Noise Policy for Industry

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About this document

The *Noise Policy for Industry* is not a statutory document but may be referenced in instruments in relation to the assessment and management of industry noise sources. The NSW Environment Protection Authority will use this policy to inform its decision-making when regulating and managing noise from industry. Where there is inconsistency between this policy and the requirements of an environment protection licence or other instrument, the provisions of a licence or other instrument prevail. It sets out a framework for the derivation of project noise trigger levels that are used to assess the potential impacts of noise from industry and indicate the noise level at which feasible and reasonable noise management measures should be considered. It also provides a process for predicting noise levels and determining achievable statutory noise limits and operational requirements for licences, consents and other statutory instruments.

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1. Introduction

Industrial growth and investment is a key objective of the NSW Government. The growth of industry in NSW brings many benefits to the community. These include providing a range of useful services and products both for the state and elsewhere in Australia and overseas. Industry growth also creates employment opportunities and generates important revenue for the state. It is vital that development of industry in NSW is properly managed to ensure the ongoing viability of industrial activities and an adequate protection of community wellbeing and amenity.

Noise from industry (refer to Section 1.4 to determine what premises the policy applies to) can result in adverse effects on surrounding residents if premises have not been designed to mitigate noise. Noise can interfere with daily activities including conversation, entertainment and studying and can result in increased annoyance and stress. Noise can also interfere with sleep. The World Health Organization (WHO, 2009) indicates that 'sleep is a biological necessity and disturbed sleep is associated with a number of adverse impacts on health'. The impacts of noise need to be managed to protect the amenity and wellbeing of local communities living near industry.

Land-use planning processes provide the first and most effective and efficient mechanism to avoid noise-related land-use conflicts. The *Noise Policy for Industry* should be used as a reference to assist strategic land-use planning functions by planning authorities.

This policy sets out the NSW Environment Protection Authority's (EPA's) requirements for the assessment and management of noise from industry in NSW. It aims to ensure that noise is kept to acceptable levels in balance with the social and economic value of industry in NSW.

The reaction to noise varies widely from individual to individual. Because of this it is not possible to adopt noise levels that will guarantee that no one will experience an impact. Annoyance caused by noise is partly due to acoustic factors and partly due to other factors including the personal and social outlook of individuals (Guski, 1999). The noise levels in this policy should not be interpreted to mean that industrial noise will be inaudible, or that all members of the community will find the noise acceptable.

When new industry is being proposed or existing industry is being upgraded, redeveloped or needs review, attention needs to be paid to controlling noise. The *Noise Policy for Industry* is designed to assist industry and authorities ensure that potential noise impacts associated with industrial projects are managed effectively.

1.1 Managing noise from industrial activities

The *Noise Policy for Industry* (NSW EPA, 2017, referred to as 'the policy') will replace the *NSW Industrial Noise Policy* (NSW EPA, 2000).

The purpose of the policy is to ensure noise impacts associated with particular industrial developments are evaluated and managed in a consistent and transparent manner. It provides noise levels for assessing the potential impact of noise from industry and includes a framework for considering feasible and reasonable noise mitigation measures. The *Environmental Planning and Assessment Act 1979* (EP&A Act) and the *Protection of the Environment Operations Act 1997* (POEO Act) require that authorities examine and take into account matters affecting the environment when making decisions about development and activities. The policy also provides a procedure for the development of appropriate and achievable statutory noise limits and operational requirements for development consents and environment protection licences.

Effective management of industrial noise impacts requires the combined efforts of industry (such as proponents and managers), regulatory and planning authorities, residential developers and the community. The policy applies to industrial development projects specified in Section 1.4.

1.1.1 Using the policy in local and regional planning

The EP&A Act sets out the framework for strategic planning, development assessment and the coordination of approvals required under environmental and other legislation.

Government bodies, including the Department of Planning and Environment (DP&E), councils and the EPA, play a number of roles that influence the level of noise in the community and its impact including:

Strategic land-use planning

Strategic planning processes, for example, regional and local plans, provide an opportunity to avoid noise impacts that can occur when industrial areas are located in close proximity to residential areas or other noise-sensitive receivers. When preparing environmental plans and strategies, planning authorities can use the noise levels in the policy to inform decisions about the potential impacts of different types of development and use approaches such as buffering high-noise areas from sensitive receivers (for example, residential areas) and locating low-noise activities (such as business centres) in intervening areas.

Put simply, appropriate separation between industrial land uses and sensitive land uses will reduce the potential for noise-related land-use conflicts. Examples of strategic planning initiatives to promote better noise outcomes include:

- identifying and locating zones in a manner that reduces the potential for land-use conflicts with adjoining land uses or, where these conflicts cannot be avoided by separation alone, applying suitable controls in the planning instruments to ensure compatibility
- implementing communication mechanisms to inform members of the public moving into noise-affected areas, in order to avoid unrealistic expectations of noise amenity in affected areas
- using controls in land-use planning instruments to promote compatibility between existing noise generating activities or industrial zoned land and new residential developments for land affected by industrial activities. Examples of existing land-use planning controls for new residential development adjacent to busy roads and rail are contained in the *State Environmental Planning Policy (Infrastructure) 2007*. Land-use planning authorities could consider developing similar requirements for new residential areas or existing residential areas undergoing urban renewal with higher-density settlement patterns near major clusters of industries, for example ports
- considering existing industry or industrially-zoned land when changing land-use zones to a more sensitive use or greater density of residential settlement pattern to ensure that the planning decision does not unduly impact on existing land uses in the area.

Development consent

Land-use zoning sets out the permissible and envisaged land uses in an area and is a key determiner in deciding whether a particular use should be granted development consent. Planning authorities can use development planning and approval processes to avoid impacts on the community from noise by ensuring that industrial developments have reasonable environmental performance requirements that are practical and socially and economically viable for the development locality.

Environmental regulation under the *Protection of the Environment Operations Act 1997* and other legislation

The EPA has a range of roles and responsibilities with respect to land-use planning and assessment of development proposals, particularly in regard to proposals that require an environment protection licence (Schedule 1 POEO Act). The EPA must take into account certain matters when making certain regulatory decisions as set out in the POEO Act. The policy provides a framework for decisions in relation to noise matters; for example, for the assessment of the impact of noise pollution, and the measures that can be taken to mitigate that impact.

The EP&A Act requires that relevant agencies that have an interest in an environmental planning policy or a development application be consulted. The EPA provides expert advice to the relevant planning authority regarding any potential environmental impacts, including noise. In addition, the EPA also provides a range of general advice in relation to other matters regulated by the EPA, including waste, water and air pollution and chemical issues. This can include how these issues are considered for both environmental planning instruments and strategic plans, as well as for development applications. The policy informs the EPA when providing advice on industrial noise impacts, and it can also be used by determining authorities and other agencies when assessing or managing noise from industry. The EPA provides advice consistent with the matters that it must take into account when making a licensing decision. Decisions made under the EP&A Act take into account the range of matters set out under that legislation.

1.2 Who is the policy for?

The policy is for proponents of industrial developments, acoustic practitioners and consent/approval authorities involved with the planning, design, approval, construction, development and management of industrial premises. The policy provides the degree of detail needed to identify noise impacts properly and develop appropriate mitigation methods.

The policy may also be used by land-use planners (such as a local council and the DP&E), to ensure that both strategic and statutory planning functions appropriately consider noise impacts as outlined in Section 1.1.1.

Members of the community can consult the policy for information on how industrial noise impacts are assessed.

1.3 Objectives

The objectives of the policy are to:

- provide the noise levels that are used to assess both change in noise level and long-term noise levels
- provide a clear and consistent framework for assessing environmental noise impacts from industrial premises and industrial development proposals
- promote the use of best-practice noise mitigation measures that are feasible and reasonable where potential impacts have been identified
- support a process to guide the determination of achievable noise limits for planning approvals and/or licences, taking into account the matters that must be considered under the relevant legislation (such as the economic and social benefits and impacts of industrial development).

1.4 What noise sources does the policy apply to?

The policy applies to industrial noise sources from activities listed in **Schedule 1 of the POEO Act** and regulated by the EPA. All scheduled activities require an environment protection licence issued under the POEO Act. The policy is also an appropriate reference document for DP&E when assessing major development proposals under the EP&A Act.

Local government is an independent regulator for noise under the legislation, and has discretion in dealing with noise within its area of responsibility.

The policy is designed for large industrial and agricultural sources and specifies substantial monitoring and assessment procedures that may not always be applicable to the types of sources councils need to address. However, local government may find the policy helpful in assessing noise from premises it regulates and in the carrying-out of its land-use planning responsibilities as outlined in Section 1.1.1. Information on noise management for local government is also provided in the EPA's *Noise guide for local government 2013*.

In general, the types of premises dealt with in the policy include:

- industrial premises
- extractive industry premises
- commercial premises (generally limited to noise from heating, ventilation, air conditioning and refrigeration, and energy generation equipment)
- warehousing premises
- maintenance and repair facility premises
- intensive agricultural and livestock premises, for example, cattle feedlots and poultry farms
- utility generation/reticulation service premises, for example, energy generation from sources other than wind.

The policy can also be used to assess noise from mechanical plant and equipment; industrial and commercial processes; mobile sources confined to a particular location (for example, drag lines, haul trucks, intermodal facilities and rail shunting yards); and vehicle movements within the premises and/or on private roads.

Note: Where a private haul road is proposed to convey materials from one premises to another and is proposed for the express purpose of removing traffic from a public road, the private haul road should be assessed against the project amenity noise levels only.

When there is question as to whether the policy is to be applied to a particular land use or premises, the relevant consent or regulatory authority should be consulted.

1.4.1 Types of development

The assessment procedures in the policy can apply to any one of the following three situations:

- new developments, for example, new industrial premises
- modification of an existing development, for example, proposed expansion of an existing industrial premises
- when noise associated with an existing development requires assessment.

1.4.2 Existing noise sources

The application of the policy to existing sources of noise would occur where a modification is proposed that requires an amendment to the existing development consent or environment protection licence, or where the requirements in place for an existing licenced activity are being reviewed.

When applying the policy to existing operations, the scope for applying feasible and reasonable mitigation measures can be more limited than for new developments. Careful consideration of noise impacts and the **feasible and reasonable mitigation measures** available at these sites is needed, noting that the noise limits might not be the same as those for a greenfield site. The assessment and management of existing premises is dealt with in Section 6.

1.5 What has been excluded from the policy?

The policy does not apply to:

- vehicles associated with an industrial premise that are on a public road
- transportation corridors (roadways, railways, waterways and air corridors)
- noise from sporting facilities, including motor sport facilities
- construction activities
- noise sources covered by regulations (domestic/neighbourhood noise)
- blasting activities
- shooting ranges
- internal or occupational noise within any workplace regulated by SafeWork NSW
- wind farms
- amplified music/patron noise from premises including those licensed by Liquor and Gaming NSW.

Other government policies, guidelines and legislation typically cover these noise sources.

1.6 Overview of the policy

The policy sets out a process for industrial noise management involving the following main steps:

1. Determining the project noise trigger levels for a development (Section 2); these are the benchmark levels above which noise management measures are required to be considered. They are derived by considering two factors: shorter-term intrusiveness due to changes in the noise environment (Section 2.3), and maintaining the noise amenity of an area (Section 2.4). Measurement of existing background levels, using procedures outlined in Fact Sheets A and B (this document), is required for this step.
2. Predicting or measuring the noise levels produced by the development (Section 3.3), having regard to the presence of annoying noise characteristics (Fact Sheet C) and meteorological effects such as temperature inversions and wind (Fact Sheet D).
3. Comparing the predicted or measured noise level with the project noise trigger level, and assessing impacts and the need for noise mitigation and management measures (Section 3.4).
4. Considering residual noise impacts, that is, noise levels that exceed the project noise trigger levels after the application of feasible and reasonable noise mitigation measures. This may involve balancing economic, social and environmental costs and benefits from

the proposed development against the noise impacts, including consultation with the affected community where impacts are expected to be significant (Sections 3.2 and 4).

5. Setting statutory compliance levels that reflect the best achievable and agreed noise limits for the development (Section 5).
6. Monitoring and reporting environmental **noise levels** from the development (Section 7).

2. Industrial noise trigger levels

Industrial noise can have a significant effect on noise-sensitive receivers surrounding the premises. The policy sets out the procedure to determine the **project noise trigger levels** relevant to a particular industrial development. The project noise trigger level applies to existing noise-sensitive receivers, however, it may also be used in strategic planning processes for proposed land uses.

If it is predicted that the development is likely to cause the project noise trigger level to be exceeded at **existing noise-sensitive receivers**, management measures need to be considered to seek to reduce the **predicted noise level**.

2.1 Project noise trigger level

The project noise trigger level provides a benchmark or objective for assessing a proposal or site. It is not intended for use as a mandatory requirement. The project noise trigger level is a level that, if exceeded, would indicate a potential noise impact on the community, and so ‘trigger’ a management response; for example, further investigation of mitigation measures.

The project noise trigger level, feasible and reasonable mitigation, and consideration of residual noise impacts are used together to assess noise impact and manage the noise from a proposal or site. **It is the combination of these elements that is designed to ensure that acceptable noise outcomes are determined by decision makers**.

The trigger level is tailored for each specific circumstance to take into account a range of factors that may affect the level of impact, including:

- the receiver’s background noise environment
- the time of day of the activity
- the character of the noise
- the type of receiver and nature of the area.

The scientific literature indicates that both the increase in noise level above background levels (that is, intrusiveness of a source), as well as the absolute level of noise are important factors in how a community will respond to noise from industrial sources. The project noise trigger level established in this policy addresses each of these components of noise impact.

The project noise trigger level is the lower (that is, the more stringent) value of the project **intrusiveness noise level** and project **amenity noise level** determined in Sections 2.3 and 2.4.

The project intrusiveness noise level aims to protect against significant changes in noise levels, whilst the project amenity noise level seeks to protect against cumulative noise impacts from industry and maintain amenity for particular land uses. Applying the most stringent requirement as the project noise trigger level ensures that both intrusive noise is limited and amenity is protected and that no single industry can unacceptably change the noise level of an area.

The worked case studies in Fact Sheet E show how both components are used to determine the project noise trigger level.

Typically, the intrusiveness level will inform the project noise trigger level in areas with little industry (and/or ambient noise levels), whereas the amenity level will inform the project noise trigger level in areas with higher existing background noise levels.

Intrusive noise levels are only applied to residential receivers (residences). For other receiver types identified in Table 2.2, only the amenity levels apply.

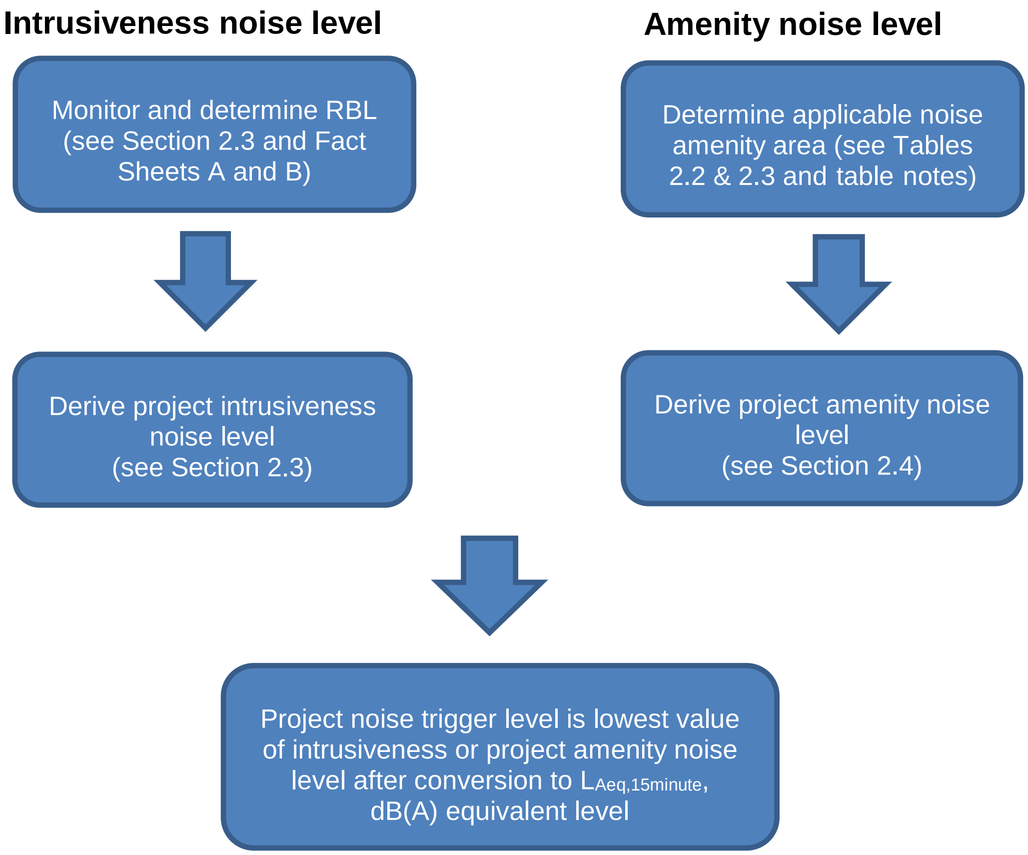

Figure 1: Determining the project noise trigger level. RBL = rating background noise level.

2.2 Noise descriptors

The noise levels in this policy differentiate between noise impacts during the day, evening and night. More stringent levels are applied for evening and night-time. It is widely accepted that noise is generally more disturbing in the evening and night because more noise-sensitive activities occur at those times (such as socialising, relaxing and sleeping). Also, most residents are typically at home and noise is more intrusive due to lower background levels during the evening and at night.

L_{Aeq} descriptor

The **L_{Aeq} descriptor** is used for both the intrusiveness noise level and the amenity noise level. This descriptor represents the level of average noise energy over the relevant period of measurement and takes account of peak noise levels as well as the degree of noise fluctuation. This descriptor is most widely correlated with the subjective effect of noise (Miedema and Vos, 2004).

The L_{Aeq} is determined over a 15-minute period for the project intrusiveness noise level and over an assessment period (day, evening and night) for the project amenity noise level. This leads to the situation where, because of the different averaging periods, the same numerical value does not necessarily represent the same amount of noise heard by a person for different time periods. To standardise the time periods for the intrusiveness and amenity noise levels, this policy assumes that the **$L_{Aeq,15min}$** will be taken to be equal to the **$L_{Aeq, period}$ + 3 decibels (dB)**, unless robust evidence is provided for an alternative approach for the particular project being considered.

