121	Not recommended as OOHW
		Excavator (tracked) 35t	110	85	1		
		Chainsaw 4-5hp	114	89	2		
		Tub grinder/ mulcher 40-50hp	116	91	1		
		Dump truck	110	85	4 per hour		
	House/ building demolition	Excavator (tracked) 35t	110	85	1	122	Not recommended as OOHW
		As above + hydraulic hammer	122	97	1		
		Front end loader 23t	112	87	1		
		Dump truck	108	83	4 per hour		
Rock crushing	Crushing and screening of building waste/ rock material for re-use on site	Rock crusher	118	93	1	118	Not recommended as OOHW
		Bulldozer D9	116	91	1		
		Excavator (tracked) 35t	110	85	1		

Activity	Description of Activity	Plant/ Equipment	L_{Aeq} SWL	L_{Aeq} at 7m	Assumptions for quantitative assessment		
					No. Units	Activity total L_{eq} SWL	Activity total L_{A1} SWL
		Dump truck	110	85	4 per hour		
Bulk earthworks	Formation of road alignment. Excavation of soil and rock, hammering/rock breaking, drilling, loading, haulage, compaction of fill areas, grading	Bulldozer D9	116	91	1	123	Not recommended as OOHW
		Scraper 651	110	85	1		
		Excavator (tracked) 35t	110	85	1		
		As above + hydraulic hammer	122	97	1		
		Grader	113	88	1		
		Dump truck	110	85	8 per hour		
		Compactor	106	81	1		
		Roller (large pad foot)	109	84	-		
		Water cart	107	82	-		
Drainage infrastructure	Excavation of trenches and pits; Delivery and placement of precast pipes and pits; filling and compacting.	Backhoe	110	85	-	115	116
		Franna crane 20t	98	73	1		
		Excavator (tracked) 35t	110	85	1		
		Concrete truck	109	84	4 per hour		
		Truck compressor	75	50	1		
		Vibratory roller	109	84	1		
		Road truck	108	83	4 per hour		
Bridge works	Casting; concrete pours; placement of pre-cast elements; piling (mainly bored); and demolition.	Franna crane 20t	98	73	1	120	124 (Piling not recommended as OOHW)
		Piling rig -driven	116	91	-		
		Piling rig -bored	112	87	1		
		Power generator	100	75	1		
		Concrete pump	102	77	1		
		Concrete truck	109	84	4 per hour		
		Compressor	109	84	1		

Activity	Description of Activity	Plant/ Equipment	L_{Aeq} SWL	L_{Aeq} at 7m	Assumptions for quantitative assessment		
					No. Units	Activity total L_{eq} SWL	Activity total L_{A1} SWL
		Pneumatic hammer	115	90	-		
		Welding equipment	105	80	-		
Retaining walls / noise walls	Construction of retaining walls and noise walls	Piling rig -bored	112	87	1	119	130 (Piling and air track drill not recommended as OOHW)
		Power generator	103	78	1		
		Mobile crane	113	88	1		
		Concrete vibrator	113	88	1		
		Concrete pump	109	84	1		
		Welding equipment	105	80			
		Excavator (tracked) 35t	112	87	1		
		Air track drill	124	99			
Paving/ asphalting (including concrete sawing)	Delivery of raw materials	Pavement laying machine	114	89	1	118	130
	Placement of surface material	Dump truck	110	85	4 per hour		
	Saw cutting	Asphalt truck & sprayer	103	78	1		
		Concrete truck	109	84	1		
		Smooth drum roller	107	82	1		
		Concrete saw	118	93	1		
Compounds	Deliveries	Front end loader	91	66	1	114	116
	Plant and equipment	Excavator (tracked) 35t	110	85	-		
	Maintenance	Road truck	108	83	4 per hour		
	Office areas	Compressor	109	84	1		
	Storage areas	Welding equipment	105	80	1		
		Light vehicles	88	63	12 per hour		
		Power generator	103	78	1		
Road furniture installation	Signposting and line marking	Road truck	108	83	4 per hour	110	116
		Scissor lift	98	73	1		

