Interim Construction Noise Guideline

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1 Introduction

1.1 Overview

This Interim Construction Noise Guideline (the Guideline) has been developed by a number of agencies including the Department of Environment and Climate Change NSW (DECC), NSW Department of Planning, Roads and Traffic Authority, NSW (RTA), WorkCover NSW and NSW Health together with the Local Government and Shires Associations of NSW. In preparing the document there was extensive public consultation. The views of industry stakeholders were sought at an early stage and have contributed significantly to this document. The Standards Australia committee was consulted to address any potential inconsistencies between the Guideline and relevant standards.

The Guideline will be reviewed after three years to ensure it meets stakeholder and community needs.

Construction noise is one of the major environmental noise issues in NSW – not only from building works but also from demolition, remediation, renewal and maintenance. Construction can generate high noise levels that can adversely affect:

- sleep
- concentration, and thus learning performance
- mental and physical health.

Construction can occur close to residences or other sensitive land uses and be variable in times of occurrence. These aspects of construction can exacerbate noise levels and their effects. Construction noise by its nature is temporary, may not be amenable to purpose-built noise control measures applied to industrial processes, and may move as construction progresses.

With these constraints in mind, this Guideline has been developed to focus on applying a range of work practices most suited to minimise construction noise impacts, rather than focusing only on achieving numeric noise levels. While some noise from construction sites is inevitable, the aim of the Guideline is to protect the majority of residences and other sensitive land uses from noise pollution most of the time.

1.2 What the Guideline covers

The Guideline is specifically aimed at managing noise from construction works regulated by DECC, and will be used to assist DECC in setting statutory conditions in licences or other regulatory instruments. The types of construction regulated by DECC under the *Protection of the Environment Operations Act 1997* (POEO Act) are:

- construction, maintenance or renewal activities carried out by a public authority (section 6 of the POEO Act). An example is maintenance and repair of public roads.
- non-scheduled activities for the purpose of regulating water pollution (section 43(d) of the POEO Act) – in this case the licence may include conditions for managing noise impacts. An example is a small construction project that discharges to environmentally sensitive waters.
- scheduled development work that will enable scheduled activities to be carried out (section 47 of the POEO Act). An example is the construction stage of a new coal loader terminal or a new major marina.
- construction, maintenance or renewal related activities described in Schedule 1 of the POEO Act – DECC regulates these activities through an environment protection licence. An example is construction, maintenance or repair of railway lines.

Rail maintenance often involves work in a narrow corridor (DECC)

The local council is the appropriate regulatory authority for noise from non-scheduled construction activities in its area, except as described in section 6(2) of the POEO Act, and thus has discretion in dealing with noise. Some local councils have their own policy (for example, City of Sydney) whereas other local councils that do not have the resources to develop their own policy often seek guidance from DECC. The Guideline may be of assistance to local councils in guiding their decision making.

Other determining and consent authorities (defined in the *Environmental Planning and Assessment Act 1979*), such as the Department of Planning, may also find the Guideline useful when dealing with noise from construction and maintenance works that require planning approval. Approval conditions may differ from the approaches set out in this Guideline, depending on factors such as the duration of works and specific community needs.

Examples of noise that is *not* covered by the Guideline are:

- occupational noise exposure – this is covered by the NSW Occupational Health and Safety Regulation 2001
- noise from power tools and equipment used on residential premises – this is covered by the Protection of Environment Operations (Noise Control) Regulation 2008 – clause 50 of this Regulation only applies where planning approval is not required for construction works at residential premises
- noise from public roads and construction traffic on public roads – this is assessed under the *Environmental Criteria for Road Traffic Noise* (EPA 1999) (currently under review)
- noise from industrial sources (for example, factories, quarrying, mining, and including construction associated with quarrying and mining) – this is assessed under the *NSW Industrial Noise Policy* (EPA2000)
- vibration from construction works – human comfort vibration is assessed under *Assessing Vibration – a technical guideline* (DEC 2006).

The above documents published by the Environment Protection Authority (EPA) and the Department of Environment and Conservation (NSW) (DEC) are current and applied by DECC.

1.3 Objectives of the Guideline

The main objectives of the Guideline are to:

- promote a clear understanding of ways to identify and minimise noise from construction works
- focus on applying all 'feasible' and 'reasonable' work practices to minimise construction noise impacts
- encourage construction to be undertaken only during the recommended standard hours (Table 1), unless approval is given for works that cannot be undertaken during these hours
- streamline the assessment and approval stages and reduce time spent dealing with complaints at the project implementation stage
- provide flexibility in selecting site-specific feasible and reasonable work practices in order to minimise noise impacts.

Feasible work practices are practical to implement, while reasonable work practices take into account the balance of costs and benefits and community views.

Those involved in construction, including the project team, consent authorities and regulators, need to understand noise impacts and relevant work practices. To assist this, guidance is provided on noise levels that can trigger a selection of work practices to minimise noise.

Streamlining assessment and complaint handling is achieved through a clear and consistent process for noise impact assessment and the application of work practices to minimise noise. Work practices can include notifying the community of expected noise impacts and when they are expected to occur.

Responsibility for applying the Guideline lies with:

- construction project planners and acoustical practitioners at the approval, detailed design and project implementation stages
- construction managers and contractors at the detailed design and project implementation stages
- approval and regulatory authorities.

Project planners and acoustical practitioners assess noise levels from proposed activities and identify work practices that can be applied to minimise noise, and consult with the community on mitigation.

Construction managers review work practices at the approval stage and apply feasible and reasonable work practices based on detailed knowledge of the construction work to be carried out. They also consult with and notify the community on potential noise impacts, and implement conditions of consents, licences or approvals.

Approval and regulatory authorities review the application of all feasible and reasonable work practices and also regulate against unacceptable levels of noise at all stages of a project.

1.4 Feasible and reasonable

One of the most important parts of this Guideline is the application of feasible and reasonable measures to minimise noise impacts. The terms 'feasible' and 'reasonable' are explained below.

Feasible

A work practice or abatement measure is feasible if it is capable of being put into practice or of being engineered and is practical to build given project constraints such as safety and maintenance requirements.

Source control of noise often involves modifications to existing technology or practices that result in small but cumulatively significant reductions in generated noise. Examples of such modifications include the use of low noise power tools or hydraulic or electrically controlled equipment instead of petrol or pneumatic equipment. Control of noise at the source is always the preferred method of noise control as it reduces the impact on the entire surrounding area. Noise path control or mitigation at the receiver usually requires the adoption of measures that block the transmission of noise by means of barriers or architectural treatments to building facades. As the benefit from these measures would only apply to a limited area, in general, this should only be done after endeavouring to control noise at the source.

Reasonable

Selecting reasonable measures from those that are feasible involves making a judgment to determine whether the overall noise benefits outweigh the overall adverse social, economic and environmental effects, including the cost of the measure. To make such a judgement, consideration may be given to:

Noise level impacts –

- existing and future levels and projected changes in noise levels
- number of people affected or annoyed
- any noise performance criteria required for land uses affected by the construction

Noise mitigation benefits –

- the amount of noise reduction expected including the cumulative effectiveness of the proposed work practices/abatement measures
- potential ability of the work practices/abatement measures to reduce noise during the construction stage (and preferably also the operational stage) of the project
- the number of people protected

Cost effectiveness of noise mitigation –

- total cost of mitigation measures, taking into account the physical attributes of the site, such as topography and geology, and the cost variation to project given benefit expected
- noise mitigation costs compared with total project costs taking into account capital and maintenance
- impact of disruption to essential transport and utility networks (for example, main roads, railways, water supply, electricity supply)
- risk to worker safety during live traffic (road or rail) conditions

Community views –

- engagement with affected land users when deciding about the aesthetic or other impacts of work practices/abatement measures
- views of all affected land users not just those making complaints, determined through early community consultation
- practices/measures with majority support from the affected community.

Temporary noise barriers around a pipeline worksite (DECC)

The regulatory authority may review the information on feasible and reasonable work practices provided by the proponent, and compare the proposed practices against those applied on other similar projects. The regulatory authority may negotiate additional work practices that it considers may also be feasible and reasonable.

Some examples of feasible and reasonable practices applied on construction projects are:

- **A new large pipeline** – construction methods and the best pipeline route were chosen to minimise noise for residents and businesses. Two construction methods were used: 'microtunnelling' together with temporary noise barriers in residential areas, and 'trenching' in non-residential areas. Also, where possible, the pipeline was laid in industrial areas or reserves away from sensitive land uses.
- **Construction project near a waterway** – the contractor trialled three different types of piling: impact piling, push piling and secant piling. Secant piling, which involved installing reinforced concrete piles by drilling a hole into the ground and then filling with concrete to interlock with the neighbouring pile. Secant piling was chosen over impact or push piling, due to its lower vibration impact on the community, although it was not considered the most effective construction method.
- **A new pedestrian bridge over a main road** – the bridge footings were constructed during standard hours and night-time works were limited to two non-consecutive nights of operating a crane to lift the pre-fabricated bridge sections into position.
- **Use of alternatives to 'beeper' style reversing alarms** – to minimise noise impacts from reversing alarms, expecially during out of hours, a major infrastructure constructor required contractors to supply and use mobile equipment fitted with reversing alarms that are not the 'beeper' style alarms. An example is a broadband style alarm, sometimes referred to as a 'quacker' alarm.

A temporary noise barrier between the worksite and a neighbour (DECC)

- **A multi-storey building** – given the proximity to neighbouring residences, the contractor installed temporary barriers along the property in consultation with the affected neighbours.
- **A permanent roadside barrier at early stage of the construction** – the regulator's previous experience and knowledge indicated that most of a permanent noise barrier could be built before construction works progressed, despite contrary advice from the proponent. Negotiations between the regulator and proponent led to a revised design of the permanent barrier, construction of the permanent barrier in stages with defined timeframes, and also construction of a temporary barrier using plywood.

1.5 Applying the Guideline

The aim of the Guideline is to provide guidance on managing construction works to minimise noise (including airborne noise, ground-borne noise and blasting), with an emphasis on communication and cooperation with all involved in, or affected by, construction noise.

No single approach can minimise noise from all types of construction. The level of effort and sophistication needed to assess impacts and identify ways to minimise noise will be guided by factors such as the duration of works and the extent of the noise. Short-term works or low noise level works will be typically easier to assess and manage. The Guideline may also be useful for determing authorities and other approval authorities when dealing with noise from construction and maintenance works on smaller-scale projects.

The steps for managing noise impacts from construction are:

1. **identify sensitive land uses** that may be affected
2. **identify hours** for the proposed construction works

3. **identify noise impacts** at sensitive land uses
4. **select and apply the best work practices** to minimise noise impacts.

Depending on the extent of impact and the scale of the works, managing noise impacts may involve engaging the community. As more information becomes available through each stage of the project, the description of feasible and reasonable work practices will need to be made more detailed.

The Guideline presents two ways of assessing construction noise impacts – the quantitative method (see section 4), which is generally suited to longer-term construction, and the qualitative method (see section 5), which is generally suited to short-term works such as infrastructure maintenance.

The noise levels in section 4 apply to quantitative assessment. In all cases these levels should not simply be included in licence or planning approval conditions, but rather are intended to guide the need for, and the selection of, work practices to minimise noise impacts. Refer to section 7.1 for more detail on how to frame regulatory conditions. Section 6 gives a comprehensive list of work practices that should be used when evaluating options for noise mitigation or when a noise management plan is required.

When determining the best mix of work practices, the proponent needs to consider what practices are feasible and reasonable.

For many small construction projects that are dealt with by local councils, sections 2, 5 and 8, and Appendices A and B may be most relevant. The other sections of the Guideline may provide guidance for major construction projects that are dealt with by local councils. Local councils are best placed to decide what level of assessment should be applied to the types of construction projects they regulate in their area.

Six case studies which cover a range of situations are given in Appendix A as examples of how the Guideline can be applied to minimise noise impacts from construction sites.