All project noise trigger levels and limits derived in this policy will be expressed as $L_{Aeq,15min}$ values, except as otherwise expressed in Section 2.8.

L_{AF90} descriptor

The **L_{AF90} descriptor** is used to measure the background noise level. This descriptor represents the noise level that is exceeded for 90% of the time over a relevant period of measurement using ‘A’ frequency weighting and fast time weighting.

This policy describes a process to derive a **rating background noise level** (RBL) that provides a single figure that represents the background noise level for assessment purposes.

L_{AFmax} descriptor

The L_{AFmax} descriptor is used to measure and quantify maximum noise level events. The L_{AFmax} is the maximum sound pressure level of an event measured with a sound level meter satisfying *AS IEC 61672.1-2004* set to ‘A’ frequency weighting and fast time weighting.

Rounding

Noise levels used in this policy shall be rounded to the nearest integer.

2.3 Project intrusiveness noise level

The intrusiveness of an industrial noise source may generally be considered acceptable if the level of noise from the source (represented by the **L_{Aeq} descriptor**), measured over a 15-minute period, does not exceed the background noise level by more than 5 dB when beyond a minimum threshold. This intrusiveness noise level seeks to limit the degree of change a new noise source introduces to an existing environment.

To account for the temporal variation of background noise levels, the method outlined in Fact Sheet A is required for determining the background noise level or rating background noise level (RBL) to be used in the assessment. The outcome of this approach aims to ensure that the intrusiveness noise level is being met for at least 90% of the time periods over which annoyance reactions can occur (taken to be periods of 15 minutes).

The intrusiveness noise level is determined as follows:

$L_{Aeq,\ 15min}$ = rating background noise level + 5 dB	
where:	
$L_{Aeq,\ 15min}$	**represents the equivalent continuous (energy average) A-weighted sound pressure level of the source over 15 minutes.**
and	
Rating background noise level	**represents the background level to be used for assessment purposes, as determined by the method outlined in Fact Sheets A and B.**

Intrusiveness noise levels are not used directly as regulatory limits. They are used in combination with the amenity noise level to assess the potential impact of noise, assess reasonable and feasible mitigation options and subsequently determine achievable noise requirements.

In some rural situations, the RBL may be the same for the day, evening and night. In these cases, it is recognised that excursions of noise above the project intrusiveness noise level during the day would not usually have the same impact as they would during the evening or night. This is due to the more sensitive nature of activities likely to be disturbed at night (for example, sleep and relaxation).

Minimum assumed RBLs apply in this policy. These result in minimum intrusiveness noise levels as follows:

Table 2.1: Minimum assumed RBLs and project intrusiveness noise levels.

Time of day	Minimum assumed rating background noise level (dB[A])	Minimum project intrusiveness noise levels ($L_{Aeq,15min}$ dB[A])
Day	35	40
Evening	30	35
Night	30	35

The objective of carrying out long-term background noise monitoring at a location is to determine existing background noise levels that are indicative of levels during the entire year. However, the RBL for evening or night periods calculated from long-term unattended background noise monitoring can sometimes be higher than the RBL for the daytime period. This situation can arise due to increased noise from, for example, insects or frogs during the evening and night in the warmer months, or due to temperature inversion conditions during winter.

In determining project noise trigger levels from RBLs, the community's expectations also need to be considered. The community generally expects greater control of noise during the more sensitive evening and night-time periods than during the less sensitive daytime period. Therefore, in determining project noise trigger levels for a particular development, it is generally recommended that the project intrusiveness noise level for evening be set at no greater than the project intrusiveness noise level for daytime. The project intrusiveness noise level for night-time should be no greater than the project intrusiveness noise level for day or evening. Alternative approaches to these recommendations may be adopted if appropriately justified.

2.4 Amenity noise levels and project amenity noise levels

To limit continuing increases in noise levels from application of the intrusiveness level alone, the ambient noise level within an area from **all** industrial noise sources combined should remain below the recommended amenity noise levels specified in Table 2.2 where feasible and reasonable. The recommended amenity noise levels will protect against noise impacts such as speech interference, community annoyance and some sleep disturbance.

The recommended amenity noise levels have been selected on the basis of studies that relate industrial noise to annoyance in communities (Miedema and Voss, 2004). They have been subjectively scaled to reflect the perceived differential expectations and ambient noise environments of rural, suburban and urban communities for residential receivers. They are based on protecting the majority of the community (90%) from being highly annoyed by industrial noise.

The recommended amenity noise levels represent the objective for **total** industrial noise at a receiver location, whereas the **project amenity noise level** represents the objective for noise from a **single** industrial development at a receiver location.

To ensure that industrial noise levels (existing plus new) remain within the recommended amenity noise levels for an area, a **project amenity noise level** applies for each new source of industrial noise as follows:

Project amenity noise level for industrial developments = recommended amenity noise level (Table 2.2) minus 5 dB(A)

The following exceptions to the above method to derive the project amenity noise level apply:

1. In areas with high traffic noise levels (see Section 2.4.1).

2. In proposed developments in major industrial clusters (see Section 2.4.2).
3. Where the resultant project amenity noise level is 10 dB or more lower than the existing industrial noise level. In this case the project amenity noise levels can be set at 10 dB below existing industrial noise levels if it can be demonstrated that existing industrial noise levels are unlikely to reduce over time.
4. Where cumulative industrial noise is not a necessary consideration because no other industries are present in the area, or likely to be introduced into the area in the future. In such cases the relevant amenity noise level is assigned as the project amenity noise level for the development.

Where the project amenity noise level applies and it can be met, no additional consideration of cumulative industrial noise is required. However, in circumstances where this level cannot be feasibly and reasonably met, an assessment of existing industrial noise, and the combined resulting noise level from existing and the proposed industries, is required so the impact of the residual noise levels can be determined in accordance with Section 4.2. Therefore, it may be prudent to determine the existing level of industrial noise during initial surveys.

Amenity noise levels are not used directly as regulatory limits. They are used in combination with the project intrusiveness noise level to assess the potential impact of noise, assess reasonable and feasible mitigation options, and subsequently determine achievable noise requirements.

Table 2.2: Amenity noise levels.

Receiver	**Noise amenity area**	**Time of day**	**L_{Aeq}, dB(A)**
(see Table 2.3 to determine which residential receiver category applies)			**Recommended amenity noise level**
Residential	Rural	Day	50
		Evening	45
		Night	40
	Suburban	Day	55
		Evening	45
		Night	40
	Urban	Day	60
		Evening	50
		Night	45
Hotels, motels, caretakers' quarters, holiday accommodation, permanent resident caravan parks	See column 4	See column 4	5 dB(A) above the recommended amenity noise level for a residence for the relevant noise amenity area and time of day
School classroom – internal	All	Noisiest 1-hour period when in use	35 (see notes for table)
Hospital ward internal external	 All All	 Noisiest 1-hour Noisiest 1-hour	 35 50
Place of worship – internal	All	When in use	40
Area specifically reserved for passive recreation (e.g. national park)	All	When in use	50

Active recreation area (e.g. school playground, golf course)	All	When in use	55
Commercial premises	All	When in use	65
Industrial premises	All	When in use	70
Industrial interface (applicable only to residential noise amenity areas)	All	All	Add 5 dB(A) to recommended noise amenity area

Notes: The recommended amenity noise levels refer only to noise from industrial sources. However, they refer to noise from all such sources at the receiver location, and not only noise due to a specific project under consideration. The levels represent outdoor levels except where otherwise stated.

Types of receivers are defined as follows:

- rural residential – see Table 2.3
- suburban residential – see Table 2.3
- urban residential – see Table 2.3
- industrial interface – an area that is in close proximity to existing industrial premises and that extends out to a point where the existing industrial noise from the source has fallen by 5 dB or an area defined in a planning instrument. Beyond this region the amenity noise level for the applicable category applies. This category may be used only for existing situations (further explanation on how this category applies is outlined in Section 2.7)
- commercial – commercial activities being undertaken in a planning zone that allows commercial land uses
- industrial – an area defined as an industrial zone on a local environment plan; for isolated residences within an industrial zone the industrial amenity level would usually apply.

Time of day is defined as follows:

- day – the period from 7 am to 6 pm Monday to Saturday or 8 am to 6 pm on Sundays and public holidays
- evening – the period from 6 pm to 10 pm
- night – the remaining periods.

(These periods may be varied where appropriate, for example, see A3 in Fact Sheet A.)

In the case where existing schools are affected by noise from existing industrial noise sources, the acceptable L_{Aeq} noise level may be increased to 40 dB $L_{Aeq(1hr)}$.

Table 2.3 provides guidance on assigning residential receiver noise categories; however, careful judgement based on site-specific circumstances and consultation with the relevant planning/licensing authority may be required in some circumstances.

Table 2.3: Determining which of the residential receiver categories applies.

Receiver category	Typical planning zoning – standard instrument*	Typical existing background noise levels	Description
Rural residential	RU1 – primary production RU2 – rural landscape RU4 – primary production small lots R5 – large lot residential E4 – environmental living	Daytime RBL <40 dB(A) Evening RBL <35 dB(A) Night RBL <30 dB(A)	**Rural** – an area with an acoustical environment that is dominated by natural sounds, having little or no road traffic noise and generally characterised by low background noise levels. Settlement patterns would be typically sparse. Note: Where background noise levels are higher than those presented in column 3 due to existing industry or intensive agricultural activities, the selection of a higher noise amenity area should be considered.
Suburban residential	RU5 – village RU6 – transition	Daytime RBL<45 dB(A) Evening RBL<40 dB(A)	**Suburban** – an area that has local traffic with characteristically intermittent traffic flows or with some limited commerce or industry. This area often has the

	R2 – low density residential R3 – medium density residential E2 – environmental conservation E3 – environmental management	Night RBL <35dB(A)	following characteristic: evening ambient noise levels defined by the natural environment and human activity.
Urban residential	R1 – general residential R4 – high density residential B1 – neighbourhood centre (boarding houses and shop-top housing) B2 – local centre (boarding houses) B4 – mixed use	Daytime RBL> 45 dB(A) Evening RBL> 40 dB(A) Night RBL >35 dB(A)	**Urban** – an area with an acoustical environment that: • is dominated by 'urban hum' or industrial source noise, where urban hum means the aggregate sound of many unidentifiable, mostly traffic and/or industrial related sound sources • has through-traffic with characteristically heavy and continuous traffic flows during peak periods • is near commercial districts or industrial districts • has any combination of the above.

Notes: *As cited in Standard Instrument – Principal Local Environmental Plan, New South Wales Government, Version 15 August 2014. RBL = rating background noise level.

2.4.1 Amenity noise levels in areas of high traffic noise

The level of transport noise, road traffic noise in particular, may be high enough to make noise from an industrial source effectively inaudible, even though the L_{Aeq} noise level from that industrial noise source may exceed the project amenity noise level. In such cases the project amenity noise level may be derived from the $L_{Aeq,\ period(traffic)}$ minus 15 dB(A).

High traffic project amenity noise level for industrial developments = $L_{Aeq,\ period(traffic)}$ minus 15 dB(A)

General and more specific case studies showing how the high traffic project amenity noise level works are included in Fact Sheet E.

This high traffic project amenity noise level may be applied only if all the following apply:

- traffic noise is identified as the dominant noise source at the site
- the existing traffic noise level (determined using the procedure outlined in A2, Fact Sheet A, that is, measuring traffic instead of industrial noise) is 10 dB or more above the recommended amenity noise level for the area
- it is highly unlikely traffic noise levels will decrease in the future.

The applicability of these traffic noise provisions needs to be determined for each assessment period (that is, day, evening and night).

2.4.2 Amenity noise levels in areas near an existing or proposed cluster of industry

The recommended amenity noise level from Table 2.2 represents the **total** industrial noise level from all sources (new and proposed) that is sought to be achieved using feasible and reasonable controls.

The approach of deriving the project amenity noise level resulting from a new development on the basis of the recommended amenity noise level minus 5 dB is based on a receiver not being impacted by more than three to four individual industrial noise sources.

Where an existing cluster of industry, for example, an industrial estate or port area, is undergoing redevelopment and/or expansion and the development constitutes a single premises addition or expansion, with no other redevelopment planned in the foreseeable future, the project amenity noise level approach procedure in Section 2.4 can be applied.

However, where a greenfield or redevelopment of an existing cluster of industry consisting of **multiple new** noise-generating premises is proposed, the approach for determining the project amenity noise level in Section 2.4 is not applicable and the approach below should be applied.

Equation 1: New multiple premises or redevelopment of existing clusters of industry

Individual project amenity noise level = $10\text{Log}\left(10^{(\text{ANL} - 5\text{ dB}/10)}/\text{N}\right)$

where:

ANL = relevant recommended amenity noise level from Table 2.2

N = number of proposed additional premises.

Where a greenfield development is proposed and it can be demonstrated that existing levels of industrial noise are more than 5 dB lower than the relevant recommended amenity noise level, equation 1 can be modified to reflect 'amenity noise level' in lieu of 'amenity noise level – 5 dB(A)'.

2.4.3 Effects of changing land use

When land uses in an area are undergoing significant change, for example, residential subdivisions with associated development of local and regional roads, the background noise levels would be expected to change, sometimes significantly. The impact of noise from an existing industry on a proposed new residential area should be made using the recommended amenity noise level for the residential land use, not the project intrusiveness noise level. Where impacts exceed the amenity noise level, consideration should be given to how these impacts can be avoided or mitigated, such as modifying the location of the proposed residential development, placing screening land uses in-between the proposed residences and existing industry, or ensuring residences are built in a manner that provides acceptable indoor noise amenity.

2.5 Maximum noise level event assessment

The potential for sleep disturbance from maximum noise level events from premises during the night-time period needs to be considered. Sleep disturbance is considered to be both awakenings and disturbance to sleep stages.

Where the subject development/premises night-time noise levels at a residential location exceed:

- $L_{Aeq,15min}$ 40 dB(A) or the prevailing RBL plus 5 dB, whichever is the greater, and/or
- L_{AFmax} 52 dB(A) or the prevailing RBL plus 15 dB, whichever is the greater,

a detailed maximum noise level event assessment should be undertaken.

The detailed assessment should cover the maximum noise level, the extent to which the maximum noise level exceeds the rating background noise level, and the number of times this happens during the night-time period. Some guidance on possible impact is contained in the review of research results in the NSW Road Noise Policy.

Other factors that may be important in assessing the extent of impacts on sleep include:

- how often high noise events will occur
- the distribution of likely events across the night-time period and the existing ambient maximum events in the absence of the subject development
- whether there are times of day when there is a clear change in the noise environment (such as during early-morning shoulder periods)
- current scientific literature available at the time of the assessment regarding the impact of maximum noise level events at night.

Maximum noise level event assessments should be based on the L_{AFmax} descriptor on an event basis under ‘fast’ time response.

The detailed assessment should consider all feasible and reasonable noise mitigation measures with a goal of achieving the above trigger levels.

2.6 Assessment locations

For a **residence**, the project noise trigger level and maximum noise levels are to be assessed at the reasonably most-affected point on or within the residential property boundary or, if that is more than 30 metres from the residence, at the reasonably most-affected point within 30 metres of the residence, but not closer than 3 metres to a reflective surface and at a height of between 1.2–1.5 metres above ground level. This should not be read to infer that the project noise trigger level (or a limit in a statutory document) applies only at the reasonably most-affected location.

For multi-storey residential buildings (greater than two storeys) where a ground floor assessment location is deemed to be unrepresentative of the exposure of upper stories, the assessment may be undertaken at a representative elevation and closer than 3 metres to a reflective surface, as agreed with the regulator. However, the assessed/measured noise level is to be suitably adjusted to reflect a ‘free field’ (that is, nominally no reflective signals) assessment/measurement location.

In assessing amenity noise levels at **commercial or industrial premises**, the noise level is to be assessed at the reasonably most-affected point on or within the property boundary. Again, this requirement should not be read to infer that the noise level **only** applies at the ‘reasonably worst-affected location’.

Where internal amenity noise levels are specified, they refer to the noise level at the centre of the habitable room that is most exposed to the noise and apply with windows opened sufficiently to provide adequate ventilation, except where alternative means of ventilation complying with the Building Code of Australia are provided. In cases where gaining internal access for monitoring is difficult, then external noise levels 10 dB(A) above the internal levels apply.

In assessing amenity noise levels at passive and active recreational areas, the noise level is to be assessed at the most-affected point within the area that is reasonably expected to be used by people, for example, picnic areas or walking tracks.

2.7 Industrial interface

The industrial interface assessment provisions recognise that a marginally reduced acoustic amenity is acceptable for existing residences co-located with existing industry, and that the availability of noise mitigation measures might be limited in these circumstances.

The industrial interface assessment generally applies only for existing situations (that is, an existing residential receiver near an existing industry that is proposing expansion or modification) and generally only for those residential receivers that are:

- in the immediate area surrounding the existing industry (that is, the region that extends from the boundary of the existing industry to the point where the noise level of the existing industry, measured at its boundary, has fallen by 5 dB or as agreed between the proponent and the relevant authority at the commencement of a noise impact assessment or related study), and
- where existing industrial noise levels (including noise from the premises under consideration) are above the relevant rural, suburban or urban recommended amenity noise levels.

Beyond the interface region (that is, beyond the point where noise has fallen by 5 dB) the recommended amenity noise level relevant to the receiver category that most describes the area (rural, suburban or urban) would apply.

For developments of a limited nature such as an extension to **existing** process or plant, or replacement of part of an **existing** process or plant with new technology, the industrial interface assessment applies.

However, where a new development on an existing site is of a substantial nature (for example, demolition of the existing plant and replacement with current technology or different type of plant) and where replacement of the existing plant has a realistic potential to significantly reduce receiver noise levels through using feasible and reasonable noise mitigation (that is, where the existing plant is the dominant or a significant contributor to receiver noise levels), then the applicable noise level for the new development is the appropriate (rural, suburban or urban) amenity noise level for the location.

In most cases the situation will be apparent, but in some cases careful judgement will be required to determine whether the new development is of sufficient magnitude to effectively replace the existing plant. In situations where no clear conclusion on the magnitude of change created by the new development is possible, then the industrial interface assessment should apply.

In all cases, however, the proponent/licensee is required to demonstrate that all feasible and reasonable noise mitigation measures are being applied before the industrial interface criteria is adopted.