Activity	Description of Activity	Plant/ Equipment	L_{Aeq} SWL	L_{Aeq} at 7m	Assumptions for quantitative assessment		
					No. Units	Activity total L_{eq} SWL	Activity total L_{A1} SWL
		Franna crane 20t	98	73	1		
		Line marking truck	108	83	1		
Construction Compound Site Establishment		Chainsaw 4-5hp	114	89	2	119	Not recommended as OOHW
		Pneumatic hammer	113	88	-		
		Fixed crane	113	88	1		
		Front end loader	112	87	1		
		Excavator (tracked) 35t	110	85	-		
		Grader	113	88	1		
		Vibratory roller	109	84	-		
		Concrete truck	109	84	4 per hour		
		Dump truck	110	85	4 per hour		
		Water cart	107	82	-		
		Concrete vibrator	113	88	1		
		Concrete pump	109	84	1		
		Power generator	103	78	1		
		Light vehicles (e.g., 4WD)	103	78			
Local Roads Works		Bulldozer D9	116	91	1	120	128
		Excavator (tracked) 35t	110	85	-		
		Chainsaw 4-5hp	114	89	2		
		Tub grinder/ mulcher 40-50hp	116	91	1		
		Front end loader	112	87	1		
		Scraper 651	110	85	1		
		Backhoe	111	86	-		
		Compactor	106	81	1		
		Dump truck	110	85	4 per hour		

Activity	Description of Activity	Plant/ Equipment	L_{Aeq} SWL	L_{Aeq} at 7m	Assumptions for quantitative assessment		
					No. Units	Activity total L_{eq} SWL	Activity total L_{A1} SWL
		Road truck	108	83	4 per hour		
		Water cart	107	82	-		
Re-surfacing works	Milling the asphalt to expose the underlying concrete, then laying new asphalt	Daymakers	98	73	2	118	123
		Pavement profiler	117	92	1		
		Dump truck	110	85	4 per hour		
		Front-end loader	112	87	1		
		Pavement laying machine	114	89			
		Asphalt truck and sprayer	106	81			
		Smooth drum roller	107	82			

Table F.2: Affected distances for construction scenario

Construction scenario	Affected Distance, metres[2]								
Mitigation Level (dBA)	**35**	**40**	**45**	**50**	**55**	**60**	**65**	**70**	**75[3]**
Rural community									
Road furniture installation	565	390	265	185	125	75	35	25	15
Compound operation	755	525	360	250	170	115	65	35	20
Site establishment / drainage infrastructure	815	565	390	265	185	125	75	40	25
Utility works	875	605	420	290	195	135	85	45	25
Crushing plant / paving / asphalting / re-surfacing works	1010	700	485	335	230	155	105	60	30
Retaining walls / noise walls / compound establishment	1085	755	525	360	250	170	115	65	35
Bridge works / local road works	1165	815	565	390	265	185	125	75	40
Corridor clearing	1245	875	605	420	290	195	135	85	45
Demolition work	1335	940	650	450	310	215	145	95	50
Bulk earthworks	1430	1010	700	485	335	230	155	105	60

Urban community									
Road furniture installation	745	500	330	215	140	85	45	25	15
Compound operation	1010	685	460	305	200	125	75	40	25
Site establishment / drainage infrastructure	1090	740	500	330	215	140	85	45	25
Utility works	1170	800	540	360	235	150	95	50	25
Crushing plant / paving / asphalting / re-surfacing works	1355	935	635	425	280	180	115	70	35
Retaining walls / noise walls / compound establishment	1455	1010	685	460	305	200	130	75	40
Bridge works / local road works	1560	1085	740	500	330	215	140	85	45
Corridor clearing	1670	1170	800	540	360	235	155	95	50
Demolition work	1790	1260	865	585	390	255	165	105	60
Bulk earthworks	1910	1355	935	635	425	280	180	115	70

Notes:
1. Typical plant items operating individually for road construction works.
2. Distances may be halved where there is no direct line of sight between the plant and receiver.
3. Highly noise affected.

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