1.6 Occupational noise management

In addition to managing environmental noise from construction work, contractors and employers must ensure compliance with the occupational noise management provisions of the NSW Occupational Health and Safety Regulation 2001 which is administered by WorkCover NSW. Specifically, clause 49 of the Regulation requires workplaces to take appropriate control measures when managing workers' exposure to noise. In addition the *Code of practice: Noise management and protection of hearing at work* (WorkCover 2004a) and *Moving plant on construction sites: Code of practice* (WorkCover 2004b) provide practical advice on managing noise levels in the workplace.

Work practices that both reduce noise levels in the workplace as well as reduce noise impacts in the community should be given a high priority for any project.

2 Identifying sensitive land uses and construction hours

2.1 Identifying sensitive land uses

The first step in assessing and managing noise impacts is to identify sensitive land uses with the potential to be affected by noise from construction, and these include:

- residences
- classrooms
- hospitals
- places of worship
- passive recreation areas such as outdoor grounds used for teaching
- active recreation areas such as parks and sports grounds.

Other land uses that may at times be sensitive to noise from construction include:

- commercial premises, such as film and television studios, research facilities, entertainment spaces, temporary accommodation (such as caravan parks and camping grounds), child care centres, restaurants, office premises and retail spaces
- industrial premises.

Residences and other sensitive land uses potentially impacted by noise from proposed works should be identified in the proponent's application. Noise from the site can vary greatly depending on the distance to each sensitive land use, as well as any intervening topography or buildings. These factors should be considered when identifying sensitive land uses, as locations other than those closest to the site may also be affected.

2.2 Recommended standard hours

The recommended standard hours for construction work are shown in Table 1; however, they are not mandatory. There are some situations, as described below, where construction work may need to be undertaken outside of these hours. The likely noise impacts and the ability to undertake works during the recommended standard hours should be considered when scheduling work.

Table 1: Recommended standard hours for construction work

Work type	Recommended standard hours of work*
Normal construction	Monday to Friday 7 am to 6 pm Saturday 8 am to 1 pm No work on Sundays or public holidays
Blasting	Monday to Friday 9 am to 5 pm Saturday 9 am to 1 pm No blasting on Sundays or public holidays

* The relevant authority (consent, determining or regulatory) may impose more or less stringent construction hours.

Road maintenance often needs to be done at night (DECC)

2.3 Construction outside the recommended standard hours

The five categories of works that might be undertaken outside the recommended standard hours are:

- the **delivery of oversized plant or structures** that police or other authorities determine require special arrangements to transport along public roads
- **emergency work** to avoid the loss of life or damage to property, or to prevent environmental harm
- **maintenance and repair of public infrastructure** where disruption to essential services and/or considerations of worker safety do not allow work within standard hours
- **public infrastructure works** that shorten the length of the project and are supported by the affected community
- works where a proponent demonstrates and justifies **a need to operate outside the recommended standard hours**.

In the last two categories, the proponent should provide the relevant authority with clear justification for reasons other than convenience, such as to sustain operational integrity of road, rail and utility networks. The relevant authority may be the same as the government organisation undertaking the works.

In general, only works undertaken on public infrastructure need to be undertaken outside the recommended standard hours. This need is typically based on a requirement to sustain the operational integrity of public infrastructure, as works to restore operation of the infrastructure provide benefit to the greater community (that is more than just local residents). Examples of public infrastructure are:

- transport – railways, roads, ferries, airports
- utilities – water, electricity or gas, sewerage or drainage.

The proponent should address in reports prepared under the environmental impact assessment (EIA) process any expected need to undertake work outside the standard hours. Consultation required under the EIA process allows community views to be considered when deciding whether the need to work outside standard hours has been adequately justified.

3 Selecting the assessment method

Once the proposed hours of work are identified, the next step in assessing and managing noise impacts is to select the assessment method. The choice of assessment method is not dependent on what time of day the works are proposed to take place, instead it relates to the proposed duration of the works.

People are usually annoyed more by noise from longer-term works than by the same type of works occuring for only a few days. Construction of new public infrastructure or major commercial development warrants a quantitative assessment, as the works often occur for longer periods of time and can involve lots of equipment and/or stages of work. Maintenance and repair works on existing public infrastructure typically warrant a qualitative assessment of noise as such works are often of short duration.

The quantitative assessment method, described in section 4, may be applied to major construction projects. Major construction projects are typically subject to the EIA process. Examples of major construction projects that are licensed by DECC are:

- new public infrastructure such as a tollway, railtrack or major water pipeline
- major commercial or industrial development, such as a major marina, a coal loader terminal, or a major power plant.

See Schedule 1 of the POEO Act for a complete list.

The qualitative assessment method, described in section 5, may be used on short-term infrastructure maintenance. Short-term means that the works are not likely to affect an individual or sensitive land use for more than three weeks in total. Examples of maintenance works that are regulated by DECC are:

- repair and maintenance of public powerlines
- maintenance or repair of a public road
- maintenance or repair of a railway.

No assessment would be required for emergency works (as defined in the glossary).

The proponent should check with the person responsible for issuing a project approval, determination, development consent or licence, to ensure that the assessment method selected is suitable. The assessment should be selected to best provide information on noise impacts, such as:

- how loud it will be
- how long the works will go on for
- whether there will be night work, and if so how loud it will be and how long it will last.

Equipment may move along as the project progresses (RTA)

4 Quantitative assessment method

The quantitative assessment method involves predicting noise levels and comparing them with the levels in this section of the Guideline. Guidance noise levels are given for airborne noise at sensitive land uses, including commercial and industrial premises, ground-borne noise and sleep disturbance. Vibration is not covered in this Guideline. The noise levels in this section are important indicators for construction managers to avoid or minimise noise that, if not considered, could delay construction work.

The information on noise levels in this section should only be referenced where a quantitative assessment is used.

The level of detail required for a quantitative assessment is likely to vary according to the potential noise and the size and complexity of the project. The proponent should check with the person responsible for issuing a project approval, determination, development consent or licence about their requirements for assessing noise.

Where noise from construction works is above the 'noise affected' levels presented below, the proponent should apply all feasible and reasonable work practices to minimise noise. The proponent should also inform potentially affected parties of the activities to be carried out, the expected noise impacts and duration.

4.1 Airborne noise

4.1.1 Residences

People's reaction to noise from construction will depend on the time of day that works are undertaken. Residents are usually most annoyed by work at night-time as it has the potential to disturb sleep. Noise from work on evenings, Saturday afternoons, Sundays and public holidays can also be annoying to most residents as it may interrupt leisure activities.

A quantitative assessment usually suits complex works (Transport Infrastructure Development Corporation)

Table 2 sets out management levels for noise at residences and how they are to be applied. Restrictions to the hours of construction may apply to activities that generate noise at residences above the 'highly noise affected' noise management level.

In Table 2 the rating background level (RBL) is used when determining the management level. The RBL is the overall single-figure background noise level measured in each relevant assessment period (during or outside the recommended standard hours). The term RBL is described in detail in the *NSW Industrial Noise Policy* (EPA 2000).

As a guide, the difference between the internal noise level and the external noise level is typically 10 dB with windows open for adequate ventilation.

Table 2: Noise at residences using quantitative assessment

Time of day	Management level $L_{Aeq\ (15\ min)}$ *	How to apply
Recommended standard hours: Monday to Friday 7 am to 6 pm Saturday 8 am to 1 pm No work on Sundays or public holidays	Noise affected RBL + 10 dB	The noise affected level represents the point above which there may be some community reaction to noise. • Where the predicted or measured $L_{Aeq\ (15\ min)}$ 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.
	Highly noise affected 75 dB(A)	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: 1. 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 2. if the community is prepared to accept a longer period of construction in exchange for restrictions on construction times.
Outside recommended standard hours	Noise affected RBL + 5 dB	• 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 dB(A) above the noise affected level, the proponent should negotiate with the community. • For guidance on negotiating agreements see section 7.2.2.

* Noise levels apply at the property boundary that is most exposed to construction noise, and at a height of 1.5 m above ground level. If the property boundary is more than 30 m from the residence, the location for measuring or predicting noise levels is at the most noise-affected point within 30 m of the residence. Noise levels may be higher at upper floors of the noise affected residence.

4.1.2 Other sensitive land uses

Other sensitive land uses, such as schools, typically consider noise from construction to be disruptive when the properties are being used (such as during school times). Table 3 presents management levels for noise at other sensitive land uses based on the principle that the characteristic activities for each of these land uses should not be unduly disturbed. The proponent should consult with noise sensitive land use occupants likely to be affected by noise from the works to schedule the project's work hours to achieve a reasonable noise outcome.

Internal noise levels are to be assessed at the centre of the occupied room. External noise levels are to be assessed at the most affected point within 50 m of the area boundary. Where internal noise levels cannot be measured, external noise levels may be used. A conservative estimate of the difference between internal and external noise levels is 10 dB for buildings other than residences. Some buildings may achieve greater performance, such as where windows are fixed (that is, cannot be opened). The management levels in Table 3 are 5 dB above the corresponding road traffic noise levels in the *Environmental Criteria for Road Traffic Noise* (EPA 1999) (and the 'maximum' levels in the *NSW Industrial Noise Policy* (EPA 2000) for commercial and industrial uses) to account for the variable and short-term nature of construction noise.

Table 3: Noise at sensitive land uses (other than residences) using quantitative assessment

Land use	Management level, $L_{Aeq\ (15\,min)}$ (applies when properties are being used)
Classrooms at schools and other educational institutions	Internal noise level 45 dB(A)
Hospital wards and operating theatres	Internal noise level 45 dB(A)
Places of worship	Internal noise level 45 dB(A)
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)	External noise level 65 dB(A)
Passive recreation areas (characterised by contemplative activities that generate little noise and where benfefits are compromised by external noise intrusion, for example, reading, meditation)	External noise level 60 dB(A)
Community centres	Depends on the intended use of the centre. Refer to the recommended 'maximum' internal levels in AS2107 for specific uses.

4.1.3 Commercial and industrial premises

Due to the broad range of sensitivities that commercial or industrial land can have to noise from construction, the process of defining management levels is separated into three categories. The external noise levels should be assessed at the most-affected occupied point of the premises:

- industrial premises: external $L_{Aeq\ (15\ min)}$ 75 dB(A)
- offices, retail outlets: external $L_{Aeq\ (15\ min)}$ 70 dB(A)
- other businesses that may be very sensitive to noise, where the noise level is project specific as discussed below.

Examples of other noise-sensitive businesses are theatres and child care centres. The proponent should undertake a special investigation to determine suitable noise levels on a project-by-project basis; the recommended 'maximum' internal noise levels in AS 2107 *Acoustics – Recommended design sound levels and reverberation times for building interiors* may assist in determining relevant noise levels (Standards Australia 2000).

The proponent should assess construction noise levels for the project, and consult with occupants of commercial and industrial premises prior to lodging an application where required.

During construction, the proponent should regularly update the occupants of the commercial and industrial premises regarding noise levels and hours of work.

4.2 Ground-borne noise at residences

Ground-borne noise is noise generated by vibration transmitted through the ground into a structure. Ground-borne noise caused, for example, by underground works such as tunnelling can be more noticeable than airborne noise. The following ground-borne noise levels for residences indicate when management actions should be implemented. These levels recognise the temporary nature of construction and are only applicable when ground-borne noise levels are higher than airborne noise levels. The ground-borne noise levels are for evening and night-time periods only, as the objectives are to protect the amenity and sleep of people when they are at home.

Evening (6 pm to 10 pm)
Internal: $L_{Aeq\ (15\ min)}$ 40 dB(A)

Night-time (10 pm to 7 am)
Internal: $L_{Aeq\ (15\ min)}$ 35 dB(A)

The internal noise levels are to be assessed at the centre of the most affected habitable room.

Mitigation options to deal with ground-borne noise may include extensive community consultation to determine the acceptable level of disruption and the provision of respite accommodation in some circumstances, not just restriction of work hours. The level of mitigation of ground-borne noise would depend on the extent of impacts and also on the scale and duration of works. Any restriction that the relevant authority (consent, determining or regulatory) may impose on the days when construction work is allowed should take into account whether the community:

- has identified times of day when they are more sensitive to noise (for example, Sundays or public holidays)
- is prepared to accept a longer construction duration in exchange for days of respite.