The project noise trigger levels apply to noise from the whole premises (existing and proposed). However, where the works are relatively minor or contained in a particular area within premises, contribution noise levels from the new works only may be acceptable and should be set at:

- 10 dB below premises-based project noise trigger levels, or
- 10 dB below existing premises noise levels where they exceed the project noise trigger levels and cannot be reduced with feasible and reasonable noise mitigation measures.

Where this approach is proposed, this should be discussed and agreed to by the consent/regulatory authority.

2.8 Noise management precincts

2.8.1 What is a noise management precinct?

A **noise management precinct** is a mechanism to allow new development without causing further noise impacts in areas where noise levels might already be above desired levels. It also has the potential to be used to manage legacy noise issues associated with industrial land that is close to residential areas.

The precinct approach has the following objectives:

- to ensure that noise impacts are not exacerbated in residential areas close to a nominated industrial precinct
- to provide a mechanism that will allow noise impacts to be managed over time
- to allow a nominated industrial precinct to be fully utilised in a cost-effective and efficient manner.

The precinct approach allows noise from multiple sites to be managed as a single site by giving the operator of an activity or proposed activity the flexibility to take action to reduce noise in another nearby location, or work with others to take action to reduce noise on their behalf.

While a new noise source always adds to existing noise levels, the precinct approach ensures any nominal increase from a single development is not significant and not detectable by the community. By maintaining the requirement to implement the usual suite of reasonable and feasible mitigation options, there is also potential for noise levels to be reduced over time.

Within a precinct the source of the noise affecting receivers is managed as a single site. When a new development is proposed, the responsible landowner or entity can use any available method to ensure the precinct meets the recommended amenity noise level. For example, it might be possible to re-locate a new activity in a different area to the original proposal, or to reduce noise levels at other sources in order to accommodate the new activity.

In all cases, the principle that all reasonable and feasible means of mitigating noise impacts must be undertaken will remain.

2.8.2 Why have a noise management precinct?

A noise management precinct is a form of economic instrument. Economic instruments enable environmental requirements to be achieved at a lower cost than strict controls alone. In the case of a noise management precinct, the options for mitigating or managing noise are increased compared to traditional approaches. The ability to relocate a noise source, or trade or purchase noise mitigation at another site once standard mitigation measures have been applied, can reduce the cost of development when compared to traditional approaches.

2.8.3 Principles for noise management precincts

Noise management precincts should follow these principles:

- all reasonable and feasible mitigation options must be implemented consistent with this policy
- all standard regulatory requirements must still be met
- a precinct will not be put in place to authorise poor environmental performance
- a precinct must complement other regulatory instruments such as land-use planning requirements
- the use of a precinct must be expected to result in a net reduction in noise impacts over time.

2.8.4 Essential elements of a noise management precinct

A noise management precinct must:

- be binding on all relevant parties
- have a mechanism for quantifying impacts from new developments in combination with existing noise sources, for example, a noise model

- identify a party or mechanism that is responsible for managing the agreed method of noise quantification
- identify a party or mechanism for recording transactions
- have clear spatial boundaries and be characterised by a common function or activity type as, for example, with ports
- ensure that precinct requirements are enforceable through development consent conditions, licence conditions, conservation agreements or contracts.

2.8.5 Implementation of a noise management precinct

A precinct may be implemented through development consent conditions, other planning instruments, regulation, environment protection licence requirements, covenants, or a contract. The form of implementation will depend on the specific circumstances in each case but is always binding. Implementation of a noise management precinct will occur with the checks and balances appropriate under the relevant legislation. It can be expected that development of a noise management precinct would involve assessment of the noise sources and their impacts, consideration of the most appropriate approach, and consultation, discussion and negotiation with stakeholders as needed.

When a new development is proposed and noise mitigation action is carried out in another area in the precinct, the character as well as the noise level must be considered. Where the character of the noise from the new development is different from the existing noise, the adjustments in Fact Sheet C must be used where relevant.

Other components of a noise management precinct could include:

- noise amelioration programs for existing industrial activities
- noise abatement programs for existing residential properties exposed to noise from the precinct (such as home acoustic treatments to reduce noise levels inside houses)
- planning controls for new residential developments close to the precinct, to ensure that they incorporate acoustic measures, so that the development is compatible with the industrial activity.

The suite of noise management measures would be tailored to the specifics of the precinct and the surrounding land uses.

2.8.6 Industrial interface and the industry precinct approach

Where it has been clearly demonstrated that the noise levels set out in this policy cannot be achieved in the short or long term due to the physical relationship between an industrial precinct and surrounding residential land uses (that is, due to existing legacy noise issues), the application of the industrial interface will be considered.

Under these circumstances a planning instrument could be used to declare a zone around an existing and/or expanding industrial precinct as an interface zone. This would be done in recognition of the importance of the industrial land use and based on balancing social, economic and environmental considerations on a regional level.

3. Assessment of industrial noise impacts

An assessment of industrial noise impacts may be needed as part of an environmental assessment under the EP&A Act, or where noise pollution is being reviewed for environmental regulation purposes under the POEO Act. It is not the role of this policy to offer a detailed procedure on how to prepare an environmental assessment, as site-specific factors will often influence the assessment process. However, this section contains advice on the key elements of a noise impact assessment, and the following information should be taken into account when preparing such assessments for consideration by the consent authority or decision maker.

An important aspect of noise assessment is the prediction of noise levels from an industrial noise source so that a determination of noise impact can be made. Assessment of industrial noise impacts involves:

- determining the appropriate **project noise trigger level** (Section 2)
- identifying all significant source, pathway and receiver parameters so that noise can be adequately predicted
- predicting noise levels from the source at receiver locations, taking into account all important parameters identified, including an assessment of meteorological conditions in accordance with Fact Sheet D, and taking account of annoying characteristics of the noise source in accordance with Fact Sheet C
- comparing the predicted noise level with the project noise trigger level to determine the need to consider noise mitigation measures.

3.1 Applying project noise trigger levels and determining feasible and reasonable mitigation measures

When the project noise trigger level identified in this policy is likely to be exceeded, the noise assessment should identify feasible and reasonable mitigation. The proponent for the project must prepare this assessment.

> Where the project noise trigger level is exceeded, assess the feasible and reasonable mitigation measures that could be implemented to reduce noise down towards the relevant project noise trigger level. If it is reasonable to achieve these levels, the proponents should do so. If not, then achievable noise levels should be identified. It is not mandatory to achieve the trigger levels but the assessment should provide justification if they cannot be met. An assessment of the acceptability of residual impacts should also be provided.

A noise mitigation measure is feasible if it can be engineered and is practical to build and implement, given project constraints such as safety and maintenance requirements.

Selecting reasonable measures from those that are feasible involves judging whether the overall noise benefits outweigh the overall adverse social, economic and environmental effects, including the cost of the mitigation measure.

Guidance on the interpretation of feasible and reasonable mitigation measures is provided in Fact Sheet F, and Section 3.4 outlines possible mitigation measures.

For new developments and redevelopments, mitigation strategies should be considered in a hierarchical approach:

- controlling noise at the source
- once the controls at the source are exhausted, controlling the transmission of noise
- once source and transmission controls are exhausted, considering mitigation measures at the noise-sensitive receivers.

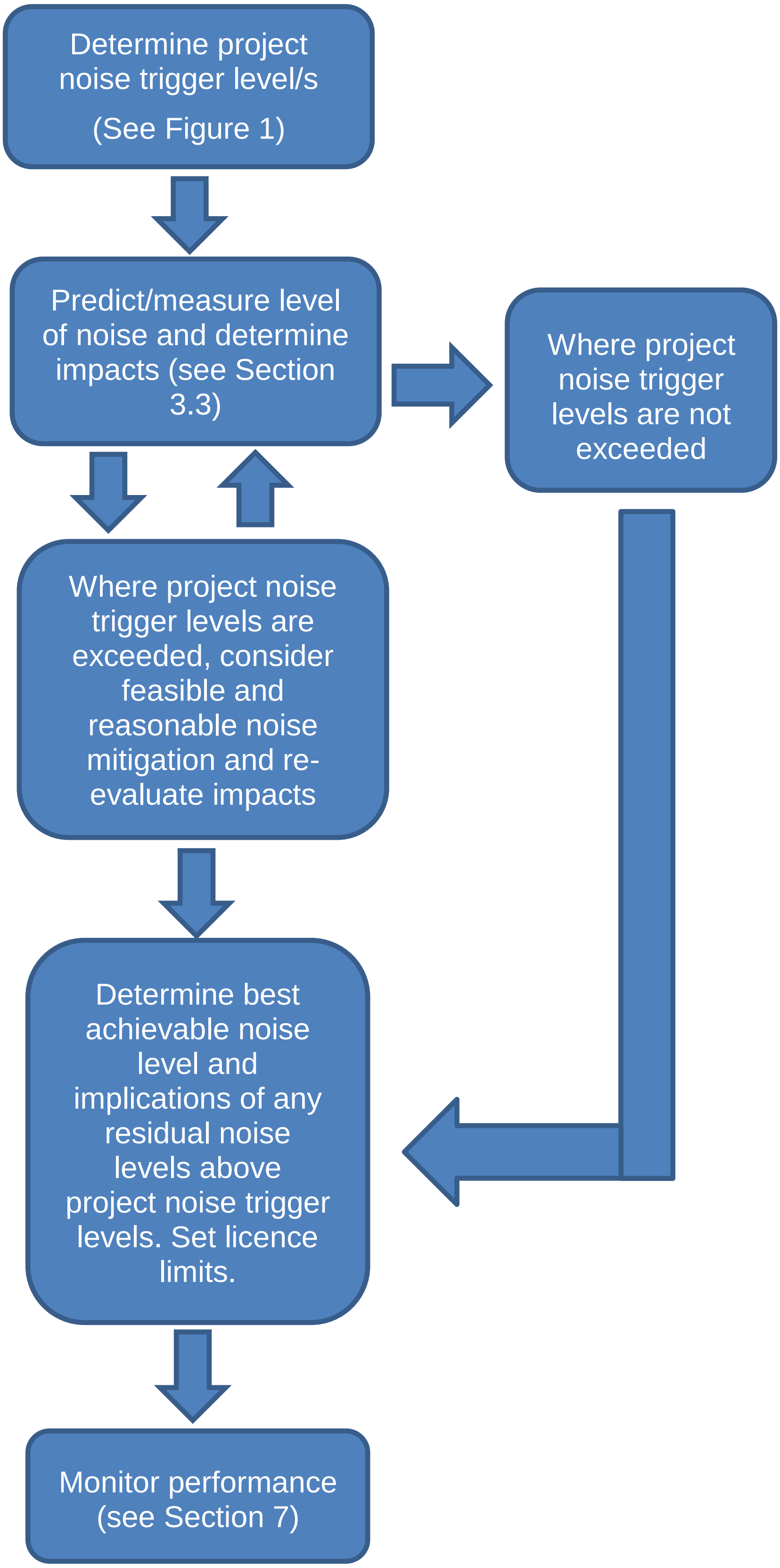

Figure 2: Typical noise impact assessment process.

3.2 Community engagement

The management of industrial noise impacts requires effective public involvement and communication strategies to help everyone understand the impact of industrial noise on the community. This is best approached by proponents/owners of industrial premises providing the community with:

- information about proposed industrial developments that may affect surrounding receivers
- the opportunity, where appropriate, for input and/or involvement in developments and activities that may affect it
- a means of ongoing communication once industrial activities begin (such as complaint and response mechanisms).

Noise-mitigation planning for industrial projects is greatly assisted by effective community consultation throughout the environmental assessment process. This includes the formal public exhibition phase, which invites written submissions in line with the relevant legislation or statutory requirements. These processes allow the community to participate in any mitigation selection process in a transparent, equitable and consistent way. Effective community involvement is particularly needed where impact assessment finds there will still be noise impacts even after applying all feasible and reasonable mitigation measures.

It is equally important for land-use planning authorities to ensure that existing and proposed industrial developments are considered when making and/or determining land-use planning instruments. This includes rezoning proposals and residential development applications.

3.3 Predicting noise levels and determining impacts

3.3.1 Identifying noise parameters

The important parameters for predicting noise are listed below. These will set the boundaries of the noise prediction process. They need to be determined and clearly identified for noise impacts to be predicted adequately. The parameters are:

- all noise sources related to the proposed development, including vehicles that operate on site
- source noise levels, site location and effective height of the noise source – references should be provided for all source noise levels used in the assessment (for example, direct measurement, previous Environmental Impact Statement, and manufacturers' specifications)
- annoying characteristics of the noise sources that may be experienced at receiver locations (for example, tonality, low frequency, and intermittency; see Fact Sheet C)
- all stages of project development, including whether noise emissions may vary depending on site operations, for example, during delivery/despatch activities
- all receivers potentially affected by the development
- meteorological conditions applicable to the site (from Fact Sheet D) to determine the meteorological conditions that should be adopted for the noise impact assessment
- site features (including natural and constructed, development and surrounding land uses) that affect noise propagation
- operating times of the development.

3.3.2 Noise prediction

To quantify the noise impact, the noise levels from the source at all potentially affected receivers should be predicted, taking account of the parameters identified in Section 3.3.1.

The noise levels predicted should be on the basis of $L_{Aeq,15min}$ values (as project noise trigger levels are expressed using this descriptor; see Section 2.2 for converting the project amenity noise level) and the L_{Amax} level for assessing the potential for sleep disturbance (Section 2.5).

For small or simple projects, the predicted noise level from the source may be calculated manually, taking into account the distance from the source to receiver and any shielding between the source and receiver.

For large or difficult projects, noise is generally predicted through the use of computer noise models. Such models generally take account of noise attenuation due to distance, atmospheric absorption, barriers, and effects of intervening ground types and weather conditions. They use information about source noise levels, location of sources, topography between source and receiver, and weather conditions to calculate overall noise levels at a receiver location.

The model selected should be capable of considering the standard and noise-enhancing meteorological conditions identified in Fact Sheet D.

Evidence of the suitability of the noise propagation model to accurately predict noise under Australian conditions should be referenced in any noise impact assessment, for example, peer-reviewed publications. All user-adjusted variables in a noise model should be identified and justified at the project level. Noise predictions should be presented in both point-to-point outputs and noise contours for larger projects in 5-dB increments.

Prediction approaches that present a statistical distribution of noise levels based on a range of prevailing meteorological conditions are useful in explaining to the community the range of noise levels that could result from a development. However, it is the proponent's responsibility to present a noise level that can be met under the meteorological conditions that apply to the site based on Fact Sheet D.

Where the proposed development is expected to produce annoying noise characteristics, adjustments are to be applied to the predicted noise levels, as outlined in Fact Sheet C, to arrive at a final predicted level that will be compared with the project noise trigger levels.

3.3.3 Determining impacts

The noise impact of the development can be determined by comparing the predicted noise levels at the receiver with the corresponding project noise trigger levels that have been derived for that particular location. The development is considered to cause a noise impact if the predicted noise level at the receiver exceeds the corresponding project noise trigger level. The extent of noise impact from the development is defined by the extent the predicted noise level exceeds the project noise trigger level.

3.4 Mitigating noise from industrial developments

Where the project noise trigger levels are exceeded, feasible and reasonable noise mitigation measures should be evaluated, with the aim of reducing noise to the project noise trigger levels.

This section gives a broad overview of ways to mitigate noise from industrial activities. It is not intended to be prescriptive guidance. It will be the responsibility of the proponent to demonstrate the selected mitigation measures are appropriate, and to justify any mitigation measures proposed (or disregarded) as part of a noise impact assessment. This advice provides useful guidance to developers of industrial activities to consider during the early stages of planning and design. The aim of this process is to evaluate what mitigation measures are both feasible and reasonable and the effect these will have on noise outcomes if applied.

Measures for reducing noise impacts from industrial activities follow three main control strategies:

- reducing noise at the source
- reducing noise in transmission to the receiver
- reducing noise at the receiver.

These control strategies should be considered in a hierarchical way so that all the measures that reduce noise for a large number of receivers (that is, source controls) are exhausted before more localised mitigation measures are considered.

The scope for applying feasible and reasonable mitigation measures to existing industrial activities is generally more limited and potentially more costly than for new greenfield developments. Implementing effective noise management strategies is an integral part of the planning phase for industrial developments and is potentially a cost-saving approach compared to retrospective mitigation.

When determining whether noise mitigation is ‘feasible and reasonable’, the starting point is identifying mitigation measures that would result in achieving the relevant project noise trigger levels, and then identifying why particular measures may not be either feasible or reasonable.

3.4.1 Reducing noise at the source

Best management practice

Best management practice (BMP) is the adoption of particular operational procedures that minimise noise while retaining productive efficiency.

When an appropriate mitigation strategy that incorporates expensive engineering solutions is being considered, the extent to which cheaper, non-engineering-oriented BMP can contribute to the required reduction of noise should be taken into account.

Where applied, these measures and practices are often documented in a noise management plan so that operational practices and undertakings are clearly understood and applied at all levels of an industrial operation.

Application of BMP can include the following types of practice:

- using the quietest plant that can do the job
- in open-cut mines, restricting movement of trucks on ridgelines and exposed haul routes where their noise can propagate over a wide area, especially at night – this could potentially mean restricting night-time movement of spoil to areas shielded by barriers or mounds, and reserving large-scale spoil movement for daytime
- scheduling the use of noisy equipment at the least-sensitive time of day
- not operating, or reducing operations at night (see below regarding night-time activities in the agricultural sector)
- siting noisy equipment behind structures that act as barriers, or at the greatest distance from the noise-sensitive area; or orienting the equipment so that noise emissions are directed away from any sensitive areas, to achieve the maximum attenuation of noise
- where there are several noisy pieces of equipment, scheduling operations so they are used separately rather than concurrently
- keeping equipment well-maintained and operating it in a proper and efficient manner
- employing ‘quiet’ practices when operating equipment, for example, positioning idling trucks in appropriate areas

- running staff-education programs and regular tool box talks on the effects of noise and the use of quiet work practices

Best available technology economically achievable

Allied with BMP is ‘best available technology economically achievable’ (BATEA). With BATEA, equipment, plant and machinery that produce noise incorporate the most advanced and affordable technology to minimise noise output. Affordability is not necessarily determined by the price of the technology alone. Increased productivity may also result from using more advanced equipment, offsetting the initial outlay; for example, using ‘quieter’ equipment that can be operated over extended hours. Old or badly-designed equipment can often be a major source of noise.

Where BMP fails to achieve the required noise reduction by itself, the BATEA approach should then be considered. Most of the noise-control measures listed in Section 3.4.5 belong to this approach. Examples of uses of BATEA include:

- considering alternatives to tonal reversing alarms (where work health and safety is appropriately considered)
- using equipment with efficient muffler design
- using quieter engines, such as electric instead of internal combustion
- fitting and maintaining noise reduction packages on plant and equipment
- using efficient enclosures for noise sources
- using vibratory piling in place of impact piling
- using high-pressure hydraulic systems to split rock, instead of hydraulic or pneumatic hammers
- damping or lining metal trays or bins
- active noise control.

For many industries there are a wide range of factors that can restrict the reasonableness and feasibility of implementing BMP or BATEA measures on a particular site. Work health and safety considerations must also be taken into account as well as any other regulatory and process requirements. In the agriculture sector considerations such as animal welfare or harvesting will be a factor. For example, animal welfare considerations during transport means that for the poultry sector animals should be moved during the night. In these cases a range of other measures may need to be investigated and taken to mitigate noise, where necessary.

3.4.2 Controlling noise in transmission

Barriers

Barriers are more effective if they are near the source or the receiver. Their effectiveness is also determined by their height, the materials used (absorptive or reflective), and their density. The relationship of these design features to attenuation is well documented.

Barriers can take a number of forms including free-standing walls between a source and a receiver, grass or earth mounds or bunds, and trenches or cuttings within which noise sources are sited. They are employed when source and receiver control is either impractical or too costly.

The use of noise barriers should be carefully considered as they can have negatives, such as unattractive visual impacts, or be associated with unwanted behaviours such as graffiti or littering, particularly when poorly sited or designed.

3.4.3 Controlling noise at the receiver

Noise controls at the receiver are expensive when many receivers require treatment, but may be attractive and cost-effective where only a few receivers would be affected by noise and the alternatives are even more expensive source controls. Cost effectiveness is also determined by the increase in the number of future potential receivers where residential land is being developed near the noise source.

The two major architectural controls are insulation and upgraded glazing of windows. For these to be effective, the residence needs alternative means of ventilation to enable windows to be maintained in the closed position so that noise amelioration measures are not compromised. Providing a comfort benefit (that is, air conditioning as well as ventilation) may be considered a reasonable trade-off for the reduced internal amenity associated with closed windows.

In some circumstances other trade-offs for benefits that are acceptable to all parties may be appropriate. For example:

- a structure that provides shielding to the residence, for example, a shed or courtyard wall
- additional landscaping designed to provide visual screening and provide masking noise when windy (note that vegetation will not normally provide a significant reduction in noise levels).

The most extreme control is property acquisition. Receiver treatments, including the extreme case of acquisition, are normally only applicable for isolated residences in rural areas.

3.4.4 Noise mitigation strategies

Selecting an appropriate strategy for a proposed development or alterations to an existing development involves the following steps:

- determining the noise reduction required to achieve the project noise trigger levels
- identifying the specific characteristics of the industry and the site that would indicate a preference for specified measures
- examining the mitigation strategy chosen by similar industries on similar sites with similar requirements for noise reduction, and considering that strategy’s appropriateness for the subject development
- considering the range of noise-control measures available (as generically suggested in this chapter)
- considering community preferences for particular strategies. This is especially important when the community has particular sensitivities to noise.

The preference ranking (from most preferred to least preferred) for particular strategies is:

- **Land-use controls** – essentially separating noise-producing industries from sensitive areas, which avoids more expensive short-term measures.
- **Control at the source**, **BMP and BATEA** used in conjunction – these strategies are the best after land-use planning, as they serve to reduce the noise output of the source so that the surrounding environment is protected against noise.
- **Control in transmission** – the next-best strategy to controlling noise at the source as it serves to reduce the noise level at specific receivers but not necessarily the broader environment surrounding the source.
- **Receiver controls** – the least-preferred option, as it protects only the internal environment of specific receivers and not the external noise environment.

Proponents will take into account the cost-effectiveness of strategies in determining how much noise reduction is affordable. A proponent's choice of a particular strategy is likely to have unique features due to the economics of the industry and site-specific technical considerations.

The above steps and the range of measures described in the chapter can be used as a guide in assessing the strength of the proponent's mitigation proposals.

Where a proposed mitigation strategy will not achieve the desired noise reduction and leaves a residual noise impact, the significance of the impact needs to be assessed, as described in Chapter 4.

3.4.5 Generic noise-control measures

Typical noise sources on industrial sites include:

- engines
- exhausts
- fans
- transport of materials, such as on conveyors and trucks
- milling and stamping (metal works)
- sawing and debarking (wood mills)
- processors such as crushing and separating plant
- pumps and compressors
- whistles and alarms
- material dumping and scraping
- electrical transformers and switching equipment.

The choice of noise-control measures depends on both the degree of mitigation required and the undesirable characteristics of the noise source that need to be controlled. The actual measures chosen will also depend on site factors, such as the ability of the site to accommodate particular engineering measures relative to other measures and their site costs.

A generic set of noise-control measures is set out below, with additional measures shown that may apply to particular developments.

Generic list of mitigation measures

Noise-source controls can include:

- selecting quieter equipment (including noise as a consideration in procurement policies and practices)
- enclosing the source; the design of the enclosure and materials used to absorb sound will affect the attenuation achieved
- closing doors on enclosures/buildings at sensitive times
- silencing exhausts – muffler design and noise-barrier systems
- active noise control, effective on a limited range of noise sources
- times of operation
- smooth roadways and vehicular access points.

Controls along the sound-transmission path can include:

- noise barriers: more effective if near source or receiver; effectiveness also controlled by materials used (reflective or absorptive) and by height
- mounds and bunds
- site design to maximise the distance from the critical noise source to the receiver, and with intervening buildings to act as barriers.

Controls at the noise receiver include:

- insulation
- upgraded glazing of windows and use of mechanical ventilation and/or air conditioning
- other mutually accepted trade-offs for benefits
- voluntary acquisition.

Additional mitigation measures for extractive industries

Noise mitigation measures for on-site transport of materials can include:

- selecting vehicles with minimum noise output, including tyre noise, exhaust and compressor/fan noise
- using rolling stock with quiet couplings and brakes
- using locomotives with components that do not emit tonal or low-frequency noise
- using trenches, cuttings, tunnels and barriers for transport routes
- restricting times for truck operations on ridgelines and in locations that are line-of-sight with receivers
- giving preference to haul routes with low grades
- using conveyor systems with low noise output, paying particular attention to rollers
- enclosing conveyors where necessary
- maintaining plant and equipment to ensure that the designers’ noise-output specifications continue to be met
- using ‘smart’ or broad-band reversing alarms.

Noise mitigation measures for mine and quarry operation can include:

- locating materials processing in the least noise-sensitive area, or enclosing it if necessary
- dumping spoil and waste behind barriers
- using reactive management systems that allow for operations to be modified under adverse meteorological conditions.

Additional mitigation measures for sites with specific noise characteristics

Noise mitigation measures for piling can include:

- using piling shrouds or vibratory piling instead of impact piling to control impulsive noise.

Noise mitigation measures for milling and metal works include:

- using efficient enclosures, where needed, to reduce the impact of impulsive noise from metal stamping
- reducing the impact or output of tonal noise from cutting equipment and saws, by using enclosures, or through equipment redesign.

Noise mitigation methods for pumps, transformers and machinery producing low-frequency or tonal noise can include:

- where low-frequency noise is difficult to isolate, seeking specialist advice about machinery redesign and restricted operating times
- reducing tonal noise through machinery redesign, enclosure, or restricted operating times, or by applying active noise control.

Noise mitigation for sites producing intermittent noise during night-time operations can include:

- control that may be specific to the way the noise source is designed or how it fits into the overall industrial process. Using barriers, enclosing or redesigning the source, or changing the operation to provide for a more continuous output, are possible measures.

Noise mitigation for night-time collection of poultry

- Vehicles should have engine compression brakes disabled on approach, departure, and while manoeuvring on the premises where it is safe to do so. No harsh acceleration or braking should occur on or near the premises.
- Vehicular crossing points and access driveways should be smooth and free of deformities (such as pot holes) to avoid impact noises.
- Gates should be well maintained and opened/closed by site personnel to avoid vehicles stopping or accelerating, or vehicle doors slamming at the access point.
- Vehicle engines should be switched off during loading activities.
- Raised voices and amplified music should not occur during night-time periods.
- Soft rubber pads between cages or use of plastic cages and other measures to avoid impact noises should be investigated and applied where practical.
- Reversing beepers should be avoided by the use of forward manoeuvring where practical.
- Non-tonal reversing beepers should be used on site plant and equipment where determined to be safe.
- Regular maintenance of noise-control equipment of site mobile plant and equipment should be undertaken (for example, integrity of mufflers and silencers).
- Drive-through loading enclosures and localised barriers should be considered where feasible and reasonable.

Note: Further resource documents for best-practice management of intensive poultry activities are available, such as *Best Practice Management for Meat Chicken Production in NSW, Manuals 1 & 2* (Department of Primary Industry, 2012), and *National Environmental Management System for the Meat Chicken Industry - Version 2*.

Proponents may wish to use the following matrix, or develop a similar decision-making tool, to determine and justify what mitigation measures are feasible and reasonable. This may be taken into account by the planning authority.

Table 3.1: Example of 'feasible and reasonable' mitigation decision-making matrix for inclusion within an environmental impact assessment.

Mitigation option	Feasible mitigation test	Reasonable mitigation test	Justification for adopting or disregarding this option
Mitigation at the source **Option 1** **Option 2** (… and so on, for all mitigation options)	Comment on whether the option under consideration is feasible. Refer to Fact Sheet F for further advice.	Comment on whether the option under consideration is reasonable. Refer to Fact Sheet F for further advice.	Provide details why the particular option under consideration will be included or disregarded, based on: • the noise impacts with and without the option • the noise mitigation benefits • the cost effectiveness of noise mitigation • community views. Refer to Fact Sheet F for further advice.
Mitigation in the transmission path to the receiver **Option 1** **Option 2** (…)	As above	As above	As above
Mitigation at the receiver **Option 1** **Option 2** (…)	As above	As above	As above

4. Determining the significance of residual noise impacts

4.1 Residual noise impacts

A residual noise impact may exist where the best-achievable noise level from a development, when assessed at a sensitive receiver location, remains above the project noise trigger levels.

Residual noise impacts are identified **after** all source and pathway feasible and reasonable noise mitigation measures have been considered. The significance of the residual impact and the need to assess receiver-based treatment options may need to be considered as part of an authority's determination/approval process.

As set out in Section 2, the project noise trigger level is the lowest value of the project intrusiveness or project amenity noise level after conversion to $L_{Aeq,15min}$, dB equivalent level.

Determining the significance of any residual noise impact is an essential component of the noise assessment process, to ensure that effective and appropriate mitigation measures are taken in each case.

4.2 Guide to the acceptability of residual noise impacts

Planning decisions for proposed developments take into account social, economic and environmental factors. Noise impact is one factor taken into account and decisions can be made that result in residual noise impacts (that is, noise levels above the project noise trigger level). In these cases, a consent **may** include an obligation on proponents to undertake noise mitigation at receiver locations.

The types of receiver-based noise-control options are outlined in Section 3.4.3. Receiver treatment, including the extreme case of voluntary acquisition, is normally only applicable for isolated residences in rural areas. The purpose of this component of the policy is to identify the significance of the residual noise impact. Residual noise impacts are taken into account in decision-making processes in accordance with the requirements of the relevant legislation or process. As a general guide, where all source and pathway feasible and reasonable noise mitigation measures have been applied, the significance of residual noise levels (that is, noise levels above the project noise trigger level) will be considered, as outlined in Table 4.1.

The significance of residual noise impacts should be addressed on a case-by-case basis. The guidance contained in Table 4.1 should **not** be applied to existing situations without proper consideration of the specific circumstances.

Table 4.1: Significance of residual noise impacts.

If the predicted noise level minus the project noise trigger level is:	And the total cumulative industrial noise level is:	Then the significance of residual noise level is:
≤ 2 dB(A)	Not applicable	Negligible
≥ 3 but ≤ 5 dB(A)	< recommended amenity noise level or > recommended amenity noise level, but the increase in total cumulative industrial noise level resulting from the development is less than or equal to 1dB	Marginal
≥ 3 but ≤ 5 dB(A)	> recommended amenity noise level and the increase in total cumulative industrial noise level resulting from the development is more than 1 dB	Moderate
> 5 dB(A)	≤ recommended amenity noise level	Moderate
> 5 dB(A)	> recommended amenity noise level	Significant

Note: This approach is designed for new and substantially-modified developments and should be applied with caution to assessments of existing operations.

Examples of noise mitigation at a residence that **may** be required by planning authorities to mitigate residual noise impacts are outlined in Table 4.2.

Table 4.2: Examples of receiver-based treatments to mitigate residual noise impacts.

Significance of residual noise level	Example of potential treatment
Negligible	The exceedances would not be discernible by the average listener and therefore would not warrant receiver-based treatments or controls.
Marginal	Provide mechanical ventilation/comfort condition systems to enable windows to be closed without compromising internal air quality/amenity.
Moderate	As for ‘marginal’, but also upgraded façade elements, such as windows, doors or roof insulation, to further increase the ability of the building façade to reduce noise levels.
Significant	May include suitable commercial agreements where considered feasible and reasonable.

5. Consent and licence conditions

5.1 What is included in the planning approval/licence

A planning approval or licence condition arrived at through the process described in this policy will have taken a number of matters into account, in accordance with the requirements of the relevant legislation. These can include:

- the assessed noise impact, which includes the impact of the noise source and any additional impact caused by meteorological conditions
- mitigation measures required to achieve the project noise trigger level
- identification of a practical (achievable) noise level after adopting all feasible and reasonable mitigation measures
- the significance of any residual noise impacts and the number of receivers affected
- consideration of trade-offs
- whether the final noise level proposed is acceptable.

It is important to note that the agreed limits in the planning approval or licence apply under the meteorological conditions outlined in the policy to be relevant to the assessment site.

Compliance with noise limits will not always safeguard against complaints because it is not possible to protect the whole range of individual sensitivities in a community to noise.

5.2 Specifying meteorological conditions in the consent/licence

Noise limits derived from this policy should be based on the following broad principles:

- they should be based on noise levels that have been demonstrated to be achievable and should apply at specific locations (consideration should be given to nominating the location using a co-ordinate system suitable to the planning or regulatory authority)
- noise level limits that apply under either standard or noise-enhancing metrological conditions (see Fact Sheet D), depending on the significance of occurrence of noise-enhancing conditions
- inversion conditions will be identified using Pasquill–Gifford stability categories, as opposed to stipulating temperature lapse rates in degrees per 100 metres
- noise level limits that apply under ‘very noise-enhancing conditions’ based on the limits that apply under either standard or noise-enhancing conditions plus 5 dB

  Note: Atmospheric enhancement of noise propagation is a complex phenomenon that in some cases can be difficult to predict. Regulators should have regard to rare or unusual circumstances when responding to, or considering regulatory action, for a non-compliance with a noise limit.
- the conditions under which monitoring will not meet accepted measurement standards should be identified. For example, measurement should not be undertaken when wind at microphone heights exceeds 5 metres per second (m/s), or during rain
- the location and method for determining prevailing meteorological conditions will be clearly stated in noise conditions.

6. Applying the policy to existing industrial premises

The principles and approaches to assessing and managing noise in the policy can be applied to existing sites using a pollution reduction program or in environmental improvement programs. This recognises that existing activities are established based on agreed performance requirements, and allows established industries to adapt to changes in the noise expectations of the community, where needed.

A review of noise limits and a requirement to implement a noise reduction program or environmental improvement program may be triggered by actions such as:

- the site becoming the subject of serious, persistent noise complaints
- a proposal to upgrade or expand the site
- the site having no formal consent or licence conditions and management wishing to clarify their position
- the owner or occupier choosing to initiate an environmental improvement program.

These programs provide formal, structured approaches to reduce high existing noise levels to acceptable levels over time, by applying feasible and reasonable control measures. It establishes certainty through an agreed process to achieve noise reduction, while providing flexibility in the choice of noise reduction measures.

6.1 Applying the policy to existing sites

Many existing industrial sources were designed for higher noise emission levels than the project noise trigger levels outlined in this policy. In other cases, industries may have been in existence before neighbouring noise-sensitive developments and even before noise-control legislation was introduced. The range of mitigation measures available for these sites can be limited or costly.

Applications for extensions to existing premises often provide an opportunity to redress issues that relate to the whole site. Where noise emissions from the site exceed the project noise trigger levels, the regulatory authorities and the noise-source manager will determine achievable noise limits for the site, taking into account matters that must be considered in accordance with the relevant legislation or process, including negotiation with proponents and discussion with stakeholders as required.

There is no ‘one-size-fits-all’ approach to determine the impact from an existing industry. The following governing principles should be applied when determining the project noise trigger levels and/or assessment requirements for existing industry:

- The project noise trigger levels should not be applied as mandatory noise limits. The project noise trigger level is the level used to assess noise impact and drive the process of assessing all feasible and reasonable control measures.
- Where an existing industry has been in operation for more than 10 years and existing site operations exceed the project amenity noise level, the project amenity noise level may be adopted as the project noise trigger level to assess existing, and existing plus proposed site operations, as relevant.
- Where a development proposal involves a discrete process, and premises-wide mitigation has or is to be considered outside of the development proposal, a project noise trigger level for noise from new/modified components (not the whole site) of the operation may be set at 10 dB(A) or more below existing site noise levels or requirements. This approach means that the increase in noise from the whole site is

minimised and provides scope for existing components to achieve noise reductions over time.

Note that for sites with limited mitigation measures available, the achievable noise limits can be above the project noise trigger levels.

In some instances noise will be required to be managed as an integral part of site upgrades. The development of formal operating practices to reduce noise generation do not always need to be linked to site upgrades and, where feasible, these operating practices should be applied at the earliest opportunity. Where this process occurs as a part of the EPA's regulatory activity, the measures required to achieve the noise limits are usually set out in a pollution reduction program attached to the environment protection licence.

6.1.1 Steps in the process

The process for applying the policy to existing sites is:

- Undertake an initial evaluation, including whether approvals/licences include noise limits and whether they are being met.
- Establish relevant project noise trigger levels, in accordance with the policy, to establish a benchmark level to assess the need to consider noise mitigation.
- Measure/predict the noise levels produced by the source in question, having regard to meteorological effects such as wind and temperature inversions. Noise from both the whole premises and the upgraded section in isolation should be presented.
- Compare the measured/predicted noise level with the project noise trigger levels.
- Where the project noise trigger levels are exceeded, assess feasible and reasonable noise mitigation strategies.
- Develop and refine achievable noise limits that will become goals for pollution reduction programs for the site. This will involve interaction between the regulator and operator, and can also include consultation with the community, depending on the process. Regulators and operators need to consider the technical practicalities and cost of noise reduction measures, and how long it will take to implement these measures, along with the environmental consequences of exceeding the project noise trigger levels.
- Measures to achieve the limits by specified dates may be set out in a pollution reduction program.
- Monitor compliance with the noise reduction program, and review and amend the program as required.
- **Note:** This process should include consultation, discussion and negotiation between the regulator and the noise-source manager, as needed and appropriate, throughout all stages of the process.