4.3 Sleep disturbance at residences

Where construction works are planned to extend over more than two consecutive nights, and a quantitative assessment method is used, the analysis should cover the maximum noise level, and the extent and the number of times that the maximum noise level exceeds the RBL. Some guidance indicating the potential for sleep disturbance is in the *NSW Environmental Criteria for Road Traffic Noise* (EPA 1999).

Factors that may be important in assessing the extent of impact on sleep include how often high noise events occur at night, the predicted maximum noise levels at night, whether there are times when there is a clear change in the noise environment (such as during early morning shoulder periods), and the degree of maximum noise levels above the background noise level at night.

4.4 Blasting and vibration

Overpressure and vibration from blasting are to be assessed against the levels in the *Technical Basis for Guidelines to Minimise Annoyance Due to Blasting Overpressure and Ground Vibration* (ANZEC 1990). Human comfort vibration from construction works, including continuous, intermittent or impulsive vibration from construction, but excluding blasting, is to be assessed in accordance with section 2.5 'Short-term works' in *Assessing Vibration – a technical guideline* (DEC 2006).

4.5 Predicting noise levels – quantitative assessment

The parameters for predicting noise impacts need to be clearly identified for noise impacts to be predicted adequately. These parameters are:

- all noise sources related to the proposed construction works, including vehicles that operate on site
- location and height of noise sources on site
- type of noise, such as airborne or ground-borne noise
- proposed movement alarms on plant and vehicles
- the number and timing of proposed blasts per day and per week
- alternative work methods (including noise mitigation measures) and justification of the selected work methods
- equipment or plant noise levels – references should be provided for all noise source levels in the assessment (see Appendix B)
- all stages of the construction works
- all residences and other sensitive land uses potentially impacted
- site features (including topography, buildings and surrounding land uses) that affect noise propagation
- proposed construction hours and the percentage of time the equipment operates
- other concurrent construction works in the vicinity that may contribute additional noise.

A number of activities have proven to be particularly annoying to nearby residents:

- use of 'beeper' style reversing or movement alarms, particularly at night-time
- use of power saws, such as used for cutting timber, rail lines, masonry, road pavement or steel work
- grinding metal, concrete or masonry
- rock drilling
- line drilling
- vibratory rolling
- rail tamping and regulating
- bitumen milling or profiling
- jackhammering, rock hammering or rock breaking
- Impact piling.

If any of these activities are to be undertaken they should be factored into the quantitative assessment by adding 5 dB to the predicted levels.

To quantify the noise impact, the realistic worst-case or conservative noise (and blasting) levels from the source should be predicted for assessment locations representing the most noise-exposed residences or other sensitive land uses, taking into account the parameters above, and compared with the relevant noise levels in section 4.

Worked example – predicting noise levels

It is proposed to construct a jersey kerb on the edge of a roadway between 7 am and 5 pm, approximately 25 m from the nearest residences along the road. The jersey kerb is constructed by pouring concrete from a concrete truck into a moving kerb-forming machine which moves at a rate of 150 m per 10-hour day. Noise levels from these works, measured on a previous project, were 67–70 dB(A) at 25 m. For the proposed works, the maximum predicted $L_{Aeq\ (15\ min)}$ is therefore 70 dB(A).

Deciding on the level of detail needed in calculations, cost and accuracy are important factors. Typically an increase in accuracy in the calculations will result in greater costs, and the proponent should consider the trade-off between these two factors. The proponent may choose to start with a rough calculation to indicate the magnitude of expected noise levels. If the calculated noise levels are above the relevant noise management levels, the proponent may choose to undertake more detailed calculations using computer models. The additional detail and accuracy gained through the use of a computer model may help in selecting work practices that will be applied to achieve the noise management levels.

For simple construction projects, the predicted levels from the source may be calculated by hand, taking into account the distance and any shielding between the source and the residences or other sensitive land uses.

For large or complex projects, noise is generally predicted through the use of computer models. Such models generally account for attenuation due to distance, atmospheric conditions, barriers and buildings, effects of topography and weather conditions to calculate overall levels at an assessment location. Preference should be given to the use of modelling approaches that have been the subject of peer review and that have been extensively used on other noise impact assessments. Any modelling would need to be validated by the proponent. Where many people are likely to be affected by construction noise, a map showing predicted noise contours surrounding the site may be required.

Worked example – rough calculation of noise levels

A proponent wishes to use a rock breaker on a construction project. The proponent has contacted a range of possible suppliers and has been given the following information on two different rock breakers:

Rock breaker A: $L_{Aeq\ (15\ min)}$ sound power level of 124 dB(A).
Rock breaker B: $L_{Aeq\ (15\ min)}$ sound pressure level of 98 dB(A) at 10 m.

The proponent chooses to do a rough calculation initially to gauge whether noise impacts will be likely. The proponent had previously determined that the noise management level applicable to the site is 57 dB(A) at the nearest residence.

The proponent plans for the rock breaker to be used up to 18 m from the nearest residence. The following calculations only take distance into account.

Rock breaker A:

Sound pressure level $= \text{Sound power level} - 10\log(2\pi r^2)$
$= 124 - 10\log(2\pi \times 18 \times 18)$
$= 124 - 33$
$= 91$ dB(A)

Rock breaker B:

Sound pressure level at 18 m = Sound pressure level at 10 m $- 10\log(r_1^2/r_2^2)$
where $r_1 = 18$ m and $r_2 = 10$ m.

Sound pressure level at 18 m $= 98 - 10\log((18 \times 18) / (10 \times 10))$
$= 98 - 5$
$= 93$ dB(A)

Compared to the management level of 57 dB(A), the calculations indicate that either rock breaker will cause significant noise. The proponent decides there is a need to investigate alternative work practices to address the likely noise impacts.

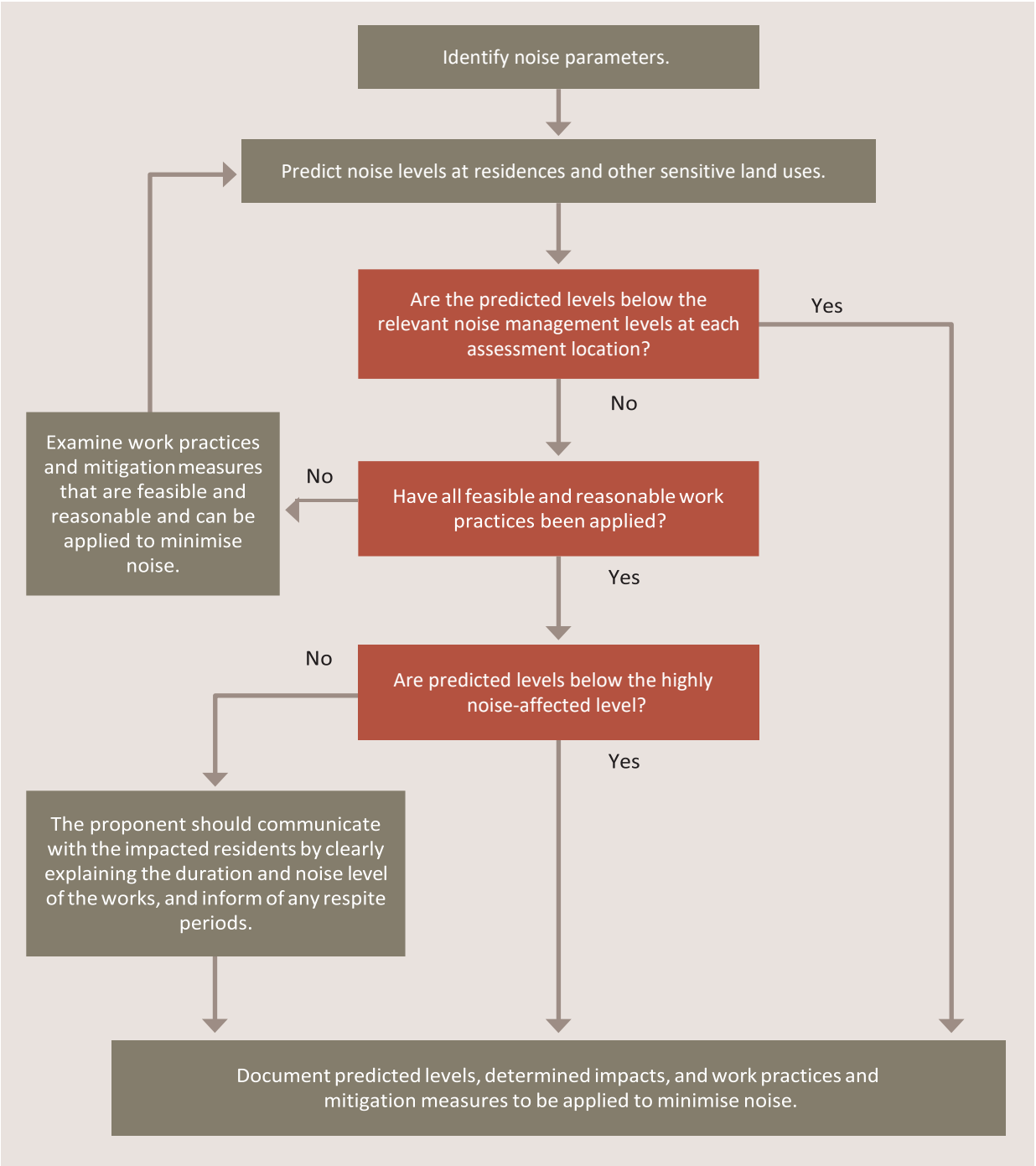
Note that the distance attenuation equations used here are approximate only and are for a point source with hemispherical propagation (that is, the noise source is not elevated high above ground level). The equations assume a flat ground surface and do not take into account other propagating effects, such as ground effects, atmospheric absorption or weather.

4.6 Assessing impacts

The potential for noise impact from the proposed construction can be assessed by comparing the predicted noise at the assessment locations with the levels given in section 4. The construction works are considered to have the potential to cause a noise impact if the predicted noise exceeds the levels in Tables 2 and 3.

Noise modelling to predict noise should incorporate the work practices that will be applied. This may be an iterative process of adjusting work practices according to predicted noise levels, and is summarised in Figure 1.

Figure 1: Prediction and assessment of impacts – quantitative method



5 Qualitative assessment method

The qualitative method for assessing noise is a simplified way to identify the cause of potential noise impacts. It avoids the need to perform complex predictions by using a checklist approach to assessing and managing noise. As described in section 3, the qualitative method may be used for short-term maintenance works. Short-term means that the works are not likely to affect an individual or sensitive land use for more than three weeks in total. Examples of maintenance works that are regulated by DECC are:

- repair and maintenance of public powerlines
- maintenance of a public road.

5.1 Steps in assessing noise

The first step in a qualitative noise assessment is to determine whether there are any residences or other sensitive land uses near the construction site. Small construction projects in rural areas may not generate significant noise at surrounding residences due to the typically large distances involved. Larger construction projects may generate noise that can be annoying at residences some distance away from the works (such as over one kilometre away in a rural area), and therefore a quantitative assessment following the approach set out in Section 4 would be better suited if noise impacts are anticipated.

Where residences or other sensitive land uses may be affected by noise, the work practices described in section 5.2 should be used.

Where construction is planned to occur at night, guidance is given in Table 4 on suitable ways to minimise sleep disturbance.

Noise management plans

The relevant consent or determining authority may require that a noise management plan be prepared as part of an environmental management plan. A copy of the noise management plan should be kept on site. For small construction projects, the noise management plan may include:

- identification of nearby residences and other sensitive land uses
- description of approved hours of work and what work will be undertaken
- description of what work practices will be applied to minimise noise
- description of the complaints handling process.

High noise level equipment

Where a qualitative assessment is followed and very annoying activities (such as those described in section 4.5) are proposed, the proponent should carefully consider feasible and reasonable alternative work methods to minimise noise impacts and provide justification for the method selected.

Complaints

If there are complaints concerning noise once the project has started, the steps below can be followed to address the noise. A copy of the complaints register should be kept on site.