An example showing how this process works is contained in Fact Sheet E.

6.2 Pollution reduction programs and environmental improvement programs for noise

A pollution reduction program or environmental improvement program can document the actions required to assess and achieve noise limits or reduce noise impacts on the community.

A program will be source- and site-specific and can include the following elements:

- the aim and scope of the program

- identification of noise levels and targets for the site
- time frame for implementation of measures
- an upper limit for new equipment
- an upper limit for partial upgrades of the site
- plans to eliminate problematic characteristics that have been identified, such as tonal and low-frequency noise
- a sound power target for relevant sections of the site
- operating practices to reduce noise emissions
- training and awareness initiatives
- an ongoing monitoring program to evaluate noise-emission levels
- communicating with the affected community using tools such as a complaints-handling process, liaison group or newsletters.

6.3 Noise reduction strategies for existing sites

The range of noise reduction strategies for existing situations is generally more limited than those available for new development at the planning stage. For example, spatial separation between the source and receiver is not an option for existing situations. The initial focus for existing sites should be operational procedures and prioritising noise-control measures that provide the greatest benefits to residents at least cost.

The applicability, effectiveness and cost of particular mitigation measures often depend strongly on site variables. Section 3.4 provides advice on a range of typical mitigation strategies, and is a useful guide in deciding suitable mitigation measures for a particular site.

The significance of residual noise impacts should be addressed on a case-by-case basis. **The guidance contained in Table 4.1 should not be routinely applied to existing situations.**

7. Monitoring performance

Determining compliance with a noise limit can range from a simple exercise to a technically complex process. This section presents a range of compliance assessment techniques that may be used individually, or in combination, to provide a means of determining compliance with a noise limit. At times, the best available compliance assessment methodology will only allow for a **balance-of-probabilities** type determination of compliance, and repeat assessment may be needed.

A noise limit applies to the noise from a particular development/activity and not to general ambient noise. Therefore it is often necessary to use techniques to attempt to separate the noise from a facility versus noise from other sources. There is often no easy way to do this, and professional judgement and multiple techniques are sometimes required in combination to give the necessary level of confidence in the results.

7.1 Monitoring environmental noise

7.1.1 Options for noise monitoring

Direct measurement at a receiver location

The preferred method of determining compliance with a noise limit is operator-attended direct measurement of noise at a location identified for compliance, using a sound level meter. Where the compliance location is dominated by noise from the industrial premises under investigation, this can be an effective and simple exercise. However, many locations are not controlled by a single noise source, and techniques, including professional judgement, are often needed to determine the level of noise from the source under investigation.

Some examples of techniques used to isolate the noise from a facility include:

- pausing the sound level meter during extraneous noise events, for example, when a dog is barking or road traffic noise is clearly audible and affecting the measurements
- using frequency filtering techniques where certain frequencies of noise are excluded from the measurements. For example, local insect noise can be excluded by using a low pass filter on a sound level meter. Depending on the instrument being used, frequency filtering can be applied in real time or using post processing of recorded/stored data
- using other noise descriptors such as the L_{A90} to filter extraneous noise events where the noise under consideration is continuous and the difference between the source L_{Aeq} and L_{A90} is expected to be small
- turning the source noise on and off, or waiting for times when extraneous noise is low. This is not always practical, but sometimes can be effectively used, especially when dealing with a source that is intermittent, for example, a gas-fired power station
- using directional noise monitoring instrumentation where noise from only a given direction is measured, thereby removing extraneous noise from other directions. As with any noise monitoring instrument, the capabilities and limitations of the instrument need to be well understood to validly interpret and use the acquired data.

Direct measurement at alternative or intermediate location/s

Where direct measurement of noise at a compliance location is not practical because of poor signal-to-noise ratios (that is, extraneous noise is louder than the noise under investigation), or where access to the location has been denied or is unavailable, measurements at intermediate locations between the source and the receiver location, where signal-to-noise

ratios are higher, may be a viable option. For this approach to be effective there needs to be well-established theoretical and/or empirical relationships between the intermediate location and the receiver location in terms of noise exposure. Noise modelling may be one option to establish this relationship. The techniques under the above section 'Direct measurement at a receiver location' would also be relevant in terms of quantifying the level of noise from the source at the intermediate location(s).

Where this technique is relied upon, it is the responsibility of the proponent to demonstrate a robust acoustic relationship between the compliance location and the intermediate location.

Unattended monitoring

Unattended monitoring using remote instrumentation should not generally be used as the sole means to determine compliance with a noise limit. This is because of the added difficulty in isolating the noise under investigation from ambient noise not related to the subject noise source. However, unattended monitoring can be used in conjunction with recorded noise and post processing and analysis to confirm sound sources and levels.

Unattended continuous noise monitoring can be used effectively as a noise management tool for many mining projects. It generally involves the deployment of continuous noise monitoring equipment at intermediate locations where relationships with noise at a compliance location have been established. These instruments are configured to send alert messages to mine managers when a noise limit is likely to be approached. They allow remote access so that mine managers can listen to audio to determine whether the mine is the likely reason for the alert. Under these circumstances the mine managers are able to alter operations so that a noise limit exceedance is avoided.

Modelling

In some cases it will be impossible to determine whether a development is satisfying noise limits using direct measurement at a compliance location or intermediate locations. An example is a facility located in an industrial estate with co-located, but separate, noise-producing developments that all impact a particular sensitive receiver location. In these cases, noise modelling techniques may be the only way of determining compliance with individual premises noise limits. This may involve on-site measurement of noise-producing plant and equipment to determine (or confirm) the source noise level (sound power level). The sound power levels may then be used in a noise model to determine the level of noise at a sensitive receiver location from the operation of the individual development.

These modelling techniques could range from simple manual distance attenuation calculations to complex noise modelling that considers intervening terrain and structures, meteorological conditions, and attenuation factors (such as distance, atmospheric absorption, and ground effects). Modelling methods should only be used where it has been demonstrated that direct measurement techniques are not viable.

Models should be calibrated and validated to produce accurate results under Australian conditions. The use of intermediate locations as a means of model validation or calibration can be a useful technique.

7.1.2 Notes on noise monitoring

Items to be monitored

To check compliance with the consent/licence condition, the following items are the minimum requirements:

- noise levels from the development at locations specified in the condition, or at the nearest affected receivers where no locations are specified. During monitoring the meter should be generally set as follows:
    - for L_{eq} measurements the meter should be set to linear averaging

  - where frequency analysis is required the meter should be set to Z frequency weighting
  - where statistical descriptors or maximum noise levels are measured (for example, L_{Amax}, L_{A90}), the meter should be set to fast time weighting and exponential averaging
  - the frequency weighting selected should align with the frequency weighting of the limit/level being assessed
- the wind speed and direction
- the meteorological conditions prevailing during the monitoring, as required by the condition
- the operational condition of the noise source/emitter (for example, not operating, at full capacity, or at some percentage capacity)
- compliance assessment resources should generally be focused on sensitive times of operation, for example, the night-time period.

7.1.3 Noise monitoring reports

The results of a noise monitoring test should be clearly reported and forwarded to the relevant authority (if requested), or kept on file for reference. The following items are to be included in a noise monitoring report:

- the type of monitoring test conducted
- the development noise limits on the consent/licence
- the monitoring location
- the noise instrumentation used (the instrumentation specifications required for compliance monitoring are the same as those required for background noise monitoring set out in Fact Sheet A)
- the weather instrumentation used (the instrumentation specifications are the same as those set out in Fact Sheet D)
- the weather conditions during noise monitoring and the location of the weather monitoring station used
- the time(s) and duration(s) of monitoring, including dates. In the case of receiver complaints, these should coincide with the time that the noise is considered to be most intrusive. In the case of development-stage monitoring, these should cover the full cycle of activity
- the results of noise monitoring at each monitoring location, including a comparison with the noise limits
- a statement outlining the development's compliance or non-compliance with the limit
- where non-compliances of noise limits are found, the reasons for non-compliance should be stated and strategies for management identified
- where the noise exceedance is due to excessive noise levels from the development, the strategies to be used to manage the noise exceedance should be identified and stated.

In addition to the above requirement, section 66(6) of the POEO Act requires that pollution monitoring data that is required to be collected by a licence condition must also be published by the licensee, in accordance with the written requirements issued by the EPA as set out in *Requirements for publishing pollution monitoring data* (NSW EPA, 2013).

7.1.4 Compliance justification

Where a proponent is required by a consent or regulatory authority to demonstrate compliance with a noise limit, the methodology used to determine the noise levels shall be clearly identified and justified. As a minimum, this will involve the techniques used to quantify the noise contribution from the development/activity under consideration, together with the parameters under which the noise limits apply, for example, the meteorological conditions prevailing at the time of compliance assessment.

7.1.5 Regulatory response to a noise limit non-compliance

The response of a regulatory or consent authority to an exceedance of a noise limit will be guided by the authority’s compliance or prosecution guidelines as relevant. The response may take into account, for example, the impact of the exceedance.

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Glossary

Term	Definition
Above ground level (AGL)	Above ground level.
A-weighted	See dB(A).
Ambient noise	The all-encompassing noise associated within a given environment. It is the composite of sounds from many sources, both near and far.
Amenity noise level	See the fourth column of Table 2.2.
Annoyance	An emotional state connected to feelings of discomfort, anger, depression and helplessness. It is generally measured by means of the ISO15666 defined questionnaire (EEA, 2010).
Assessment period	The period in a day over which assessments are made: day (7 am to 6 pm); evening (6 pm to 10 pm); or night (10 pm to 7 am).
Assessment background level (ABL)	The single-figure background level representing each assessment period: day, evening and night (that is, three assessment background levels are determined for each 24-hour period of the monitoring period). Its determination is by the methods described in Fact Sheet B.
Background noise	The underlying level of noise present in ambient noise, generally excluding the noise source under investigation, when extraneous noise is removed. This is described using the L_{AF90} descriptor.
Best available technology economically achievable (BATEA)	Equipment, plant and machinery incorporating the most advanced and affordable technology available to minimise noise output.
Best management practice (BMP)	Adoption of particular operational procedures that minimise noise while retaining productive efficiency.
C-weighted	C-weighting is an adjustment made to sound-level measurements that takes account of low-frequency components of noise within the audibility range of humans.
Cluster of industry	An industrial/port estate, area, zone, or proposed area or zone where more than three separate industrial uses are co-located in a contiguous fashion and are operating or proposed to operate.
Compliance	The process of checking that source noise levels meet with the noise limits in a statutory context.
Construction activities	Activities that are related to the establishment phase of a development and that will occur on a site for only a limited period of time.
Cumulative industrial noise level	The total level of noise from all industrial sources.
Day	The period from 7 am to 6 pm (Monday to Saturday) and 8 am to 6 pm (Sundays and public holidays).
Decibel (dB)	A measure of sound level. The decibel is a logarithmic way of describing a ratio. The ratio may be power, sound pressure, voltage, intensity or other parameters. In the case of sound pressure, it is equivalent to 10 times the logarithm (to base 10) of the ratio of a given sound pressure squared to a reference sound pressure squared.

Term	Definition
decibel (A-weighted; dB[A])	Unit used to measure ‘A-weighted’ sound pressure levels. A-weighting is an adjustment made to sound-level measurement to approximate the response of the human ear.
EP&A Act	*Environmental Planning and Assessment Act 1979.*
Evening	Refers to the period from 6 pm to 10 pm.
Extraneous noise	Noise resulting from activities that are not typical of the area. Atypical activities may include construction, and traffic generated by holiday periods and by special events such as concerts or sporting events. Normal daily traffic is not considered to be extraneous.
Feasible and reasonable mitigation	As defined in Fact Sheet F.
Greenfield site	Undeveloped land.
High traffic amenity level	See Section 2.4.1.
Impulsive noise	Noise with a high peak of short duration, or a sequence of such peaks.
Industrial noise sources	As defined in Section 1.4.
Intrusive noise	Refers to noise that intrudes above the background level by more than 5 decibels. The intrusiveness noise level is set out in Section 2.3.
$L_{AF90,15min}$ dB	The A-weighted sound pressure level measured using fast time weighting that is exceeded for 90% of the time over a 15-minute assessment period. This is a measure of background noise.
$L_{AF90,(day,\ evening,\ night)}$ dB	The A-weighted sound pressure level measured using fast time weighting that is exceeded for 90% of the time over a day, evening or night-time assessment period. This is a measure of background noise.
$L_{AF90,(shoulder\ period)}$ dB	The A-weighted sound pressure level measured using fast time weighting that is exceeded for 90% of aggregate sound pressure level data for the equivalent of one week’s worth of valid data taken over the shoulder period.
$L_{Aeq,T}$	The time-averaged sound pressure level. The value of the A-weighted sound pressure level of a continuous steady sound that, with a measurement time interval T, has the same mean square sound pressure level as a sound under consideration with a level that varies with time (AS1055.1-1997).
L_{Amax}	The maximum sound pressure level of an event measured with a sound level meter satisfying AS IEC 61672.1-2004 set to ‘A’ frequency weighting and fast time weighting.
Low frequency	Noise containing major components in the low-frequency range (10 hertz [Hz] to 160 Hz) of the frequency spectrum.
Masking	The phenomenon of one sound interfering with the perception of another sound. For example, the interference of traffic noise with use of a public telephone on a busy street (Bies and Hansen, 1996).
Median	The middle value in a number of values sorted in ascending or descending order. Hence, for an odd number of values, the value of the median is simply the middle value. If there is an even number of values, the median is the arithmetic average of the two middle values.
Meteorological conditions	Wind and temperature-inversion conditions.

Term	Definition
Noise impact assessment (NIA)	The component of an Environmental Impact Statement, Environmental Assessment, Statement of Environmental Effects, or licence application that considers the impacts of noise resulting from a development or activity.
Noise limits	Enforceable noise levels that appear in conditions on consents and licences. The noise limits are based on achievable noise levels which the proponent has predicted can be met during the environmental assessment.
Night	The period from 10 pm to 7 am (Monday to Saturday), and 10 pm to 8 am (Sundays and public holidays).
Noise-sensitive land uses	Land uses that are sensitive to noise, such as residential areas, churches, schools and recreation areas.
Non-compliance	Any exceedance of a consent/licence limit is considered a non-compliance. However, the type of regulatory action taken by a regulatory authority will depend on a number of factors, in accordance with the authority's prosecution policies and guidelines.
Non-mandatory	In this policy this means not required by legislation. The policy specifies project noise trigger levels to be strived for, but the legislation does not make these levels compulsory. However, the policy will be used as a guide to setting statutory (legally enforceable) limits for licences and consents.
Operator	Noise-source manager.
Performance-based goals	Goals specified in terms of the outcomes/performance to be achieved, but not in terms of the means of achieving them.
Premises	As defined in the *Protection of the Environment Operations Act 1997*.
Project noise trigger levels	Target noise levels for a particular noise-generating facility. They are based on the most stringent of the project intrusiveness noise level or the project amenity noise level.
Proponent	The developer of the industrial noise source.
POEO Act	*Protection of the Environment Operations Act 1997*
Rating background noise level (RBL)	The overall, single-figure background level representing each assessment period (day/evening/night) over the whole monitoring period (as opposed to over each 24-hour period used for the assessment background level). This is the level used for assessment purposes. See Fact Sheets A & B.
Residence	A lawful and permanent structure erected in a land-use zone that permits residential use (or for which existing use rights under the EP&A Act apply) where a person/s permanently reside and is not, nor associated with, a commercial undertaking such as caretakers' quarters, hotel, motel, transient holiday accommodation or caravan park.
Reasonably most-affected location	Locations that experience (or will experience) the greatest noise impact from the noise source under consideration. In determining these locations, one needs to consider existing background levels, exact noise source location(s), distance from source (or proposed source) to receiver, and any shielding between source and receiver. This should not be construed to mean that limits **only** apply at the worst, most-affected location.
Receiver	The noise-sensitive land use at which noise from a development can be heard.
Significant meteorological effects	In relation to temperature inversions, this means at least 30% of the total night-time during the winter months. In relation to wind speeds this means at least 30% of the time or more in any assessment period (day, evening, night) in any season.
Sleep disturbance	Awakenings and disturbance to sleep stages.

Term	Definition
Spectral characteristics	The frequency content of noise.
Temperature inversion	An atmospheric condition in which temperature increases with height above the ground.
Temporal variation of noise	Variation in noise levels over time.
Tenth (10^{th}) percentile method	See Fact Sheet B.
Time of maximum impact	The time during which the difference between the background noise level and the source noise is expected to be greatest.
Tonality	Noise containing a prominent frequency and characterised by a definite pitch.
Transportation	Includes road, rail and air traffic.
Very noise-enhancing meteorological conditions	Meteorological conditions outside of the range of either standard or noise-enhancing meteorological conditions as adopted in the noise impact assessment following the procedures in Fact Sheet D.

Fact Sheet A: Determining existing noise levels

A1 Determining background noise for the intrusiveness noise level

The background noise level is defined here as ‘the underlying level of noise present in ambient noise, generally excluding the noise source under investigation, when extraneous noise is removed’. Sound levels contributing to background levels can include sound from nearby traffic (see Section A1.3), birds, insects, animals, machinery and similar sources, if these sounds are a normal feature of the location. The background noise level is represented by the $L_{AF90,15min}$ descriptor when undertaking short-term monitoring. In comparison, the rating background noise level (as defined in Section A1.2) is the single-figure background noise level derived from monitoring over a representative period of time, typically one full week. The rating background noise level is used for assessment purposes.

Background noise levels need to be determined before intrusive noise can be assessed. The background noise levels to be measured are those that are present at the time of the noise assessment and without the subject development operating. For the assessment of modifications to existing premises, the noise from the existing premises should be excluded from background noise measurements. The exception is where the premises has been operating for a significant period of time and is considered a normal part of the acoustic environment; it may be included in the background noise assessment under the following circumstances:

- the development must have been operating for a period in excess of 10 years in the assessment period/s being considered and is considered a normal part of the acoustic environment; and,
- the development must be operating in accordance with noise limits and requirements imposed in a consent or licence and/or be applying best practice.

Where a project intrusiveness noise level has been derived in this way, the derived level applies for a period of 10 years to avoid continuous incremental increases in intrusiveness noise levels. This approach is consistent with the purpose of the intrusiveness noise level to limit significant change in the acoustic environment. The project amenity noise level will moderate against background noise creep.

When assessing a new development, it is important to undertake sufficient monitoring of background noise to allow intrusive noise to be assessed adequately. However, when assessing noise levels in response to complaints, the background noise level during the period of the complaint is of interest, and monitoring over a shorter length of time may be appropriate.

Before embarking on a noise-monitoring program, the potential for the development/activity to cause noise annoyance, and the need for accurate noise assessment, should be considered. Two measurement regimes are presented below. The first is a definitive method to be used when assessing developments with the potential for significant noise impact. The second is a shorter method that can be used for complaint-assessment purposes.

A1.1 Methods of determining background noise

Table A1 summarises the two procedures for determining background noise: the long-term method to be used at the planning and approval stage, and the short-term method for complaint and compliance assessment purposes. The long-term method involves a two-step process to determine the rating background noise level. The short-term method involves only one step. Fact Sheet B gives a detailed description of instrumentation requirements, and procedures for measurement and analysis for each method.

The long-term method for determining background noise (summarised in Table A1) is designed to ensure that the level for intrusive noise will be achieved for approximately 90% of the time periods over which annoyance reactions may occur (taken to be periods of 15 minutes).

Definitions and technical considerations to help users interpret and apply the methods are set down in the following sections.

Table A1: Methods for determining background noise.

Features	**Method**	
	Long term	**Short term**
When to use	During planning and approval stage where there is significant potential for noise impact, e.g. extractive industries and industrial developments. Note: Would normally be required where a background level exceeding the minimum rating background noise levels (in any time period) has been adopted in the assessment.	During complaint assessments, compliance checks, when determining the effect of background noise on a source noise measurement, and for low-risk developments.
Type of monitoring	Continuous sampling accompanied by periods of operator-attended monitoring.	Individual sampling, operator-attended measurements.
Length of monitoring	Equivalent to one week's worth of valid data covering the days and times of operation of the development (see Section A5).	15-minute measurements covering the times of operation of the development.
Conditions for monitoring	Average wind speed < 5 m/s[1], no rain, no extraneous noise (see Sections A1.2 and A4).	Average wind speed < 5 m/s[1], no rain, no extraneous noise (see Sections A1.2 and A4).
Monitoring location	Reasonably most- or potentially most-affected residence(s).[3]	Reasonably most- or potentially most-affected residence(s)[3] and/or location of complaint.[3]
Assessment time periods	Day (7 am–6 pm) Evening (6 pm–10 pm) Night (10 pm–7 am) (see Section A3 for exceptions)	Times when maximum impacts occur (see glossary).
Base measure	$L_{A90,15min}$	$L_{A90,15min}$
Analysis method	Determine the assessment background level for each day, evening and night by using the 10th percentile method[2]. The rating background noise level is the median assessment background level over all days for each period. Note: Current generation noise logging instrumentation with high sampling rates and increased storage capabilities allows for the calculation of $L_{AF90,(day/evening/night)}$ dB(A) noise levels. These period L_{A90} levels may be adopted as the ABL for the purposes of calculating the rating background noise level.	The rating background noise level is the measured $L_{AF90,15min}$ value, or, where a number of measurements have been made, the lowest $L_{A90,15min}$ value.

Notes:

1. Refers to the wind speed at the microphone height.
2. See Fact Sheet B for how to determine the assessment background level using the 10th percentile method.
3. Where it is impractical or not possible to monitor at the reasonably most- or potentially most-affected location(s), the location selected should be fully justified as being representative of background noise levels.

A1.2 Definitions to support methodologies

Extraneous noise – noise due to activities that are not a usual feature of the area. These activities might include construction, changes in road, rail or air traffic due to holiday periods, and special events such as concerts or sporting events. Normal daily road traffic and other transportation noise are not considered to be extraneous noise. Where an industry in an industrial estate wishes to extend its operations, the measured background noise level may include the general hum of industries nearby, but should not include any noise from the site itself or noise from any intrusive sources nearby that could affect the $L_{AF90,15min}$ value, with the exception of circumstances outlined in Section A1. As a reasonable guide, any extraneous noise present for at least half of a 15-minute monitoring period, and having the potential to affect the $L_{AF90,15min}$ value, should be excluded.

Special care needs to be taken when doing short-term measurements to ensure that the measurements reflect the time of maximum impact. For example, in a residential neighbourhood short-term noise measurements should not be taken when there are other noisy activities going on, such as lawn-mowing, idling vehicles, neighbourhood chatter and vehicle movements that may not be a characteristic of the whole assessment period of interest (see A1.3). When in doubt about whether an activity is typical of the area, it is best to exclude data affected by noise from that activity.

Reasonably most-affected residence(s) – locations that are reasonably most affected (or that will be most affected) by noise from the source under consideration. In determining these locations, the following need to be considered: existing background levels, noise source location(s), distance from source(s) (or proposed source[s]) to receiver, and any shielding (for example, a building or barrier) between source and receiver. Often several locations will be affected by noise from the development. In these cases, locations that can be considered representative of the various affected areas should be monitored. Where monitoring cannot be undertaken at a residence, the location selected as representative should be fully justified.

Time when maximum impacts occur – the time during which the difference between the background noise level and the source noise is expected to be the greatest.

Assessment background level (ABL) – the single-figure background level representing each assessment period day, evening and night (that is, three assessment background levels are determined for each 24-hour period of the monitoring period). Determination of the assessment background level is by the 10^{th} percentile method described in Fact Sheet B. Alternatively the ABL may be calculated on the basis of $L_{AF90,period(day/evening/night)}$ dB(A) noise levels. **Only those days and assessment periods that are applicable to the times of operation of the proposed development are required to be assessed.**

$L_{AF90period(day/evening/night)\ dB(A)}$ noise level – The A-weighted sound pressure level, obtained by using fast time weighting that is equal to or exceeded for 90% of the day, evening and night periods (as defined in this policy) for each 24-hour period.

Rating background noise level (RBL) – the overall single-figure background level representing each assessment period (day/evening/night) over the whole monitoring period (as opposed to over each 24-hour period used for the assessment background level). The rating background noise level is the level used for assessment purposes. **Where the rating background noise level is found to be less than 30 dB(A) for the evening and night periods, then it is set to 30 dB(A); where it is found to be less than 35 dB(A) for the daytime period, then it is set to 35 dB(A)**.

For the short-term method, the rating background noise level is simply the lowest measured $L_{AF90,15min}$ level. For the long-term method, the rating background noise level is defined as the median value of:

- all the day assessment background levels over the monitoring period for the day
- all the evening assessment background levels over the monitoring period for the evening, or
- all the night assessment background levels over the monitoring period for the night.

Median – is the middle value in a number of values. For an odd number of values, the value of the median is simply the middle value in a number of values ranked in ascending or descending order. For an even number of values, the median is the arithmetic average of the two middle values.

A1.3 Transportation noise in background noise measurements

Transportation noise (air, road and rail) may be included in background noise measurements, except when there is a reasonable expectation that transport flows are not representative of normal conditions (for example, traffic during school holidays). Air, road and rail traffic during these times are usually considered to be extraneous.

Where the period of measurement is limited (that is, with a short-term measurement), care is needed to ensure that the time at which the measurements are made reflects the period when the highest noise impacts are likely to occur. For example, where there is only intermittent traffic, the short-term noise measurement should not include transportation noise, otherwise incorrect high readings will result. However, where the traffic is constant and continuous, transportation may be included in the short-term measurement to ensure that the noise environment is adequately represented.

A2 Determining existing industrial noise levels when required

Existing industrial noise levels need to be determined when the project noise trigger level cannot be satisfied to assist in determining the significance of residual noise levels.

In determining the existing L_{Aeq} noise level from industry, it is important to obtain a representative level. Hence, assessing the existing L_{Aeq} noise level from industry is ideally as defined in Table A2 for assessing different noise risk developments.

Table A2: Determining existing industrial noise levels.

Risk of noise impact	Measurement period[1]	Definition of existing level
Low risk	One day, covering the defined day/evening/night periods relevant to the periods the proposed development would operate.	The logarithmic average[2] of individual $L_{Aeq,15min}$ levels for each day/evening/night assessment period over the measurement period.
High risk	One week, covering the defined day/evening/night periods the proposed development would operate.	

Notes:

1. It is recommended that the L_{Aeq} be measured on a 15-minute basis.

2. Logarithmic average = $10 \times \log_{10}((\sum_{i=1 \text{ to } n} 10^{(L_{Aeq,15\,min,i}/10)})/n)$, where n = number of $L_{Aeq,15\,min}$ values in each assessment period over the measurement period.

However, in many cases the direct measurement of noise from industrial sources will be difficult, if not impossible, due to extraneous noise. In these circumstances the use of ambient noise levels that contain both the existing industrial noise contribution and extraneous noise may be used to estimate cumulative industrial noise as a screening test. Where this approach suggests cumulative industrial noise levels will remain below the

relevant ‘amenity noise levels’ in Table 2.2, no additional assessment of cumulative impacts is required to enable the significance of residual impacts to be determined in accordance with Section 4.

However, where the screening approach suggests total industrial noise above the relevant ‘amenity noise level’ in Table 2.2, attempts to better quantify existing industrial noise levels are required. Professional judgement will often be needed to effectively quantify/estimate the level of noise from existing industry. In some cases reference to data contained in compliance assessments and/or environmental assessment documentation for existing industrial sources will be needed.

A3 Dealing with ‘shoulder’ periods

There will be situations that call for different assessment periods. For example, where early morning (5 am to 7 am) operations are proposed, it may be unreasonable to expect such operations to be assessed against the night-time project noise trigger levels – especially if existing background noise levels are steadily rising in these early morning hours. In these situations, and where operations outside of daytime hours can be justified, appropriate noise level targets may be negotiated with the regulatory/consent authority on a case-by-case basis. As a rule of thumb and for the purposes of deriving the intrusiveness noise level only, it may be appropriate to assign a shoulder period rating background noise level based on:

- the lowest 10th percentile of $L_{AF90,15min}$ dB measurements for the equivalent of one weeks’ worth of valid data taken over the shoulder period (that is, all days included in a single data set of shoulder period); or,
- the $L_{AF90(shoulder\ period)}$ dB value (that is, the lowest 10th percentile value of aggregate data for the equivalent of one week’s worth of valid data taken over the shoulder period).

The objective is to achieve environmental amenity in a feasible and reasonable manner. In an assessment of the likely level of noise impact, the time of day is only one of several relevant factors, such as noise level and character, and the activities affected by the noise. Noise of a lower level, and with no intrusive characteristics such as tones and impulses, can often be more acceptable over a longer period of the day than noise at a high level and/or with intrusive characteristics.

A4 Meteorological conditions for background noise monitoring

Wind and rain conditions

Noise monitoring should not be conducted (or the data should be excluded) when average wind speeds (over 15-minute periods or shorter) at microphone height are greater than 5 metres per second, or when rainfall occurs. Exceptions to this rule are allowed provided the proponent is able to show that the wind-induced noise on the microphone, and sound levels due to rain, are at least 10 dB below the noise levels under investigation.

Where high wind speeds are a feature of the area, monitoring may be permitted during higher wind speeds, provided the proponent is able to show that these wind speeds are a site feature and that the wind-induced noise on the microphone (contamination) is at least 10 dB below the noise levels under investigation. High-performance wind screens can be used to reduce the amount of data that may need to be excluded due to contamination. Specifications of the wind screen used and the data exclusion rules developed should be stated in any noise impacts assessment.

Wind blowing through leaves can raise the environmental noise levels, even at speeds less than 5 metres per second. To avoid this effect, take care to select monitoring locations that are as far away as possible from vegetation while still being representative of the subject site.

Temperature inversions

The noise levels determined using the methods just described are considered to represent the season in which they have been monitored. For this reason, monitoring may be conducted during temperature inversion to ensure that the noise environment at a site is adequately represented. However, care is needed when doing short-term measurements to ensure that the measured noise level results in an adequate assessment of impacts. For instance, measurement of short-term background noise should exclude any data collected during temperature inversions where these inversions are infrequent and are not a feature of the area. Otherwise, assessment applying the project intrusiveness noise level will not adequately assess the noise impact.

Seasonal variations

The EPA recognises that background noise levels may vary due to seasonal changes in weather conditions and wildlife activity (for example, insects, birds and other fauna), and also as a result of changes in operational activities on surrounding developments. As far as is practicable, these potential changes should be considered and addressed in a qualitative manner in the noise assessment report to ensure that noise impacts during other seasons are not ignored.

Such changes may be accounted for by excluding the season-related noise levels from the background noise measurements by filtering or other means (for example, in the case of seasonal operational activities, by monitoring in a similar location not affected by the development in question). In other cases these variations may be discounted on the basis of local knowledge in the area, but the discounting should still be justified in the noise assessment report.

A5 Duration of monitoring

Screening tests may be performed before any monitoring to assess whether monitoring is required. For example, if a minimum background noise level outlined in Section 2.3 (Table 2.1) is assumed as the rating background noise level and the assessment shows no impact, then there is no need for background noise monitoring, as this represents a conservative and limiting case.

Typically, one week’s worth of valid data covering the days and times of operation of the proposed development is required to meaningfully determine the existing noise environment. However, the duration of monitoring should be determined by taking into account the circumstances of the particular situation. The cyclic or random nature of ambient noise levels can affect the duration required.

Any variations from the specified monitoring duration in Table A1 should be fully justified in the noise assessment report.

Fact Sheet B: Measurement procedures for determining background noise

B1 Determining background noise using long-term noise measurements

The long-term background noise measurement procedure should be used during the planning and consent stage for developments that have the potential to cause significant noise nuisance. Both the type of development and its proximity to noise-sensitive locations are important elements to be considered in deciding whether the long-term method is the most appropriate.

Some examples of developments that may present a high risk of noise impact include:

- extractive industries (for example, mines and quarries)
- industrial developments (for example, bitumen plants, coal works, crushing and grinding works, drum re-conditioning, power stations, refineries and timber mills).

Essentially, the procedure for determining long-term background noise involves two components:

- Determining a representative background noise level for each day/evening/night of the monitoring period. This level is termed the assessment background level (ABL) and is a single figure representing each day/evening/night for each monitoring site required for a particular project.
- Determining an overall level representing the day, evening and night assessment periods over the entire monitoring period. This level is termed the rating background noise level (RBL) and is determined based on the individual day/evening/night ABLs as outlined in Section B1.3.

The rating background noise levels are used in determining the project intrusiveness noise level.

B1.1 Instrumentation requirements and siting

Background noise levels should be measured with a noise data logger that has an accuracy at least equivalent to the specifications of a Class 2 meter as stated in *AS IEC 61672.1 – 2004 Electroacoustics – Sound level meters, Part 1: Specifications*. The data logger should be fitted with a windshield and should have a current laboratory calibration certificate or label in accordance with calibration requirements outlined in *AS IEC 61672.1.* Equipment should also be calibrated in the field in accordance with these standards.

Site the data logger(s) at the most- (or potentially most-) affected residence(s). If this is impractical, site the logger(s) at locations with a similar acoustical environment. Be careful to choose sites that are truly representative of the noise environment at the residence(s); for example, do not choose positions screened from dominant background noise sources such as road traffic if residence(s) are not screened from such sources. Locate the microphone 1.2 to 1.5 metres above the ground and, where practicable, at least 3 metres from walls, buildings and other reflecting surfaces. **Data loggers should be sited as far away from trees as practicable to avoid noise produced by wind blowing through foliage, unless this is representative of the exposure of the receiver location.**

During monitoring, set the meter to ‘fast’ time weighting and ‘A’ frequency weighting.

Where local area weather data (within a 30-kilometre [km] radius of the monitoring location) is not available, a weather monitor that continuously monitors wind and rainfall data should be positioned within 5 metres of the data logging equipment, ideally in a place that is not

shielded from the wind. The effect of weather on the instrumentation is of interest here, so the height of the monitor should reasonably correspond to that of the noise logging equipment. Where multiple monitoring sites are required for a particular project, it is best to have simultaneous weather monitoring at each noise logger location or at locations that are demonstrated to be reasonably representative of a number of locations. The weather monitor should record average wind speed (accuracy to within $\pm$ 0.5 metres per second) over periods of at least 15 minutes (corresponding to the noise measurement interval) and record the time intervals of rainfall.

Monitoring should not be conducted (or monitoring data are to be excluded) when average wind speeds are greater than 5 metres per second at microphone height, or during rain. Exceptions to this rule are allowed, provided the proponent is able to show that the wind-induced noise on the microphone and sound levels due to rain are at least 10 dB(A) below the background noise levels under investigation. For sites where high wind speeds are a feature of the area, monitoring may be permitted during higher wind speeds provided that the proponent is able to show that these wind speeds are a site feature and that the wind-induced noise on the microphone is at least 10 dB(A) below the noise levels under investigation.

B1.2 Measurement procedure

The steps involved in monitoring background noise levels for planning purposes are:

1. Calibrate the noise monitoring equipment in the field.
2. Monitor the background noise and meteorological conditions continuously for each day of the week the proposed development will be operating and over the proposed operating hours.
3. Note dominant and background noise sources present at the site throughout the monitoring period. Simultaneous data logging and audio capture of noise levels and operator-attended measurements may be made at the site to support the identification and occurrence of noise sources.
4. Do a field calibration check at the end of the monitoring period in accordance with *AS IEC 61672.1 – 2004* and *AS2659*. Re-monitoring may be required if there is a calibration drift greater than that allowed by the standards.

B1.3 Analysis procedure (10th percentile method)

1. Remove any data that are affected by adverse weather conditions and/or extraneous noise. Where the number of excluded $L_{AF90,15min}$ samples exceeds 8, 2 or 4 for day, evening or night, respectively, re-monitor the background noise following steps 1 to 4 in B1.2, but only for the affected assessment period/s in the corresponding day/s of the week. The underlying idea is to ensure that any patterns that occur are accounted for. These are often seen temporally throughout a day, diurnally, and from weekday to weekend.