Step 1: Noise sources should be identified, such as movement of material using a bobcat, cutting of wood using electric saws, short-term foundation works using a rock breaker, loader and truck, and deliveries of building materials with utilities and trucks.

Step 2: Answer the following questions regarding each noise source:

- Is the noise from the source loud either in an absolute sense or relative to other noise sources in the area?
- Does the noise include any tones or impulses?
- Does the noise occur at times when interference with sleep or comfort is likely – for example, at night?

Step 3: Implement feasible and reasonable work practices to minimise or avoid noise.

5.2 Checklist for work practices – qualitative assessment

This section is intended for works assessed in a qualitative manner. The following checklist of work practices can be used. The consent authority may include items from this checklist that are applicable, as well as other requirements such as work practices listed in Table 4, in its consent conditions. The checklist is not exhaustive and other practices may be used where identified. Application of the practices below should take into account the safety of workers.

Community notification

- Contact potentially noise affected neighbours at the earliest possible time before any site work begins.
- Inform potentially noise affected neighbours about the nature of the construction stages and the duration of noisier activities – for example, excavation and rock-breaking.
- Describe any noise controls, such as walls to be built first that will reduce noise, temporary noise walls, or use of silenced equipment.
- Keep potentially noise affected neighbours up to date on progress.
- Provide contact details on a site board at the front of the site, and maintain a complaints register suited to the scale of works.
- Ask about any concerns that potentially noise affected neighbours may have and discuss possible solutions.
- Provide a copy of the noise management plan, if available, to potentially noise affected neighbours.

Operate plant in a quiet and efficient manner

- Where practical, undertake the noisiest works during the recommended standard hours.
- Turn off plant that is not being used.
- Examine, and implement where feasible and reasonable, alternative work practices which generate less noise – for example, use hydraulic rock splitters instead of rock breakers, or electric equipment instead of diesel or petrol powered equipment.
- Examine, and implement where feasible and reasonable, the use of silenced equipment and noise shielding around stationary plant (such as generators), subject to manufacturers' design requirements.
- Ensure plant is regularly maintained, and repair or replace equipment that becomes noisy.
- Ensure road plates are properly installed and maintained.
- Arrange the work site to minimise the use of movement alarms on vehicles and mobile plant.

- Locate noisy plant away from potentially noise affected neighbours or behind barriers, such as sheds or walls.
- Where there are no overriding project constraints, program works so as to not affect any residence or other sensitive land use for more than a total of six nights in any four week period.

Involve workers in minimising noise

- Avoid dropping materials from a height, dropping or dragging road plates.
- Talk to workers about noise from the works at the identified land uses and how it can be reduced.
- Use radios and stereos indoors rather than outdoors.

Handle complaints

- Keep staff who receive telephone complaints informed regarding current and upcoming works and the relevant contacts for these works.
- Handle complaints in a prompt and responsive manner.
- Where there are complaints about noise from an identified work activity, review and implement, where feasible and reasonable, actions additional to those described above to minimise noise output.

Consider bored piling to reduce noise and vibration (DECC)

Worked example – using a qualitative assessment

Road Works Co. plans to undertake maintenance work on behalf of local council on a pedestrian bridge that passes over a major arterial road, from 10 pm to 3 am to minimise disruption to road traffic. It is planned to use a crane to realign a section of the bridge, trucks to transport material to and from site, hand-held jackhammers to modify the concrete structure, and a loader to move material and tools. Road Works Co. plans to complete the maintenance on three consecutive nights starting on a Monday night.

In assessing potential noise impacts, Road Works Co. used a qualitative approach. A survey of the area surrounding the works indicated that a residential area adjoins the site on both sides of the pedestrian bridge, with the closest residences being approximately 60 m away. For the nearest residences, Road Works Co. identified that the following noise sources associated with the maintenance works would be operating near these residences.

Noise source	Questions relating to noise heard at residences			Is examination of work practices necessary?
	Is noise loud, in absolute terms, or relative to other noises in the area?	Does the noise include tones or impulses?	Does the noise occur at times that interfere with sleep or comfort?	
Crane	Yes, but infrequently	No	Yes	Yes
Trucks	Yes – reversing alarms	Yes – reversing alarms	Yes	Yes
Hand-held jackhammer	Yes	Yes	Yes	Yes
Loader	Yes	Yes – reversing alarms	Yes	Yes

Road Works Co. has determined that it needs to examine work practices, and considers that the feasible and reasonable work practices to minimise noise will be to:

- organise the site so that delivery trucks only drive forward to avoid the use of reversing alarms
- use a loader that has a less annoying alternative to an audible movement alarm
- schedule noise generating works over no more than two consecutive nights
- erect temporary shrouding from 20 mm marine plywood to a height of 1.5 m around the jackhammer work area
- minimise potential sleep disturbances from crane noise by avoiding dropping material or equipment from a height
- inform residents by mail of planned works one week before works are undertaken.

6 Work practices

The Guideline focuses on achieving desired environmental outcomes – there are no prescribed noise controls for construction works. Instead, all feasible and reasonable work practices should be implemented to minimise noise impacts. This approach gives construction site managers and construction workers the greatest flexibility to manage noise.

The sections below provide guidance on selecting work practices to minimise noise impacts at residences and other sensitive land uses, as well as information on contact with neighbours and the community. Not all the work practices discussed in this section may be applicable to a particular project, and they should be considered on a case-by-case basis. The options described in Table 10 may not be applicable to a qualitiative assessment as the nature of these measures typically suit longer-duration projects.

The following steps should be followed when selecting work practices to minimise construction noise:

Step 1: Identify work practices likely to be major contributors to noise.

Step 2: Select from the list of options in this section, which are intended as a guide only, the feasible and reasonable work practices relevant to the project – more comprehensive information is likely to be available from industry sources.

Step 3: Apply the applicable universal work practices described in Table 4, as well as the selected feasible and reasonable work practices.

Reduce noise from chutes and bins by lining with damping material (Abigroup Contractors Pty Ltd)

Work practices that minimise noise levels on site and provide for proper communication with the community are generally the most effective at managing noise. Noise mitigation at residences is generally least preferred as noise levels at other affected locations may remain high and costs of mitigation per dwelling can be high.

Worked example – identifying feasible and reasonable work practices

For the proposed remediation of a large industrial site adjacent to a residential area, a quantitative assessment indicated that several activities will exceed the noise management levels:

- demolition and removal of existing masonry and steel structures using rock breakers, loaders and trucks
- piling of retaining walls
- levelling of site and removal of material using graders, excavators and trucks
- movement alarms.

The construction proponent examined and documented work practices that are feasible, including:

- demolishing structures with jaw crushers and saws, as an alternative to using rock breakers
- using a lower noise and vibration generating form of piling, such as bored piling for retaining walls, instead of impact piling
- limiting noisy activities – piling and demolishing – to 9 am to 12 pm Monday to Saturday and 2 pm to 5 pm Monday to Friday to provide respite to surrounding residents
- selecting low noise equipment for site levelling works
- liaising with affected residents and informing them when noisy work will occur and what is being done to minimise the noise
- using less annoying alternatives to audible movement alarms that provide a safe system of work, or configuring the site to maximise forward movements of mobile plant.

Using the above list of feasible practices, the proponent identified what work practices were reasonable by comparing the costs of the work practices against the overall project costs and by taking into account the community views. The proponent then documented the basis for selecting those practices.

Tables 4 to 10 present a summary of options for work practices with lower noise impact.

Table 4: Options for work practices – at any time of day or night

Strategy 1 Universal work practices
Many complaints about construction noise are due to preventable activities at any time of day or night.
Work practices at any time of day • Regularly train workers and contractors (such as at toolbox talks) to use equipment in ways to minimise noise. • Ensure site managers periodically check the site and nearby residences and other sensitive land uses for noise problems so that solutions can be quickly applied. • Include in tenders, employment contracts, subcontractor agreements and work method statements clauses that require minimisation of noise and compliance with directions from management to minimise noise. • Avoid the use of radios or stereos outdoors where neighbours can be affected. • Avoid the overuse of public address systems. • Avoid shouting, and minimise talking loudly and slamming vehicle doors. • Keep truck drivers informed of designated vehicle routes, parking locations, acceptable delivery hours or other relevant practices (for example, minimising the use of engine brakes, and no extended periods of engine idling). • Develop a one-page summary of approval or consent conditions that relate to relevant work practices, and pin it to a noticeboard so that all site operators can quickly reference noise information. • Workers may at times need to discuss or negotiate practices with their managers. **Additional work practices at night** • Avoid the use of equipment which generates impulsive noise. • Minimise the need for reversing or movement alarms as described in Table 7. • Avoid dropping materials from a height. • Avoid metal-to-metal contact on equipment. • Schedule truck movements to avoid residential streets if possible. • Avoid mobile plant clustering near residences and other sensitive land uses. • Ensure periods of respite are provided in the case of unavoidable maximum noise level events.

Table 5: Options for work practices – consultation and notification

Strategy 2 Consultation and notification

The community is more likely to be understanding and accepting of noise if the information provided is frank, does not attempt to understate the likely noise level, and if commitments are firmly adhered to.

Notification before and during construction

- Provide, reasonably ahead of time, information such as total building time, what works are expected to be noisy, their duration, what is being done to minimise noise and when respite periods will occur. For works outside standard hours, inform affected residents and other sensitive land use occupants between five and 14 days before commencement.
- Provide information to neighbours before and during construction through media such as letterbox drops, meetings or individual contact. In some areas, the proponent will need to provide notification in languages other than English. A website could also be established for the project to provide information.
- Use a site information board at the front of the site with the name of the organisation responsible for the site and their contact details, hours of operation and regular information updates. This signage should be clearly visible from the outside and include after hours emergency contact details.
- Maintain good communication between the community and project staff.
- Appoint a community liaison officer where required.
- For larger projects consider a regular newsletter with site news, significant project events and timing of different activities.
- Provide a toll-free contact phone number for enquiries during the works.
- Facilitate contact with people to ensure that everyone can see that the site manager understands potential issues, that a planned approach is in place and that there is an ongoing commitment to minimise noise.

Complaints handling

- Provide a readily accessible contact point, for example, through a 24 hour toll-free information and complaints line.
- Give complaints a fair hearing.
- Have a documented complaints process, including an escalation procedure so that if a complainant is not satisfied there is a clear path to follow.
- Call back as soon as possible to keep people informed of action to be taken to address noise problems. Call back at night-time only if requested by the complainant to avoid further disturbance.
- Provide a quick response to complaints, with complaint handling staff having both a good knowledge of the project and ready access to information.
- Implement all feasible and reasonable measures to address the source of complaint.
- Keep a register of any complaints, including details of the complaint such as date, time, person receiving complaint, complainant's contact number, person referred to, description of the complaint, work area (for larger projects), time of verbal response and timeframe for written response where appropriate.

Table 6: Options for work practices – plant and equipment

Strategy 3 Plant and equipment

In terms of both cost and results, controlling noise at the source is one of the most effective methods of minimising the noise impacts from any construction activities.

Use quieter methods

- Examine and implement, where feasible and reasonable, alternatives to rock-breaking work methods, such as hydraulic splitters for rock and concrete, hydraulic jaw crushers, chemical rock and concrete splitting, and controlled blasting such as penetrating cone fracture. The suitablility of alternative methods should be considered on a case-by-case basis.
- Use alternatives to diesel and petrol engines and pneumatic units, such as hydraulic or electric-controlled units where feasible and reasonable. Where there is no electricity supply, use an electrical generator located away from residences.
- Examine and implement, where feasible and reasonable, alternatives to transporting excavated material from underground tunnelling off site at night. For example, stockpile material in an acoustically treated shed at night and load out the following day.

Use quieter equipment

- Examine different types of machines that perform the same function and compare the noise level data to select the least noisy machine. For example, rubber wheeled tractors can be less noisy than steel tracked tractors.
- Noise labels are required by NSW legislation for pavement breakers, mobile compressors, chainsaws and mobile garbage compactors. These noise labels can be used to assist in selecting less noisy plant.
- Pneumatic equipment is traditionally a problem – select supersilenced compressors, silenced jackhammers and damped bits where possible.
- When renting, select quieter items of plant and equipment where feasible and reasonable.
- When purchasing, select, where feasible and reasonable, the most effective mufflers, enclosures and low-noise tool bits and blades. Always seek the manufacturer's advice before making modifications to plant to reduce noise.