   Exception: re-monitoring may not be required, where monitoring contains weather-affected data, if it can be ascertained that the affected samples are not within the expected 'quieter' times of an assessment period (day/evening/night); that is, those time periods where the lowest 10th percentile background noise level might occur. In this case it should be fully justified in the noise-assessment report that the weather-affected data would not affect the lowest 10th percentile background noise level. This could be done through the clear identification of set daily noise patterns of ‘quiet’ periods exhibited by the measured data from the non-affected days. There should be enough non-affected data

available for the assessor to be confident that any pattern identified is valid. For these cases the affected samples need **not** be removed from the data set before the 10th percentile is determined in Step 2.

2. Determine an assessment background level for each day (7 am to 6 pm), evening (6 pm to 10 pm) and night (10 pm to 7 am), using the 10th percentile method (essentially represents the lower 10th per cent value). The 10th percentile method may be determined automatically using a spreadsheet package, or manually by applying the method shown in Table B1.

Table B1: Method for determining the 10th percentile.

Step 1	Sort the $L_{AF90,15min}$ data in each assessment period in **ascending** order.
Step 2	Work out the 10th per cent **position** of the number of samples in the assessment period. This can be calculated by multiplying the number of $L_{AF90,15\ min}$ values in the assessment period by 0.1.
Step 3	Determine the 10th percentile (essentially the lowest 10th per cent value): If the 10th per cent **position** (from Step 2) is an integer, then the 10th percentile is determined by taking the arithmetic average of the value of the $L_{AF90,15min}$ at the 10th per cent position and the next-highest value. If the 10th per cent **position** (from Step 2) is not an integer, then the 10th percentile is the next highest $L_{A90,15min}$ value above the value at the 10th per cent position. **Examples:** For a data set of size 40, the 10th per cent position is 4 (i.e. 0.1 x 40). As this is an integer, the 10th percentile is the average of the values at the 4th position and the 5th position, counting from the lowest value of the sorted data (from Step 1). For a data set of size 44, the 10th per cent position is 4.4 (i.e. 0.1 x 44). As this value is not an integer, the 10th percentile is the value at the 5th position counting from the lowest value of the sorted data (from Step 1).

3. Determine the rating background noise level to be used for assessment purposes. This is taken to be the median value of the corresponding day/evening/night assessment background levels. For example, for a week's worth of monitoring, the evening rating background noise level is the median of the seven evening assessment background levels; that is, the fourth highest (or lowest) value. Where this level is found to be less than 30 dB(A) for the evening and night periods, the rating background noise level is set to 30 dB(A); and where it is found to be less than 35dB(A) for the daytime period, it is set to 35 dB(A).

B1.4 Analysis procedure ($L_{AF90(day/evening/night)}$ dB(A) noise level)

Steps 2 and 3 in Table B1 above can be replaced by the use of the $L_{AF90(day,\ evening,\ night)}$ dB(A) noise level. Data should be excluded for further analysis for conditions outlined in Fact Sheet A4. Where the amount of invalid data exceeds 18%, 13% or 11% of the day, evening or night period respectively, then the corresponding period should be monitored again, unless the exception conditions under B1.3 can be demonstrated to apply.

B2 Determining background noise using short-term noise measurements

The short-term method is the more appropriate background noise monitoring technique for:

- establishing the difference between the background noise level and the source being measured

- checking the noise compliance of a development
- determining the effect of background noise on a source-noise measurement.

B2.1 Instrumentation requirements and siting

To measure background noise levels, use a sound level meter that meets the specifications of a precision (Class 1) or general-purpose (Class 2) sound level meter as stated in *AS IEC 61672.1*. Fit a windshield over the microphone before taking any measurements. The equipment should have a current laboratory calibration certificate or label in accordance with the calibration requirements outlined in *AS IEC 61672.*1 and *AS2659*. Equipment should also be calibrated in the field in accordance with the standards. Use a portable sound level calibrator (in current calibration) for field-checking purposes.

Wind speed during monitoring should be less than 5 metres per second (equivalent to number 3 on the Beaufort wind scale; that is, leaves and small twigs in constant motion; wind extends small flag).

Take the background noise measurement at the reasonably most-affected residence(s). If responding to a noise complaint, take the measurement as close as practicable to where the noise impact is alleged to occur.

Measure the background noise in the absence of both the noise under investigation and any extraneous noise not typical of the area (note exception under Fact Sheet A1). If it is not possible to exclude the source under investigation, then measure the background noise at a remote location judged to have a similar noise environment.

Hold the sound level meter at arm’s length or set it up on a tripod, so the microphone is 1.2 to 1.5 metres above the ground and at least 3 metres from walls, buildings and other reflecting surfaces. During monitoring, set the meter to ‘fast’ time weighting and ‘A’ frequency weighting. Do not take measurements when it is raining or when the average wind speed at microphone height exceeds 5 metres per second.

B2.2 Measurement procedure

1. During the period of the day for which the noise source is expected to operate, determine the time when the greatest impact is likely to occur and take measurements at this time. (Note: This is often when the difference between the measured background noise and the noise level generated by the new or existing development is greatest.)
2. Field-calibrate the noise monitoring equipment.
3. Measure the background noise level continuously for 15 minutes, excluding all distinct extraneous noises. (Because of the short period over which the background noise is being measured, distinct extraneous noises, including noise from transportation, conversation, birds and insects, should be excluded from the measurements.) If extraneous noise is present, pause the meter when this noise occurs or choose another measuring time or location.

   The rating background noise level to be used for assessment purposes is the $L_{A90,15\ min}$ level produced by an integrating averaging sound level meter.
4. Check the field calibration at the end of the monitoring period in accordance with *AS IEC 61672.1* and *AS2659*. Re-monitoring may be required if there is a calibration drift greater than that allowed by the standards.

5. If two or more valid measurements of background noise are recorded at the one location, adopt the lowest level as the background level.

Note: If the measured background level is less than 30 dB(A) for the evening and night periods, then it is set to 30 dB(A); where it is found to be less than 35 dB(A) for the day period, then it is set to 35dB(A).

B3 Reporting requirements

Include the following items in a report to support the determined rating background noise level.

B3.1 Long-term method

To support the determined rating background noise level, include:

- details of equipment used (include latest calibration date), equipment settings and sampling rate of the logger used
- a statement justifying the choice of monitoring site, including the procedure used to choose the site, having regard to the definitions of ‘residence(s)’ (see glossary) and ‘reasonably most-affected location(s)’ (described in A1.2)
- details of the exact location of the monitoring site and a description of land uses in surrounding areas
- a brief description of where the equipment was positioned
- a description of the dominant and background noise sources at the site
- a record of periods of affected data (due to adverse weather and extraneous noise) and statement indicating the need for any re-monitoring under Step 1 in Section B1.3 and B1.4
- day, evening and night assessment background levels for each day of the monitoring period
- the final RBL value(s)
- daily logger graphs presenting $L_{Amax,15min}$; $L_{A1,15min}$, $L_{A10,15min}$; $L_{A90,15min}$ and $L_{Aeq,15min}$. **Note:** while some of these descriptors are not used in the assessment process, they can provide a useful insight into the acoustic environment.

B3.2 Short-term method

To support the determined rating background noise level, include:

- details of equipment used (include latest calibration date), equipment settings and the sampling rate of the meter
- a statement justifying the choice of monitoring site and period, including the procedure used to choose the site, having regard to the definitions of ‘residence(s)’ (see glossary) and ‘reasonably most-affected location(s)’ (described in A1.2)
- a description of the dominant and background noise sources at the site
- a record of weather conditions during monitoring
- the measured background noise levels.

Fact Sheet C: Corrections for annoying noise characteristics

C1 Introduction

Where a noise source contains certain characteristics, such as tonality, intermittency, irregularity or dominant low-frequency content, there is evidence to suggest that it can cause greater annoyance than other noise at the same noise level. On the other hand, some sources may cause less annoyance where only a single event occurs for a limited duration. This section outlines the correction factors to be applied to the source noise level at the receiver before comparison with the project noise trigger levels specified in Section 2, to account for the additional annoyance caused by these modifying factors.

The modifying factor corrections should be applied having regard to:

- the contribution noise level from the premises when assessed/measured at a receiver location, and
- the nature of the noise source and its characteristics (as set out in this fact sheet).

Table C1 sets out the corrections to be applied. The corrections specified for tonal, intermittent and low-frequency noise are to be added to the measured or predicted noise levels at the receiver before comparison with the project noise trigger levels. The adjustments for duration are to be applied to the criterion.

Table C1: Modifying factor corrections (see definitions in Section C2).

Factor	Assessment/ measurement	When to apply	Correction[1]	Comments
Tonal noise	One-third octave band analysis using the objective method for assessing the audibility of tones in noise – simplified method (*ISO1996.2-2007 – Annex D*).	Level of one-third octave band exceeds the level of the adjacent bands on both sides by: • 5 dB or more if the centre frequency of the band containing the tone is in the range 500–10,000 Hz • 8 dB or more if the centre frequency of the band containing the tone is in the range 160–400 Hz • 15 dB or more if the centre frequency of the band containing the tone is in the range 25–125 Hz.	5 dB[2,3]	Third octave measurements should be undertaken using unweighted or Z-weighted measurements. **Note:** Narrow-band analysis using the reference method in *ISO1996-2:2007, Annex C* may be required by the consent/regulatory authority where it appears that a tone is not being adequately identified, e.g. where it appears that the tonal energy is at or close to the third octave band limits of contiguous bands.
Low-frequency noise	Measurement of source contribution C-weighted and A-weighted level and one-third octave measurements in the range 10–160 Hz	Measure/assess source contribution C- and A-weighted $L_{eq,T}$ levels over same time period. Correction to be applied where the C minus A level is 15 dB or more and: • where any of the one-third octave noise levels in Table C2 are exceeded by up to and including 5 dB and cannot be mitigated, a 2-	2 or 5 dB[2]	A difference of 15 dB or more between C- and A-weighted measurements identifies the potential for an unbalance spectrum and potential increased annoyance. The values in Table C2 are derived from

		dB(A) positive adjustment to measured/predicted A-weighted levels applies for the evening/night period • where any of the one-third octave noise levels in Table C2 are exceeded by more than 5 dB and cannot be mitigated, a 5-dB(A) positive adjustment to measured/predicted A-weighted levels applies for the evening/night period and a 2-dB(A) positive adjustment applies for the daytime period.		Moorhouse (2011) for DEFRA fluctuating low-frequency noise criteria with corrections to reflect external assessment locations.
Intermittent noise	Subjectively assessed but should be assisted with measurement to gauge the extent of change in noise level.	The source noise heard at the receiver varies by more than 5 dB(A) and the intermittent nature of the noise is clearly audible.	5 dB	Adjustment to be applied for **night-time only**.
Duration	Single-event noise duration may range from 1.5 min to 2.5 h.	One event in any assessment period.	0 to 20 dB(A)	The project noise trigger level may be increased by an adjustment depending on duration of noise (see Table C3).
Maximum adjustment	Refer to individual modifying factors.	Where two or more modifying factors are indicated.	Maximum correction of 10 dB(A)[2] (excluding duration correction).	

Notes:
1. Corrections to be added to the measured or predicted levels, except in the case of duration where the adjustment is to be made to the criterion.
2. Where a source emits tonal and low-frequency noise, only one 5-dB correction should be applied if the tone is in the low-frequency range, that is, at or below 160 Hz.
3. Where narrow-band analysis using the reference method is required, as outlined in column 5, the correction will be determined by the *ISO1996-2:2007* standard.

C2 Definitions to support the modifying factor corrections

Tonal noise: noise containing a prominent frequency and characterised by a definite pitch.

Low-frequency noise: noise with an **unbalanced spectrum** and containing major components within the low-frequency range (10–160 Hz) of the frequency spectrum.

Table C2: One-third octave low-frequency noise thresholds.

Hz/dB(Z)	One-third octave $L_{Zeq,15min}$ threshold level											
Frequency (Hz)	10	12.5	16	20	25	31.5	40	50	63	80	100	125	160
dB(Z)	92	89	86	77	69	61	54	50	50	48	48	46	44

Notes:
- dB(Z) = decibel (Z frequency weighted).
- For the assessment of low-frequency noise, care should be taken to select a wind screen that can protect the microphone from wind-induced noise characteristics at least 10 dB below the threshold values in Table C2 for

wind speeds up to 5 metres per second. It is likely that high performance larger diameter wind screens (nominally 175 mm) will be required to achieve this performance (Hessler, 2008). In any case, the performance of the wind screen and wind speeds at which data will be excluded needs to be stated.

- Low-frequency noise corrections only apply under the standard and/or noise-enhancing meteorological conditions.
- Where a receiver location has had architectural acoustic treatment applied (including alternative means of mechanical ventilation satisfying the Building Code of Australia) by a proponent, as part of consent requirements or as a private negotiated agreement, alternative external low-frequency noise assessment criteria may be proposed to account for the higher transmission loss of the building façade.
- Measurements should be made between 1.2 and 1.5 metres above ground level unless otherwise approved through a planning instrument (consent/approval) or environment protection licence, and at locations nominated in the development consent or licence.

Intermittent noise: noise where the level suddenly drops/increases several times during the assessment period, with a noticeable change in source noise level of at least 5 dB(A); for example, equipment cycling on and off. The intermittency correction is not intended to be applied to changes in noise level due to meteorology.

Correction for duration: this is applied where a single-event noise is continuous for a period of less than two and a half hours in any assessment period. The allowable exceedance of the $L_{Aeq,15min}$ equivalent noise criterion is shown in Table C3 for the duration of the event. This adjustment is designed to account for unusual and one-off events, and does not apply to regular and/or routine high-noise level events.

Table C3: Adjustment for duration.

Allowable duration of noise (one event in any 24-hour period)	**Allowable exceedance of $L_{Aeq,15min}$ equivalent project noise trigger level at receptor for the period of the noise event, dB(A)**	
	Daytime and evening (7 am–10 pm)	**Night-time (10 pm–7 am)**
1 to 2.5 hours	2	Nil
15 minutes to 1 hour	5	Nil
6 minutes to 15 minutes	7	2
1.5 minutes to 6 minutes	15	5
less than 1.5 minutes	20	10

Note: Where the duration of the noise event is smaller than the duration of the project noise trigger level (that is, less than 15 minutes) the allowable adjusted project noise trigger level becomes:

$$10Log_{10}(\left(10^{\frac{PNTL}{10}}x\left(\frac{900-\ duration}{900}\right)\right)+\left(10^{\frac{PNTL+allowable\ exceedance\ (Table\ C3)}{10}}x\ duration\right))$$

Maximum correction: the maximum correction to be applied to the predicted or the measured level where two or more modifying factors are present. The maximum adjustment is 10 dB(A) where the noise contains two or more modifying factors (excluding the duration correction).

Fact Sheet D: Accounting for noise-enhancing weather conditions

Certain meteorological/weather conditions may increase noise levels by focusing sound-wave propagation paths at a single point. Such refraction of sound waves will occur during temperature inversions (atmospheric conditions where temperatures increase with height above ground level), and where there is a wind gradient (that is, wind velocities increasing with height) with wind direction from the source to the receiver.

Meteorological conditions need to be considered for both the impact assessment phase (pre-operation) and compliance assessment phase (post-operation) for an industrial activity. Compliance against noise requirements in consents and licences needs to be able to be determined under a range of meteorological conditions.

The approach is to state the meteorological conditions under which project noise trigger levels, and limits, will apply, rather than stipulating the noise modelling parameters that must be used.

Standard meteorological conditions and **noise-enhancing meteorological conditions** have been defined in Table D1 for the purposes of this policy.

Table D1: Standard and noise-enhancing meteorological conditions.

Meteorological conditions	Meteorological parameters
Standard meteorological conditions	Day/evening/night: stability categories A–D with wind speed up to 0.5 m/s at 10 m AGL.
Noise-enhancing meteorological conditions	Daytime/evening: stability categories A–D with light winds (up to 3 m/s at 10 m AGL). Night-time: stability categories A–D with light winds (up to 3 m/s at 10 m AGL) and/or stability category F with winds up to 2 m/s at 10 m AGL.

Notes: m/s = metres per second; m = metres; AGL = above ground level; where a range of conditions is nominated, the meteorological condition delivering the highest-predicted noise level should be adopted for assessment purposes. However, feasible and reasonable noise limits in consents and licences derived from this process would apply under the full range of meteorological conditions nominated under standard or noise-enhancing conditions as relevant. All wind speeds are referenced to 10 m AGL. Stability categories are based on the Pasquill–Gifford stability classification scheme.

Two options are available to a proponent to consider meteorological effects:

1. Adopt the **noise-enhancing meteorological conditions** for all assessment periods for noise impact assessment purposes without an assessment of how often these conditions occur – a conservative approach that considers source-to-receiver wind vectors for all receivers and F class temperature inversions with wind speeds up to 2 m/s at night.

Or

2. Determine the **significance** of noise-enhancing conditions. This involves assessing the significance of temperature inversions (F and G class stability categories) for the night-time period and the significance of light winds up to and including 3 m/s for all assessment periods during stability categories other than E, F or G. Significance is based on a threshold of occurrence of 30% determined in accordance with the provisions in this policy. Where **noise-enhancing meteorological conditions** occur for less than 30% of the time, **standard meteorological conditions** may be adopted for the assessment.

Notes:

- When determining the significance of F class stability category, F and G class conditions should be assessed and the combined occurrence used.
- Where F class conditions are relevant for the assessment, any wind vectors that can occur up to 2 m/s wind speed at 10 metres above ground level (AGL) while F class conditions are maintained should be considered.
- Where the significance of noise-enhancing meteorological conditions has been tested, it can result in different meteorological conditions being applied to each assessment period. **For example,** it may result in standard conditions being applied during the day and evening and noise-enhancing being applied at night, or vice versa.
- Where wind is identified as a significant feature, noise modelling should consider a 3-m/s wind in the directions identified as significant, or alternatively use a source-to-receiver component for all receivers of 3 m/s as a conservative approach.
- Where a noise limit in a consent or licence applies under noise-enhancing meteorological conditions (see Table D1), limits applicable under stability category F will also apply under stability category E.

Where an environmental assessment has either adopted by default noise-enhancing conditions, or identified noise-enhancing conditions as significant, predicted noise levels under these meteorological conditions should be compared to the relevant project noise trigger level for impact assessment purposes.

Where noise-enhancing meteorological conditions have been identified as not significant, predicted noise levels under standard meteorological conditions should be compared to the relevant project noise trigger level for impact assessment purposes.

Noise limits derived for consents and licences will apply under the meteorological conditions used in the environmental assessment process, that is, standard or noise-enhancing meteorological conditions. For ‘very noise-enhancing meteorological conditions’ (see glossary) a limit is set based on the limit derived under standard or noise-enhancing conditions (whichever is adopted in the assessment) plus 5 dB. In this way a development is subject to noise limits under all meteorological conditions.