Operate plant in a quiet and efficient manner

- Reduce throttle setting and turn off equipment when not being used.
- Examine and implement, where feasible and reasonable, the option of reducing noise from metal chutes and bins by placing damping material in the bin.

Maintain equipment

- Regularly inspect and maintain equipment to ensure it is in good working order. Also check the condition of mufflers.
- Equipment must not be operated until it is maintained or repaired, where maintenance or repair would address the annoying character of noise identified.
- For machines with enclosures, check that doors and door seals are in good working order and that the doors close properly against the seals.
- Return any hired equipment that is causing noise that is not typical for the equipment – the increased noise may indicate the need for repair.
- Ensure air lines on pneumatic equipment do not leak.

Table 7: Options for work practices – on site

Strategy 4 On site

Barriers and acoustic sheds are most suited to longer-term fixed works, as in these cases the associated cost is typically outweighed by the overall time savings.

Location of plant

- Place as much distance as possible between the plant or equipment and residences and other sensitive land uses.
- Restrict areas in which mobile plant can operate so that it is away from residences and other sensitive land uses at particular times.
- Locate site vehicle entrances away from residences and other sensitive land uses.
- Carry out noisy fabrication work at another site (for example, within enclosed factory premises) and then transport to site.

Alternatives to reversing alarms

- Avoid use of reversing alarms by designing site layout to avoid reversing, such as by including drive-through for parking and deliveries.
- Install where feasible and reasonable less annoying alternatives to the typical 'beeper' alarms taking into account the requirements of the Occupational Health and Safety legislation; examples are smart alarms that adjust their volume depending on the ambient level of noise and multifrequency alarms that emit noise over a wide range of frequencies.
- In all circumstances, the requirements of the relevant Occupational Health and Safety legislation must be complied with. For information on replacing audible warning alarms on mobile plant with less annoying alternatives, see Appendix C.

Maximise shielding

- Reuse existing structures rather than demolish and reconstruct.
- Use full enclosures, such as large sheds, with good seals fitted to doors to control noise from night-time work.
- Use temporary site buildings and materials stockpiles as noise barriers.
- Schedule construction of permanent walls so that they can be used as early as possible as noise barriers.
- Use natural landform as a noise barrier – place fixed equipment in cuttings, or behind earth berms.
- Note large reflecting surfaces on and off site that might increase noise levels, and avoid placing noise-producing equipment in locations where reflected noise will increase noise exposure or reduce the effectiveness of mitigation measures.

Table 8: Options for work practices – scheduling

Strategy 5 Work scheduling

Scheduling noisy work during periods when people are least affected is an important way of reducing noise impact.

Provide respite periods

- Consult with affected schools to ensure that noise-generating construction works in the vicinity of affected school buildings are not scheduled to occur during examination periods, unless other arrangements (such as relocation to an alternative location) acceptable to the affected schools can be made.
- Where night work near residences cannot be feasibly or reasonably avoided, restrict the number of nights per week and/or the number of nights per calendar month that the works are undertaken, in consultation with residents who will be most affected.

Schedule activities to minimise noise impacts

- Organise work to be undertaken during the recommended standard hours where possible.
- Schedule work to avoid times when there are special events, such as international sporting competitions, if the construction site is in the vicinity of the venue. When works outside the recommended standard hours are planned, avoid scheduling on Sundays or public holidays.
- Schedule work when neighbours are not present (for example, commercial neighbours, colleges and schools may not be present outside business hours or on weekends).
- Schedule noisy activities around times of high background noise (local road traffic or when other local noise sources are active) where possible to provide masking or to reduce the amount that the construction noise intrudes above the background.
- For tunnelling works examine and implement, where feasible and reasonable, the possibility of stockpiling excavated material overnight in an enclosure and restrict load-out to the recommended standard hours only.
- Consult with affected neighbours about scheduling activities to minimise noise impacts.
- Care should be taken to minimise noise from any refuelling at night.

Organise deliveries and access

- Nominate an off-site truck parking area, away from residences, for trucks arriving prior to gates opening.
- Amalgamated loads can lead to less noise and congestion in nearby streets.
- Optimise the number of vehicle trips to and from the site – movements can be organised to amalgamate loads rather than using a number of vehicles with smaller loads.
- Designate access routes to the site, through consultation with potentially noise-affected residences and other sensitive land uses, and make drivers aware of nominated vehicle routes.
- Provide on-site parking for staff and on-site truck waiting areas away from residences and other sensitive land uses. Truck waiting areas may require bunding or walls to minimise noise.
- Schedule deliveries to nominated hours only.

Table 9: Options for work practices – transmission path

Strategy 6 Transmission path

Physical methods to reduce the transmission of noise between the construction works and residences or other sensitive land uses are generally suited to works where there is longer-term exposure to the noise.

- Reduce the line-of-sight noise transmission to residences or other sensitive land uses using temporary barriers.
- Temporary noise barriers can be constructed from hoarding (plywood boards, panels of steel sheeting or compressed fibre cement board) with no gaps between the panels at the site boundary. Stockpiles, shipping containers and site office transportables can be effective barriers.
- Erect temporary noise barriers before work commences to reduce noise from works as soon as possible.
- Where high-rise dwellings adjoin the construction site, the height of a barrier may not be sufficient to effectively shield the upper levels of the residential building from construction noise. Check whether this is a consideration for the project and examine alternative means of mitigation where needed.
- Consult with most affected neighbours about how effective the proposed noise mitigation measures will be in addressing their concerns.

Table 10: Options for work practices – at residences or other sensitive land uses

Strategy 7 At residences or other sensitive land uses

Providing treatments at the affected residence or other sensitive land use should only be a last resort.

Temporary relocation

- Examine and implement, where feasible and reasonable, the option of relocating noise-affected occupants for short periods of time, such as when high noise levels from construction occur at night and there are no feasible and reasonable ways of reducing noise levels. For example, the proponent could offer alternative accommodation or other respite measures (such as movie tickets) where mitigation is sought and there are no feasible and reasonable work methods available.

Architectural treatments

- Examine and implement, where feasible and reasonable, the option of acoustical treatment to residences affected by construction noise, such as to windows at the building façade – however, alternative means of ventilation may be needed where windows are closed and airflow into a building does not meet building requirements. Note that the effectiveness of closing existing windows may be limited by the performance of the window seals.

Worked examples – treatments at residences

Example 1

After complaints were received during night-time resurfacing works on a major arterial road, the construction manager identified that complaints were from significant levels of vibration transmitted from the works to the apartment building below as the building was directly connected to the supporting column of the elevated roadway. As works could not be undertaken during the recommended standard hours due to traffic constraints and the number of affected residences was relatively small, the construction manager reviewed a range of work practices (including those listed in section 6) and decided that the most cost-effective way to address the impacts was to offer to relocate affected residents to nearby accommodation for the two nights that the work occurred.

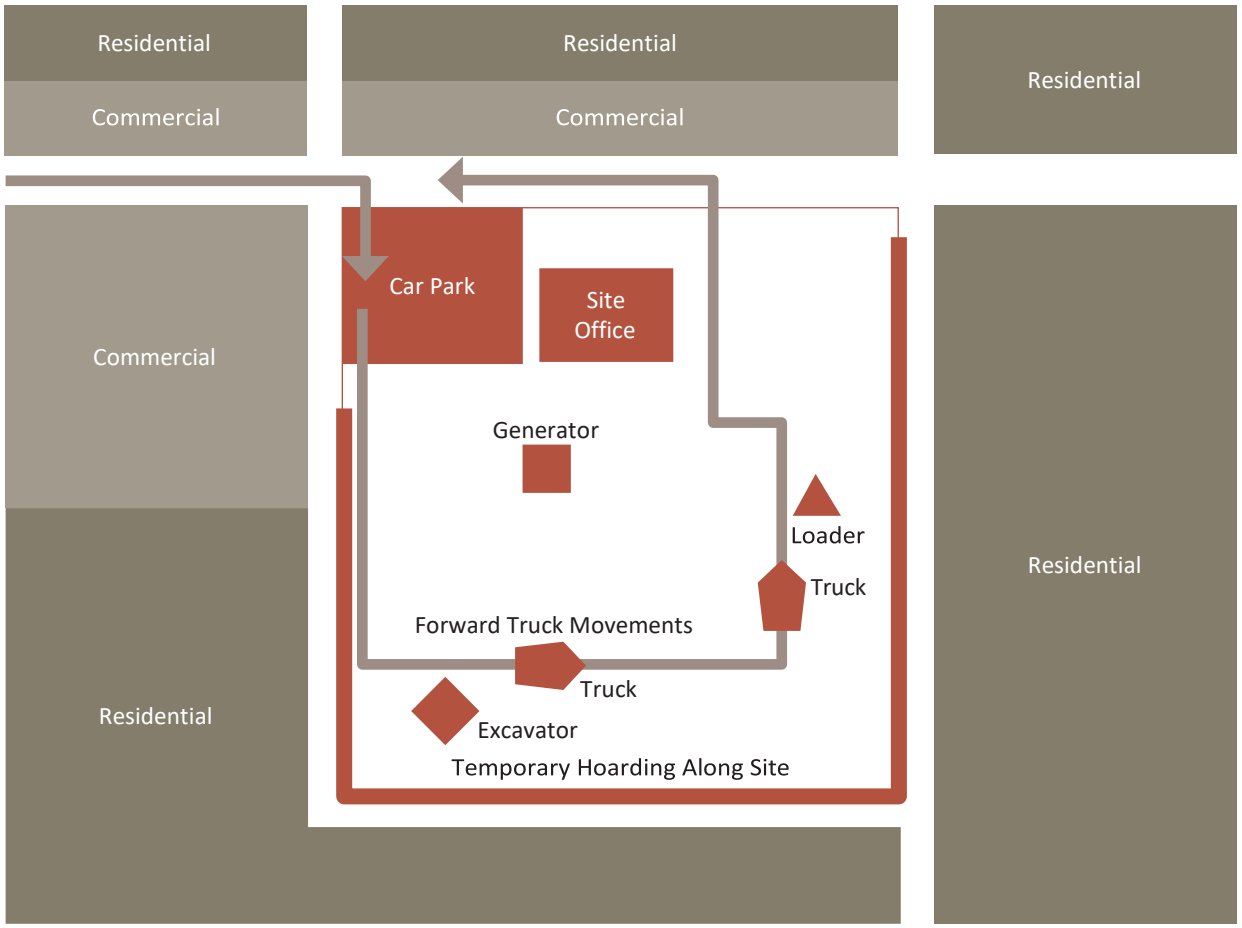
Example 2

During the construction of a major dam spillway near a residential area, the contractor provided a noise mitigation package to affected residents to address significant noise impacts. For houses closest to the site, the package comprised air conditioners augmented by external roller shutters and acoustic seals to external doors and windows. For the remainder of the affected residences, a 1.75 hp air conditioner was installed in a room that was in use during the hours of construction, with provision of a larger capacity air conditioner in a small number of 'open-plan' style houses. The cost of the noise mitigation packages was substantially less than the cost of constructing a four metre high acoustic wall.

An example of a site layout showing how to reduce noise impacts is given in Figure 2. Work practices used in this example are:

- temporary noise barriers (hoarding) along site boundary
- forward truck movements to avoid engaging reversing alarms
- vehicle entrance, car park and site office located away from residences
- limited number of mobile equipment operating near residences
- noisy fixed plant (generator) located as far as possible from residences.

Figure 2: Example site layout with quieter work practices



7 How consents and licences can regulate noise

From a community point of view, there is a need for a range of actions and processes which are incorporated into consents and licences that aim to reduce noise impacts from construction activities while encouraging community involvement and providing clarity for proponents on what is required of them.

As a project moves through the stages (from pre-approval to post-approval), more detail normally becomes available on the planned work methods, location of plant and equipment, and scheduling. The construction noise impact assessment and construction noise management plans should thus be consistent with the level of design detail available at each stage. For high noise impact projects, the community should be involved throughout the assessment process. For low noise impact projects, contact with the community is desirable once approval has been given to commence works and should be undertaken prior to any work beginning. The type of community engagement should relate to the likelihood and extent of noise impacts from the construction works.

7.1 Regulating projects through licences

The information in this section is specifically aimed at large scale construction projects regulated by DECC. DECC issues environment protection licences for the purpose of authorising scheduled activities described under Schedule 1 of the POEO Act. Licence conditions can be highly project-specific, and should relate to the noise impacts expected from the works. When developing suitable noise conditions, consideration should be given to the type of assessment method used (qualitative or quantitative) and the conceptual description of identified work practices to be applied to minimise noise impacts, as well as the planning and approval requirements for the project.

Environment protection licences

- In all cases the levels presented in sections 4.1 to 4.3 should not simply be placed in licence conditions, but are intended to guide the need for and the selection of work practices to minimise noise impacts.
- The primary focus of conditions in licences should be on referring to the **conceptual description** of feasible and reasonable work practices documented in the EIA that will be implemented to minimise noise impacts from the construction project. The conditions should also require that a **detailed description** of work practices that will be implemented be documented, such as through a noise management plan or similar as more detail becomes available on the project.
- Where both the proponent and the regulatory authority have sufficient confidence that noise levels described in the EIA will be achievable, a secondary focus on conditions in licences could be on these noise levels. In this case, the EIA documentation should make a clear commitment to the feasible and reasonable mitigation measures that will be implemented to achieve these noise levels.

7.2 Managing noise impacts through the planning approval process

The information in this section has been compiled from approval conditions on a number of recent major construction projects in NSW.

Construction noise should be assessed throughout the pre-approval and post-approval stages. Table 11 summarises the noise management tools available at the various stages of the planning approval process for the works. The most appropriate noise management approach for a project should be determined on a case-by-case basis taking into account the potential likelihood and extent of noise impacts from the construction works.

At the pre-approval stage, the proponent should contact the consent authority as early as possible in the process to ascertain any specific EIA documentation requirements. The approval and consent conditions may require any of the post-approval documents described below.

Table 11: Summary of noise management tools at various stages in the planning approval process

Type and function of document	Typical information included
Pre-approval	
EIA documentation This conceptually describes the proposal, the likely noise impacts and work practices to minimise the noise impacts.	• Description of proposed works and proposed duration • Identification of nearby residences and other sensitive land uses • Assessment of likely noise impacts • Conceptual description of feasible and reasonable work practices to minimise noise impacts • Changes made to the proposal in response to submissions or representations received.
Post-approval	
Construction Noise Management Plan This describes in detail the methods that will be implemented for the whole project to minimise the noise impacts.	• Identification of nearby residences and other sensitive land uses • Assessment of expected noise impacts • Detailed examination of feasible and reasonable work practices that will be implemented to minimise noise impacts • Strategies to promptly deal with and address noise complaints • Details of performance evaluating procedures (for example, noise monitoring or checking work practices and equipment) • Procedures for notifying nearby residents of forthcoming works that are likely to produce noise impacts • Reference to relevant licence and consent conditions.
Construction Method Statement This describes in detail the methods that will be implemented at a specific site to minimise a range of impacts from the works. Noise is often a key issue for a Construction Method Statement, but not the only issue.	
Community Consultation Plan This describes in detail the methods that will be implemented, for the whole project, to liaise with affected community members to advise on and respond to noise-related complaints and disputes.	
All stages	
Industry Best Practice Environment Manual This contains further information on best practice that the industry would expect to be used on their construction projects when assessing and managing noise impacts.	• Clarification of specific aspects of noise management to promote a better understanding • Standardisation of best practice approaches where appropriate.

7.2.1 Pre-approval stage

The EIA documentation is typically prepared at the pre-approval stage of the project. The assessment of noise impacts contained within the EIA can be either quantitative or qualitative, depending on the size, complexity and expected noise impact from a proposal. For larger complex proposals an EIA typically involves a conceptual description of feasible and reasonable work practices that can be applied to minimise noise impacts. This is made based on preliminary understanding of the expected noise impact from proposed construction works and any changes made in response to comments received during public consultation on the proposal. The EIA documentation provides the proponent with an up-front understanding of what needs to be done to minimise noise impacts (and, indirectly, the costs of managing the impacts) from the proposed works.

Issues that should be considered in preparing the EIA documentation may include:

- description of the proposed works, including a discussion of alternative construction methods and justification for selected method. Clear justification of proposed works to be undertaken outside the recommended standard hours must be given.
- identification of the residences and other sensitive land uses near the works
- description of proposed total duration of noise exposure at the identified assessment locations from the proposed works
- discussion of expected noise or blasting impacts at the most noise-exposed residences and other sensitive land uses. If a quantitative method is used, the predicted noise levels from the proposed construction works should be presented. A discussion of any community consultation undertaken in assessing the noise impacts should be included.
- discussion of feasible and reasonable work practices and mitigation measures that will be applied to minimise noise impacts from the works
- changes to the proposal in response to submissions and representations received.

7.2.2 Post-approval stage

The framework for managing environmental performance is the:

- application of best practice environmental management
- implementation of the project's commitments made during the EIA process
- implementation of the project's conditions of approval or consent
- review of information on environmental performance of the project and progress in implementing the project approval
- compliance with environmental legislation and statutory conditions (for example, in licences and consents)
- management of environmental risks associated with a project.

To ensure that a project runs smoothly through its construction stage, the proponent needs to:

- openly engage with the community to keep it informed and to discuss environmental performance
- ensure that appropriate work practices are implemented during the construction of the project to minimise noise impact.

Community engagement

The aim of community engagement is to:

- establish good working relationships between the proponent, the community and other stakeholders in relation to the construction project
- receive feedback on the project's environmental performance, discuss community concerns and identify opportunities for the resolution of community complaints
- gain advice on how best to communicate relevant information on the project and its environmental performance to the broader community
- work cooperatively towards outcomes of benefit to the project, immediate neighbours and the local and regional community.

There is a range of ways to engage the community to manage environmental performance for construction projects.

For large projects where many people are identified to be potentially impacted by noise from the works, the relevant authority (consent or determining) may require a community consultation plan. Such plans can be particularly helpful where projects propose noisy work outside normal working hours or extended work that produces high levels of noise (such as rock hammering or piling). The community consultation plan might include:

- the establishment of one or more community liaison groups or community forums
- procedures for face-to-face consultation between the proponent and affected parties
- procedures for notifying residents and occupants of other sensitive land uses of forthcoming works likely to affect their noise amenity (such as letterbox drops)

Establishing a good working relationship between the proponent and the community (Transport Infrastucture Development Corporation)

- procedures for complaints handling, and for keeping a copy of the complaints register on site
- dispute resolution procedures.

The proponent should establish appropriate representative community liaison groups or forums and nominate an independent chair for each group. The groups or forums should have opportunities to comment on the management of the project including implementation of the environmental management plan. Each group or forum would advise on how best to communicate relevant information on the project and its environmental performance to the community. The proponent should consider comments and provide a response. The proponent should bear costs associated with the establishment and ongoing function of the groups or forums.

Being up-front with the community liaison team from the outset can assist in transferring information to the affected community. An example of being up-front is to present information to community liaison groups or forums before commencing works.

An option for dispute resolution that has been used for large construction projects associated with high levels of noise has been for the proponent to appoint a person as an independent community liaison representative for the duration of the construction. Essentially, the community liaison representative is a resource available to the community to advise on concerns community members may have with the environmental performance of the project. The community liaison representative would attend local group or forum meetings, oversee community consultation obligations, be available for direct contact with the community within reasonable hours and, to the greatest extent practicable, resolve complaints. The proponent should bear the costs of employing the community liaison representative.

Noise management plans

An environmental management plan or, more specifically relating to noise, a construction noise management plan is a site or project specific plan developed to ensure that appropriate work practices are implemented during a project's construction to minimise noise impact. Noise management plans can be used to explain in detail how the proponent intends to implement work practices on a project to minimise noise.

For large projects a construction noise management plan may include the following features:

- identification of all nearby residences and other sensitive land uses and, where relevant, the noise or blasting management levels at the identified assessment locations
- an assessment of potential noise or blasting impacts from the proposed construction methods and construction vehicle movements
- detailed examination of feasible and reasonable noise mitigation measures that would minimise or avoid noise impacts – this would include a commitment to what feasible and reasonable work practices and measures are to be applied to minimise noise impacts
- preparation of regular feedback by undertaking noise monitoring and analysis of the results to improve the management plan, so that best practice noise control is continually met for the duration of the project
- development of reactive and pro-active strategies for dealing promptly with any noise complaints, including documentation and feedback mechanisms
- identification of a site contact person to follow up complaints
- details of noise or blast monitoring and reporting procedures, including where these have been established as necessary during the noise impact assessment

- the establishment of monitoring systems at affected residences and other sensitive land uses for noise levels and weather conditions (for example, wind speed and direction, rainfall)
- regular internal checks of plant and equipment to confirm there has been no degradation in noise levels
- regular independent auditing of procedures.

Negotiated agreements

When excessive noise impacts occur, alternative approaches to noise management, such as negotiated agreements between affected individuals and the construction manager, may be considered. The option of negotiated agreements is most suited to dealing with small numbers of people. For further guidance on negotiated agreements refer to section 8 of the *NSW Industrial Noise Policy* (EPA 2000). Where large numbers of people are identified as potentially affected by noise from the construction works – such as can occur with linear projects like motorways or railways – negotiated agreements are not an appropriate noise management strategy due to costs and potential diversity of community views. In these cases the proponent should develop a strategy specific to the project that encompasses the approaches listed above of management plans, community liaison groups or forums and an independent community liaison representative.

7.3 Industry published procedures

Members of the construction industry may want to use published procedures to describe in more detail the best practice approaches that they expect will be used in their projects to minimise noise impacts from construction. When preparing these procedures, an organisation should consult with the public and take into account any comments raised. Having procedures publicly available, rather than only available internally, provides the public with a greater level of transparency. This transparency, combined with consultation with the public when preparing the procedures, may result in the community supporting the organisation's implemented approaches. Any published procedures should be consistent with this Guideline.

For example, a published procedure could be used to describe work practices that the proponent and their contractors will apply in addition to the practices set out in the checklist in section 5.2 for a qualitative assessment.

Whether or not there is a published procedure, the organisation's principal obligation is to meet noise conditions of any environment protection licence that DECC has issued to them.

Examples of some industry published procedures are:

- the *Environmental Noise Management Manual* (RTA 2001) and the *Environmental Fact Sheet 02 – Noise Management and Night Works* (RTA 2007), which aim to provide guidance to RTA staff, contractors and consultants on RTA's principles in managing noise from the maintenance or upgrading of existing roads, as well as the construction of new roads in NSW
- the *Construction Noise Strategy* (TIDC 2007), which aims to guide Transport Infrastructure Development Corporation staff, contractors and consultants on managing noise from the construction of rail projects in NSW.

Other organisations involved with construction, maintenance or upgrading are encouraged to develop similar documents to describe their best-practice techniques for managing construction noise.

8 Evaluating performance and compliance

Evaluating noise and blasting impacts during construction works facilitates:

- providing feedback to the proponent on the amount of noise associated with different activities to inform future decisions regarding work methods and associated impacts
- investigating complaints relating to noise from the construction works
- determining compliance with the consent and licence conditions.

Where noise impacts from a construction project are identified and there is a need to manage complaints, two options are available for the proponent to evaluate performance against the noise conditions on a consent, approval or licence:

- examination of work practices, where a qualitative assessment has been undertaken, or
- noise monitoring, where a quantitative assessment has been undertaken.

8.1 For a qualitative assessment

Where noise conditions do not describe noise management levels or limits for the works, the most appropriate way to evaluate performance against the conditions is to examine whether *all* work practices described in the checklist in section 5.2 are being applied.

Section 6 also presents a broader range of options for work practices that may be suitable for minimising noise impacts. This may be, for example, a small project only undertaken during the recommended standard hours.

8.2 For a quantitative assessment

The duration of noise monitoring could be over an hour, a day, a week, or longer. The amount of noise monitoring will depend on the scale of the project and the extent of expected noise impacts. Monitoring should cover a representative period (typically divided into 15 minute intervals) of the construction activity. Where distinct construction activities occur and for large projects where construction is designed to occur in distinct stages, monitoring would typically be needed for the different activities and stages.

As a minimum, monitoring should be carried out at the most noise-affected sensitive land uses (that is, where noise levels are likely to be the highest). If monitoring is carried out as a result of a complaint, noise levels should be monitored at the complainant's location. Monitoring should also cover the time of day when the impacts were reported to occur.

Noise monitoring results should be clearly reported and acted on in accordance with the requirements contained in the licence and/or consent conditions. It is recommended that results also be made readily accessible to the community.

The $L_{A10\,(15\,min)}$ noise level may be a useful indicator of construction activity for use in compliance monitoring, where the existing $L_{Aeq\,(15\,min)}$ noise levels are higher than the identified management levels. The measured $L_{A10\,(15\,min)}$ levels should be adjusted to estimate the $L_{Aeq\,(15\,min)}$ for comparison with the noise management levels for the project.

Monitoring reports

The following may be included in a noise monitoring report:

- the type of monitoring conducted (for example, at a particular project stage or following complaints) and a brief statement of the measurement method
- the noise/vibration/blasting conditions on the consent/licence, or the relevant noise management objectives
- descriptions of the nearest affected residences and other sensitive land uses or, in the case of complaints, description of the complainant location and complaint
- plan or diagram showing the location of the monitoring and the noise generating works
- description of the instrumentation used (the instrumentation specifications required for compliance noise monitoring are the same as those required for background noise monitoring set out in Appendix B of the *NSW Industrial Noise Policy* (EPA 2000))
- name and relevant qualifications or professional memberships of monitoring personnel
- the weather conditions during monitoring
- the time(s) and duration(s) of monitoring, including dates – in the case of complaints
- a clear description of the construction activities taking place during the monitoring
- the results of monitoring at each monitoring location, including a comparison with the consent conditions or relevant noise management objectives
- a clear statement outlining the project's compliance or non-compliance with the conditions or objectives
- where the monitored level is higher than the conditions or objectives, the reasons for non-compliance should be stated, strategies for minimising noise identified and stated, and the appropriate actions to implement the strategies.

Trials

Trials can be used to evaluate the impact of an activity, through a controlled test over a limited period of time. Before and after the trial there should be consultation with the potentially affected community to gauge their response to the activity being trialled. Also, there should be detailed predictions to show that the trial can be properly managed to minimise noise impacts.

Appendix A: Case studies

A range of case studies illustrates various ways to manage noise impacts from construction works by applying the recommendations in the Guideline. The approaches illustrated in each case study are summarised in Table 12.

Table 12: Summary of case studies

Case study	Approaches illustrated
1. Targeted community consultation	• consultation with community
2. Night-time 'in-tunnel' blasting	• consultation with community • notification prior to works commencing, providing respite periods • using temporary barriers
3. Managing ground-borne noise	• noise prediction • complaint handling • ongoing consultation with community
4. Major road construction	• installing permanent barriers as soon as possible • using quieter plant or equipment, using alternative construction methods • consultation with community • using 'smart' reversing alarms • locating plant as far as possible from residences and other sensitive land uses
5. Major infrastructure upgrade	• consultation with community • less annoying alternatives to audible movement alarms • organising deliveries and access • temporary relocation of noise-affected occupants
6. Night-time essential maintenance works	• qualitative impact assessment • implementing work practices set out in section 5.2 • community notification letter

Case study 1: Targeted community consultation

On a large civil engineering project involving the construction of a major dam spillway approximately 200 m from a residential area, targeted community consultation was used effectively to facilitate smooth running of the project. Targeted consultation specifically directs communication with those in the community who are identified as being potentially affected by noise, vibration, and dust from the project. The main benefit of this form of consultation is that it opens channels of communication with an affected community and can deal with noise issues before they become irreconcilable issues.

Conditions of approval included a requirement that the dam owner establish a community liaison group (CLG) and appoint an environmental representative. Key players were drawn together to become part of the CLG that would address community concerns in a constructive, non-confrontational approach to resolving problems. The CLG comprised:

- the CLG chairman
- the principal (the organisation which wants the spillway constructed)
- the project manager
- the environmental representative

- three community representatives – one from each of the nearby villages that were identified as being potentially affected
- the area's Chamber of Commerce
- the local action group.

CLG members were encouraged to liaise closely with the community, both to supply accurate information on the project and to identify areas of concern for discussion at CLG meetings. Presentations to the CLG prior to construction, briefings on progress throughout the project and open discussion about issues kept the committee informed and involved in the project. Through this approach, trust developed between the committee, the project manager and the principal.

Throughout the project, the following community information tools were used:

- a toll-free 24 hour telephone contact number
- a community liaison office (CLO) in one of the villages, opened by the principal, where the community could easily make complaints or enquiries; noticeboards, displays and photos of the project were also provided at the CLO
- a monthly newsletter, explaining what processes were in place to minimise noise impacts
- an extraordinary meeting between the principal, the contractor and the environmental representative to discuss ways to resolve noise issues when numerous complaints were received.

Due to the proximity of this large project to the residential area, there was potential for widespread negative reaction from the community, which could have resulted in considerable additional costs and/or delays to the project. However, through effective consultation targeted at the potentially affected residents and implementation of a range of noise mitigation measures, all parties worked together to the satisfaction of the local community in terms of noise impacts.

Case study 2: Night-time 'in-tunnel' blasting

An application was made to the relevant authority for night-time 'in-tunnel' blasting on a major dam project in rural NSW. The application proposed a one-week trial period to verify that minimal impacts would result from the blasting. The proposal received strong support from the community as it meant that the project would be completed quickly.

Mitigation measures were identified to minimise noise impacts at the affected residences and other sensitive land uses and to ensure that the conditions on the environment protection licence (EPL) were met. These measures comprised:

- detailed blast design that was checked through initial blasts during the recommended standard hours to ensure the noise management objectives would be met
- barriers at the entrance to the tunnel portal
- replacement of the blast warning siren outside the recommended standard hours with a less annoying alternative that satisfied the requirements of the Occupational Health and Safety Regulation 2001.

The EPL required that the contractor undertake extensive consultation with the general community and the potentially affected residents prior to and following the blasting. Consultation involved a range of media, including community information sessions, meetings with potentially affected residents, one-on-one discussions with residents (by phone and face-to-face), newsletters, information boards and a website.

The community was also informed of the various ways they could contact the project staff if they had queries, concerns or complaints. This included a 24 hour toll-free complaints line, phone numbers of key project staff, and project email and website addresses.

The contractor undertook measurements at several of the most affected residences and other sensitive land uses to determine compliance with the air-blast overpressure and ground vibration limits set out in the licence. The measurements showed that the limits were met at all locations.

The contractor received no complaints during the trial blasting period, but received a number of calls from people confirming that they had heard some noise during the blasting seeking reassurance to allay their concerns.

What if the community was not consulted?

In another situation, the contractor undertook trial blasting without consulting with the community. There was a significant number of complaints received from the affected community regarding noise. The regulatory authority initiated an investigation after they also received complaints regarding noise. The contractor subsequently experienced large delays in the project through dealing with and addressing the numerous community concerns.

Case study 3: Managing ground-borne noise

During 24-hour tunnelling in a densely-populated urban area, ground-borne noise was a concern as the tunnel-boring machine was to pass very close to residences.

Conditions in the licence for the project required the contractor to identify residences and other sensitive land uses along the route of the tunnelling works, then present predicted internal ground-borne noise levels (in a graphical form) on a map showing the identified residences and other sensitive land uses. The predicted noise levels needed to be verified from measurements during a 24-hour trial period, and the predicted levels reviewed as data was obtained.

A zone of affected residences along the route was then determined, based on where the predicted levels were above the $L_{Aeq(15\ min)}$ noise level of 35 dB(A). The licence required the contractor to develop a complaint response program and specified that the contractor would need to respond within two hours for a complaint received from within this zone, and within 24 hours for complaints received outside of this zone. The contractor set up a 24-hour response line for the affected community to use for noise complaints.

Where the investigation of a complaint showed that measured levels were above the ground-borne noise limit at night (10 pm to 7 am), the licence required the contractor to develop an approach to manage the ground-borne noise impacts. The constructor was able to negotiate an agreement with the complainant to permit night-time tunnelling to continue where ground-borne noise levels were higher than the limits in the licence conditions.

This ongoing direct communication with the affected community allowed a good relationship to be developed and assisted in the works being completed on time and budget.

Case study 4: Major road construction project

A four-lane freeway that would pass through a large town was to be constructed. The noise assessment indicated that noise from the construction would significantly affect a number of residences.

Work practices to minimise noise impacts during the recommended standard hours included:

- construction of earth mounds as early as possible during the construction works to provide shielding to residences adjoining the work site – the mounds work best when they are located as close as possible either to the residences or to the noise source
- extensive consultation with the affected community, including mail-outs and advertisements in local newspapers to notify when, where and for how long noisy works would be undertaken, a 24 hour toll-free information line, a community liaison officer at an information booth and a complaints management program
- a table of set noise levels for major items of equipment used on site – when equipment arrived on site its noise level was measured and, if it was above the tabled value, the equipment was checked and modified as necessary; the equipment noise levels were checked monthly to identify equipment that required immediate maintenance
- consideration of quieter construction methods, for example, expansion joints in freshly laid concrete paving were cut using a 'soft-cutting' method that cuts the concrete when it is semi-cured to generate less noise than cutting the concrete in its harder full-cured form.

Work practices implemented to minimise noise impacts from approved works outside the recommended standard hours (such as during possession of a major road), in addition to notifying the community of the works, included:

- providing a 24-hour phone number to contact a construction officer who had the authority to alter works being undertaken where the complaint was justified
- using 'smart' (less annoying) movement alarms on mobile cranes

Works can be close to neighbouring residences (Courtesy of Sydney Water and Leighton Contractors)

- locating compressors, power generators and other fixed plant at ground level and behind site structures to provide the greatest shielding
- using plywood to form temporary barriers around noisy works, and wrapping noise-reducing material around noisy equipment where possible
- selecting the quietest equipment available – equipment fitted with high-performance mufflers on engine exhausts and sealed enclosures on engines
- locating the site entry, site offices and parking areas as far as possible from the residences.

Case study 5: Major infrastructure upgrade project

As part of a strategic plan to service the needs of an expanding residential district, a 10 km pipeline was constructed to the regional sewage treatment plant through three towns. The pipeline was 9 m deep with a diameter of 1.8 m, constructed using a tunnel-boring machine to bore out a cavity into which the pipe was pushed into place.

To manage noise impact at the affected communities, tailored mitigation plans for each site, based on the duration of works and the expected noise levels, were prepared. A range of community consultation methods were used to manage the noise impacts, including written notification, meeting with affected residents, notification in the local newspaper of noisy works, a 24 hour toll-free telephone complaints line, and street signage. In residential areas, proposed work practices included:

- installation of a temporary enclosure at the tunnel portal, as the tunnel-boring machine operated 24 hours a day
- fitting a muffler to a 35 tonne crane
- instructing all night staff about quiet work practices
- scheduling deliveries during the recommended standard hours only, unless restricted by police or other authorities
- arranging the work site to minimise the use of movement alarms on vehicles
- developing an agreement with residents where noise could not be mitigated to meet the night-time noise level.

The project team found that through noise management planning, implementation of quieter work practices and continued community consultation the project was undertaken with minimal disruption to the community.

Case study 6: Night-time essential maintenance works

Essential maintenance on a damaged section of a major arterial road was needed. The works were near a residential area and were scheduled for night-time due to high levels of commuter traffic on the road at other times.

The project manager applied to the road authority for approval to undertake the works at night. As part of this process, the project manager was required to assess the potential for noise impacts from the proposed works. The work was scheduled for only four consecutive nights (weather permitting) and the total duration of noise exposure from the works would be four nights at any residence. The project manager decided that a qualitative assessment would be the most appropriate way of assessing noise impacts from the proposed works.

Using aerial photographs, maps of the locality and knowledge of the proposed work site, the project manager identified the nearest residences to be:

- along the arterial road, a minimum of 15 m to either side of the site
- in streets off the arterial road.

The application for approval included a qualitative noise assessment report with a description of the identified residences and the proposed plant and equipment. The report indicated that the noisiest activities would probably be the bitumen removal and asphalting, and noted that the equipment involved would be operated when required between 11 pm and 4 am.

The report recommended that the work practices described in section 5.2 of this Guideline be implemented to minimise noise impacts, together with guidance from the *Environmental Noise Management Manual* (RTA 2001) and the *Environmental Fact Sheet 02 – Noise Management and Night Works* (RTA 2007). These work practices included notifying residents prior to undertaking works, considering alternative work methods that generate less noise, operating plant in a quiet and efficient manner, and training workers in ways to minimise noise (such as avoiding shouting).

The project manager prepared a letter to residents surrounding the work area informing them that noise from the proposed works may be audible; a sample notification letter is shown in Figure 3. The project manager organised a toolbox talk each night with the workers before work commenced, to explain to them the importance of minimising the noise on site. The project manager also arranged for the site manager for each night to carry a mobile phone and be the point of contact for community enquiries or complaints.

Consider respite periods for high-noise level works (DECC)

Over the four nights of work, the site manager received calls from some residents concerned about noise. As a number of the callers mentioned that they had been woken by noise from equipment left idling for long periods close to residences, the site manager talked to the workers about turning off equipment when not in use.

Figure 3: Sample notification letter to residents

Sample Constructions Pty Ltd
PO Box 999
Smithville

1 July 2009

Dear Resident and Business Operator,

Western Arterial Road: Night-time maintenance works

Sample Constructions Pty Ltd has been contracted to undertake maintenance works on a section of Western Arterial Road between Smith Street and John Street. The works will be undertaken over four nights commencing 12 July 2009, weather permitting.

During these night-time works, lane closures will occur. Traffic controls will be used and the speed limit near the construction areas will be reduced to 60 km/h.

You may hear occasional reversing beepers, truck engines, and engine noise from machines used for road surface preparation. The equipment will be used between the hours of 10 pm and 4 am each night. Lights may be used but will be directed away from residences. Workers will be asked to minimise noise from the works. All practices described in our published procedures (available at www.website.address) will be implemented at these works.

We apologise for any inconvenience or disturbance that this work may cause.

To contact the site manager whilst these works are being undertaken, please call 0400 555 555.

Yours sincerely

John Citizen
Project Manager

Appendix B Equipment noise levels

Plant and equipment noise levels can be described in two ways:

- sound power level (L_w or SWL), or
- sound pressure level at a given distance (L_p or SPL).

The sound power level is the intrinsic noise output of plant or equipment, and does not depend on distance or orientation of the machine. There are Australian and international standards that define methods for determining the sound power level of a machine (for example, the AS1217 series).

The sound pressure level is the noise at a given distance from plant or equipment, and the sound pressure level can change depending on the distance from the equipment and also the orientation of the equipment. The sound pressure level is meaningless without knowing the distance at which the sound pressure level is measured. Because sound pressure levels can vary with distance from plant or equipment, it is not the preferred data for comparing noise output – sound power level is generally best for comparison of plant or equipment as it is independent of distance.

When selecting plant or equipment, the proponent should contact manufacturers or suppliers and ask for the noise level data of a range of suitable equipment. The proponent may also wish to compare the noise level data of similar equipment from different manufacturers or suppliers. There are broadly four responses that a manufacturer may give when asked for equipment noise level data:

1. sound power level, for example, L_w 115 dB(A)
2. sound pressure level for a given distance, for example, L_p 82 dB(A) at 7.5m
3. sound pressure level without specifying the distance, for example, L_p 78 dB(A)
4. no noise level data available.

The first two responses are useful as the information allows comparison of the noise output of suitable equipment. The last two responses are not useful, and in this case the proponent should either ask the manufacturer or supplier to provide more information (such as the distance at which the sound pressure level was measured), or obtain noise level data from another manufacturer or supplier.

The noise output of equipment may vary depending on operating conditions, such as idle or under load. Where possible, equipment noise levels should be compared for similar operating conditions. When undertaking on-site compliance checks, the proponent should obtain exact noise level data from the equipment manufacturer or supplier.

There are several published databases on construction equipment noise levels:

- The Department of Environment Food and Rural Affairs in the United Kingdom published L_{Aeq} and $L_{A\,(max)}$ sound pressure levels in 2005 (DEFRA 2005).
- The Federal Highway Adminstration published $L_{A\,(max)}$ sound pressure levels in 2006 (FHWA 2006).
- The European Commission (2000) issued Directive 2000/14/EC (amended by Directive 2005/88/EC) on equipment sound power levels.
- The Department of Energy and Infrastructure in South Australia published *Infrastructure Works at Night – Operational Instruction 21.7* in 2007 (DTEI 2007).

Appendix C Audible alarms on mobile plant

The Occupational Health and Safety Regulation 2001 requires that mobile plant incorporate measures that effectively warn persons in danger from its operation. This requirement applies to:

- a designer of powered mobile plant, under clause 93(4)
- a person selling or transferring the plant, under clause 121(3)
- a person hiring or leasing the plant to another person, under clauses 127(2)(a) and 127(2)(b)
- an employer, under clauses 136(A)(1)(c), 137(1)(c) and 141(10)(a).

It is important to emphasise that the Regulation does not specify the format such warning devices must take. Audible movement alarms, such as reversing 'beepers', are not mandatory but are simply one of a range of movement alarms fitted by various manufacturers. Manufacturers may also have a range of alternative audible movement alarms that may be appropriate for the specific operation of the equipment. Where the manufacturer has fitted movement alarms, they must be maintained and operated as intended. Changing the type of alarm fitted would constitute an alteration and clauses 84 to 97 of the Regulation would apply. The *Moving plant on construction sites: Code of Practice* (WorkCover 2004b) discusses the possible inconvenience and disadvantages of using audible reversing alarms for operations with multiple plant and at night-time near residential areas.

Approval conditions (such as in licences or consents) or when altering the type of alarm fitted may require that:

- a safety risk assessment be undertaken to determine whether it is practicable to implement less annoying audible movement alarms, on powered mobile plant, and
- if the safety risk assessment determines that alternative audible movement alarms are practicable without compromising safety, then those alarms must be functional whilst undertaking the construction works.

The safety risk assessment must be determined by a competent person, and be based on an assessment of the site and its conditions as well as the machines involved. The alternative audible movement alarms must be compatible with the machine, and not adversely affect its operation. The competent person must specify the procedures involved in changing the warning measures, and the maintenance necessary to ensure their correct operation.

When a movement alarm is replaced by a less annoying audible movement alarm, all site personnel should be advised of this change and the manner in which the device functions.[1]

A loader fitted with a broadband reversing alarm rather than a beeper alarm (Abigroup Contractors Pty Ltd)

1 An example of the sound of a broadband alarm can be found at www.environment.nsw.gov.au/noise/constructnoise.htm

Abbreviations

CLG	community liaison group
CLO	community liaison office
dB	decibel
DEC	Department of Environment and Conservation (NSW)
DECC	Department of Environment and Climate Change NSW
EIA	environmental impact assessment
EPA	Environment Protection Authority
EPL	environment protection licence
POEO Act	*Protection of the Environment Operations Act 1997*
RBL	rating background level
RTA	Roads and Traffic Authority, NSW

Glossary

Airborne noise management levels – to be measured and assessed at the residential property boundary that is most exposed to construction noise, and at a height of 1.5 m above ground level. If the residential property boundary is more than 30 m from the residence, the location for measuring or predicting noise levels is at the most affected point within 30 m of the residence.

Assessment location – an identified residence or other sensitive land use.

A-weighting – an adjustment made to the sound level measurement to approximate the response of the human ear.

Background noise level – the underlying level of noise present in the ambient noise when extraneous noise is removed and excluding noise from the construction project under consideration. This is described using the L_{A90} descriptor.

Blasting – to be assessed in accordance with the *Technical Basis for Guidelines to Minimise Noise Annoyance Due to Blasting Overpressure and Ground Vibration* (ANZEC 1990).

Competent person – a person who has acquired through training, qualification or experience, or a combination of these, the knowledge and skills to carry out a particular task (as defined in Clause 3(1) of the Occupational Health and Safety Regulation 2001).

Construction works – include the erection, installation, alteration, repair, maintenance, cleaning, painting, renewal, removal, excavation, dismantling or demolition of, or addition to, any building or structure, or any work in connection with any of these activities, that is done at or adjacent to the place where the building or structure is located. Construction works occur on a site for a limited period of time only.

Decibel (dB) – a measure of sound equivalent to 20 times the logarithm (to base 10) of the ratio of a given sound pressure to a reference pressure, and 10 times the logarithm (to base 10) of the ratio of a given sound power to a reference power.

dB(A) – a measure of A-weighted sound levels.

Emergency works – unforseen works immediately needed to prevent the loss of life, damage to property or environmental harm.

Environmental impact assesment – a broad term that covers the range of assessments required under the *Environmental Planning and Assessment Act 1979* and any related amendments to the Act.

Extraneous noise – noise resulting from activities that are not typical of the area. Atypical activities include traffic generated by holiday periods and special events such as concerts or sporting events. Normal daily traffic is not considered to be extraneous.

Ground-borne noise – noise heard within a building that is generated by vibration transmitted through the ground into the structure from construction works, sometimes referred to as 'regenerated noise' or 'structure-borne noise'. Ground-borne noise can be more noticeable than airborne noise for underground works such as tunnelling. The ground-borne noise levels are only applicable when ground-borne noise levels are higher than airborne noise levels.

Habitable room – any room other than a garage, storage area, bathroom, laundry, toilet or pantry.

Internal noise level – applies at the centre of the room in use that is most exposed to the construction noise, and can include both airborne and ground-borne noise.

$L_{A1\ (1\ min)}$ – the A-weighted sound pressure level that is exceeded for 1% of the 1-minute measurement period.

$L_{A10\ (15\ min)}$ – the A-weighted sound pressure level that is exceeded for 10% of the 15-minute measurement period.

$L_{A90\ (15\ min)}$ – the A-weighted sound pressure level that is exceeded for 90% of the 15-minute measurement period, when measured in the absence of the construction works under consideration and excluding extraneous noise. This is considered to represent the background noise.

$L_{Aeq\ (15\ min)}$ – the A-weighted equivalent continuous (energy average) A-weighted sound pressure level of the construction works under consideration over a 15-minute period and excludes other noise sources such as from industry, road, rail and the community. Other descriptors may be used providing they can be justified as representing the characteristics of the construction noise.

$L_{A\ (max)}$ – the A-weighted maximum noise level only from the construction works under consideration, measured using the fast time weighting on a sound level meter.

Mandatory – required by legislation. The Guideline specifies noise management levels that guide the need to apply work practices to minimise noise impacts, but the legislation does not make it compulsory, that is not mandatory, to meet these noise levels. However, the Guideline will be used when setting statutory (legally enforceable) conditions in a licence or consent.

Most affected location(s) – location(s) that experience (or will likely experience) the greatest noise impact from the construction works under consideration. In determining these locations, existing background noise levels, noise source location(s), distance and any shielding between the construction works (or proposed works) and the residences and other sensitive land uses need to be considered.

Proponent – the developer of the construction works under consideration.

Rating background level – the overall single-figure background noise level for each assessment period. Determination of the rating background level is by the method described in the *NSW Industrial Noise Policy* (EPA 2000). This approach aims to result in the noise management level being met for at least 90% of the time periods (15 minutes each) over which reactions of annoyance can occur.

Short-term maintenance works – maintenance or repair of infrastructure, where the works are not likely to affect an individual or sensitive land use for more than three weeks in total.

Vibration – human comfort vibration to be measured and assessed in accordance with *Assessing vibration – a technical guideline* (DEC 2006).

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