It should be noted that noise limit conditions will include the wind speed (scalar quantity without direction) under which noise limits will apply.

D1 Method for determining the frequency of temperature inversions

D1.1 Background

An important part of the assessment of noise enhancement due to inversions involves determining whether inversions occur frequently enough to warrant inclusion in the assessment.

The frequency of occurrence of temperature inversions may be determined either by direct measurement of inversion parameters, or by using indirect methods that allow the prediction of wind and temperature profiles to within a moderately narrow range using readily available meteorological data. The direct-measurement method will result in actual temperature gradients and drainage-flow-wind speeds from which the percentage occurrence of inversions may be determined. The indirect methods, on the other hand, allow the susceptibility of an area to inversions to be determined through the use of the relationship developed by the US Atomic Energy Commission between atmospheric stability categories and inversions. The relationship shown in Table D2 outlines the range of temperature gradients that can be expected within each stability category. Hence, if a stability category is known, then the range of possible temperature gradients may be inferred.

A positive temperature gradient signifies a temperature inversion; hence, from the table below, inversions occur during E, F and G stability categories. These three categories are considered to represent weak, moderate and strong inversions respectively. For noise assessment purposes, only moderate and strong inversions are considered significant enough to require assessment.

Table D2: Stability categories based on DT/DZ.

Stability category	Range of vertical temperature gradient – DT/DZ (degrees Celsius/100 metres)
A	DT/DZ < –1.9
B	–1.9 ≤ DT/DZ < –1.7
C	–1.7 ≤DT/DZ < –1.5
D	–1.5 ≤ DT/DZ < –0.5
E	–0.5 ≤ DT/DZ < 1.5
F	1.5 ≤ DT/DZ < 4
G	4 ≤ DT/DZ

Three basic schemes may be used to determine the occurrence of different stability classes at a particular site, based on the following combinations of meteorological parameters:

- direct measurement of temperature lapse rate over a height interval range of 50 metres minimum, with the lower height a minimum of 10 metres, and wind speed at 10 metres height
- cloud cover, wind speed and solar elevation (Pasquill–Gifford stability classification scheme and Turner scheme)
- measurements of sigma-theta (the standard deviation of wind direction), wind speed and time of day.

All methods involve analysing three months of meteorological data collected in winter, the season during which most inversions occur. Wind measurements are to comply with *AS 3580.14-2011: Methods for sampling and analysis of ambient air, Meteorological monitoring for ambient air quality monitoring applications* (Standards Australia, 2011).

D1.2 Direct measurement of temperature lapse rate

This method involves the measurement of temperature gradient and wind speed at hourly intervals over the three winter months. The temperature gradient measurement involves measuring the temperature at two elevated levels: the lower height a minimum of 10 metres above ground, and a 50-metre height interval minimum to determine the temperature difference. Where temperature is not measured at 10 metres and 60 metres, the actual measurement heights need to be stated. The temperature gradient is then the temperature difference (that is, the temperature at the higher elevation minus the temperature at the lower elevation) multiplied by a fraction that is calculated as 100 divided by the height difference. The wind speed should be measured at a height of 10 metres. Care should be taken to ensure that measurement procedures comply with relevant standards (NSW EPA, 2014).

Inversion strengths calculated by extrapolation of the difference between temperatures measured at the same or different heights above ground level, but where one measurement is laterally displaced on elevated terrain, may give reasonable accuracy. The accuracy should be established by comparison of the calculated values against measurements from a campaign of direct measurements, such as by tethersonde.

Once all data have been collected, the percentage occurrence of each stability category may be determined. A step-by-step guide to the analysis procedure is given in Table D3.

Table D3: Step procedure for determining the percentage occurrence of inversions.

Step	Procedure
1	Sort the night-time (period between 1 hr before sunset to 1 hr after sunrise, taken to be 6 pm to 7 am) temperature gradients with associated wind speed in ascending order for the whole winter period.
2	Convert the temperature gradients into their corresponding stability categories according to Table D2.
3	If F or G stability categories occur for a period of 30% of the total night-time or more, either separately or in combination, then temperature inversions are considered to be a significant feature of the area and need to be assessed.

D1.3 Classifications of stability category based on cloud cover

The most widely used stability classification scheme is that developed by Pasquill (1961). This is based on observations of cloud cover, wind speed and solar elevation. This scheme was modified by Turner (1964) to create an alternative scheme that is more amenable to application with computer-based databases. Both schemes are discussed below.

D1.3.1 Pasquill–Gifford stability classification scheme

The Pasquill–Gifford stability classification scheme, outlined in Table D4 below, determines Pasquill stability categories using hourly or three-hourly wind-speed and cloud-cover measurements. Once these are known, the percentage frequency of temperature inversions over the three winter months may be predicted using the relationship in Table D3. The following data are required for the analysis collected over the three winter months:

- hourly or three-hourly wind speed and direction at 10 metres (the wind direction is not required to determine the Pasquill stability category but is required for the noise analysis)
- hourly or three-hourly cloud cover measurements
- times of sunrise and sunset recorded on a daily basis (these times are required to define the night-time period) or assumed to be 7 am and 6 pm, respectively.

The required data may be obtained from the Bureau of Meteorology from data collected at the closest monitoring station. The parameters needed are available from selected Bureau of Meteorology stations across NSW. Wind speeds and wind directions are subject to considerable local variation. However, cloud cover is generally not subject to such strong spatial variations and, consequently, data from a station some distance away may be acceptable. Whether or not data apply to a particular site needs to be critically assessed. For cloud cover, distance from the coast and ground elevation will have an important bearing on the cloudiness. In general, data collected from weather-monitoring stations are considered relevant for a radius of 30 kilometres from the station, provided the surrounding area is in the same topographical basin as the station.

If representative cloud data is not available from a nearby station, it is advisable to use the sigma-theta method outlined below instead to determine stability categories. This is because the numerous individual observations needed to measure cloud cover for the Pasquill–Gifford method are often not feasible.

Table D4: Key to Pasquill stability categories.[1]

Hourly average wind speed (m/s) at 10 metres AGL	Daytime stability categories	Stability categories based on night cloud cover[2] (night = 6 pm to 7 am)	
		Thinly overcast or ≥ 4/8 low cloud	≤ 3/8 cloud
< 2	A–D	F	G
2–3		E	F
3–5		D	E
5–6		D	D
> 6		D	D

Source: Adapted from Pasquill (1961).
Notes:
1. In dispersion modelling, stability class is used to categorise the rate at which a plume will disperse. In the Pasquill–Gifford stability class assignment scheme there are six stability classes, A through to F. Class A relates to unstable conditions, such as might be found on a sunny day with light winds. Class F relates to stable conditions, such as those that occur when the sky is clear, the winds are light, and an inversion is present. The intermediate classes B, C, D and E relate to intermediate dispersion conditions. A seventh class, G, has also been defined to accommodate extremely stable conditions such as might be found in arid rural areas.
2. The neutral category D should be used for overcast conditions regardless of wind speed.

D1.3.1.1 Determining the frequency of occurrence of inversions

Once the stability categories have been determined for all the data collected during the period from 6 pm to 7 am, the percentage occurrence of moderate and strong inversions occurring during F and G stability categories, respectively, may then be determined. The percentage occurrence required here is the total percentage occurrence for the night periods over the three months of winter. The Pasquill–Gifford stability classification scheme assumes that moderate and strong inversions do not occur during the daytime hours (considered here to be from 7 am to 6 pm).

Where the sum total of F and G inversions occur for at least 30% of the total night-time in winter, the project area is considered to be significantly affected by inversions warranting noise assessment. Current-generation noise modelling software does not allow for the modelling of G class stability categories. Therefore modelling should be undertaken using F class conditions. Where direct temperature lapse rates are able to be selected in a noise model, the upper bounds of F class should be selected, that is, 4 degrees Celsius per 100 metres.

D1.3.2 Turner scheme

The Turner scheme recognises that stability near the ground depends mainly on net radiation and wind speed, with net radiation being a function of cloud cover and the height of the cloud ceiling. This scheme determines stability categories based on hourly or three-hourly wind measurements of cloud cover, cloud-ceiling height, wind speed and wind direction. As with the previous scheme, the percentage occurrence of temperature inversions over the three winter months may be predicted using the relationship in Table D3. The following data need to be collected over the three winter months for analysis:

- hourly or three-hourly wind speed and direction at 10 metres (wind direction is not required to determine the Pasquill stability category, but is required for the noise analysis)
- hourly or three-hourly cloud cover measurements
- hourly or three-hourly cloud ceiling-height measurements
- daily records of time of sunrise and sunset (needed to define the night-time period) or assumed to be 6 pm to 7 am, respectively.

Similarly, the required data may be obtained from the Bureau of Meteorology from data collected at the closest monitoring station (see Section D1.3.1 regarding considerations relating to the applicability of data to a site).

If representative cloud data are not available from a nearby station, it is advisable to use the sigma-theta method outlined in Section D1.4 instead, to determine stability categories. This is because the large number of individual observations needed to measure cloud cover for the Turner scheme may not be feasible.

Table D5 gives the stability class as a function of wind speed and net radiation. The net radiation index for the night period ranges from –1 to –2 (negative radiation is radiation directed away from the earth). **Note that the Turner scheme assumes that moderate and strong inversions do not occur during daytime hours (considered here to be the period from 7 am to 6 pm).**

Note also that in the specifications for this scheme, cloud-cover data are assumed to be available in 1/10^{ths}. Usually data from the Bureau of Meteorology are reported in 1/8^{ths}, so some conversion will be needed.

The net radiation index to be used in Table D5 is:

- If the total cloud cover is 10/10 and the ceiling is less than 7000 feet (2133 metres), use net radiation index equal to 0 (whether day or night).
- For night-time (from 6 pm to 7 am):
  a) if total cloud cover ≤ 4/10, use net radiation index equal to –2
  b) if total cloud cover > 4/10, use net radiation equal to –1.

Table D5: Stability class as a function of net radiation and wind speed.

Wind speed		**Net radiation index**		
Knots	**m/s**	**0**	**–1**	**–2**
0–1	0–0.7	D	F	G
2–3	0.8–1.8	D	F	G
4–5	1.9–2.8	D	E	F
6	2.9–3.3	D	E	F
7	3.4–3.8	D	D	E
8–9	3.9–4.8	D	D	E
10	4.9–5.4	D	D	E
11	5.5–5.9	D	D	D
≥ 12	≥ 6.0	D	D	D

Note: m/s = metres per second.

Follow the procedure outlined in Section D1.3.1.1 to determine the percentage occurrence of temperature inversions, once the stability-category classifications have been made.

D1.4 Use of sigma-theta data

The sigma-theta method, developed by the US Environmental Protection Agency (US EPA), refers to observations of sigma-theta, wind speed and time of day. With this method, the Pasquill stability categories may be determined by using a relationship between stability

categories and the standard deviation of the horizontal wind direction fluctuations (σ_A in degrees). The scheme is applied in one step to determine the daytime stability category, and two steps to determine the night-time stability category as follows:

- The daytime (from 7 am to 6 pm) stability category may be determined directly from σA data using Table D6.
- The night-time (from 6 pm to 7 am) stability category may be determined in two steps:
  - Determine the stability category from σ_A data using Table D6.
  - Modify this stability category based on prevailing wind speed using Table D7.

Sigma-theta data may be measured on an hourly or three-hourly basis and should be collected as specified in *AS 3580.14-2011: Methods for sampling and analysis of ambient air*, *Meteorological monitoring for ambient air quality monitoring applications*.

Note: Table D6 strictly applies only when the σ_A measurements are made in an area where the surface roughness is 0.15 metres. To apply the scheme using σ_A data collected in an area where the surface roughness is different, the limit in the table should be modified by multiplying it by:

$(z_o/15\text{ cm})^{0.2}$ where z_o = the surface roughness of the area in centimetres.

For example, if the surface roughness is 0.20 metres, the first limit in Table D6 (that is, 22.5º) should be changed to 23.8º (that is, 22.5º **x** $[20/15]^{0.2}$).

Table D8 shows the typical surface roughness that applies for a range of surfaces.

Table D6: Wind fluctuation criteria for estimating Pasquill–Gifford stability categories for non-arid areas in NSW.[1,2]

Pasquill–Gifford stability category	Standard deviation of the horizontal wind direction fluctuations[3,4] (σ_A in degrees [º])
A	$\sigma_A \geq 22.5^\circ$
B	$17.5^\circ \leq \sigma_A < 22.5^\circ$
C	$12.5^\circ \leq \sigma_A < 17.5^\circ$
D	$7.5^\circ \leq \sigma_A < 12.5^\circ$
E	$3.8^\circ \leq \sigma_A < 7.5^\circ$
F	$2.1^\circ \leq \sigma_A \leq 3.8^\circ$
G[5]	$\sigma_A \leq 2.1^\circ$

Adapted from: Irwin (1980) and US EPA (1987).

Notes:

1. These criteria are appropriate for steady-state conditions, a measurement height of 10 metres for level terrain, and an aerodynamic surface roughness length of 15 centimetres. Ensure that the wind sensor is responsive enough for use in measuring wind direction fluctuations (US EPA, 1987).

2. The NSW EPA recommends that the sigma-theta method not be used for arid or semi-arid areas (US EPA, 1987).

3. For areas with surface roughness different from 15 centimetres, the **table** values should be modified by multiplying by the surface roughness factor of $(z_o/15\text{ cm})^{0.2}$, where z_o is the average surface roughness in centimetres within a radius of 1 to 3 kilometres of the source. Note that this factor, while theoretically sound, has not been subjected to rigorous testing and may not improve the estimates in all circumstances. A table of z_o values that may be used as a guide to estimating surface roughness is given in Smedman–Hogstrom and Hogstrom (1978).

4. These criteria are from an NRC proposal (NRC, 1972). It would seem reasonable to restrict the possible categories of A through D during daytime hours with a restriction that, for 10-metre above ground level wind

speeds above 6 m/s, conditions are neutral. Likewise, during the night-time hours, some restrictions (as in Table CA2.6 in the NRC document) are needed to preclude occurrences of categories A through C.

5. Supplemented by data from Mitchell and Timbre (1979) and US EPA (1980).

Table D7: Night-time[1] Pasquill–Gifford stability categories based on σ_A from Table D6.

If the σ_A stability category is:	And the wind speed at 10-metre AGL is (m/s)	Then the Pasquill-Gifford stability category is:
A	< 2.9 2.9-3.5 >= 3.6	F E D
B	< 2.4 2.4-2.9 >= 3	F E D
C	< 2.3 >= 2.4	E D
D	ANY	D
E	< 4.9 >= 5	E D
F	< 3 3-5 >= 5	F E D
G	< 2 2-3 3-5 >=5	G F E D

Adapted from Irwin (1980) and US EPA (1987).

Notes: AGL = above ground level.

1. Night-time is considered to be from 6 pm to 7 am.

2. The original Mitchell and Timbre (1979) table had no wind speed restrictions. However, the original Pasquill criteria suggest that, for wind speeds greater than or equal to 5 metres per second (m/s), the D category would be appropriate; and for wind speeds between 3 m/s and 5 m/s, the E category should be used. For wind speeds between 2 m/s and 3 m/s, the F category should be used, and for wind speeds less than 2 m/s, the G category should be used.

Table D8: Aerodynamic roughness of various surfaces.

Surface	Comments	Roughness (z_0) (metres)
Water	Still, open sea	0.1–10.0 x 10^{-5}
Sand, open desert		0.0003
Open soil		0.001–0.01
Grass	Mown lawn: 0.02–0.10 metres high Rough pasture: 0.25–1 metres high	0.003–0.01 0.04–0.10
Short scrub, long grass and most field crops		0.05–0.10
Forest		0.6–2
Suburban area		0.6
City		0.6–2

D1.5 Discussion

The noise-enhancing meteorological parameters of an area can either be accepted or an analysis undertaken using one of the schemes outlined above to establish whether inversions are a significant feature of the area.

The schemes that can be used to determine stability category are:

- direct measurements of temperature gradient at two heights, with the lower height being a minimum of 10 metres over a height interval of at least 50 metres, with simultaneous measurements of wind speed and wind direction at 10 metres
- the sigma-theta method
- the Pasquill–Gifford stability classification scheme and Turner scheme (equally preferred).

Other methods are detailed in the US EPA's documents (1987 and 2000), *On-site meteorological program guidance for regulating modelling applications*.

D2 Method for determining the frequency of winds

The assessment of the significance of wind needs to consider both the wind speed and direction. The assessment must also consider each of the four seasons and assessment periods (day, evening, and night) individually.

The following methods may be used to determine the frequency of winds up to and including 3 m/s:

- For circumstances involving a limited number of sensitive receivers, the Noise enhancement wind analysis (NEWA) program on the EPA website can be used to determine the significance of source-to-receiver wind conditions for individual receiver locations, or other methods demonstrated to be equally suitable.
- For more complex situations, an eight or 16-direction wind compass rose may be used. To determine whether light winds (up to and including 3 m/s) are significant, the percentage occurrence of light winds for each of the eight or 16 directions should be established and reported in the following manner:
  a. For the eight-direction wind compass rose, the percentage occurrence of light winds for each of the eight directions is the arithmetic sum of the direction being reported and the two adjoining directions (one on either side).
  b. For the 16-direction wind compass rose the percentage occurrence of light winds for each of the 16 directions is the arithmetic sum of the direction being reported and the four closest directions (that is, two on either side).

  Note: This approach approximates reporting each direction plus or minus 45°.
- Other methods acceptable to the relevant regulatory authority can also be used, provided they are fully explained and justified in the noise impact assessment.

Note: At least one year's worth of meteorological data shall be used in the analysis.

Fact Sheet E: Worked case studies

E1 General application case study

This case study aims to highlight the main aspects of the policy, and can be referred to in a number of different assessment situations.

Situation: New major development proposal near an urban residential area

A major development is proposed in an existing industrial area with a residential area located nearby. Apart from the site in question, the industrial area is fully developed. The noise impact of the proposed development needs to be assessed. The development is proposed to operate 24 hours a day, seven days per week.

Main assessment steps

1. Preliminary site investigation

The site and surrounds were visited to determine relevant information for a noise assessment including:

- the physical relationship between the industrial site and the residential area
- the nature of the acoustic environment at the residential area, and the number of acoustic monitoring locations that may be needed to characterise the noise environment
- information to assist in determining the residential receiver category (*Noise Policy for Industry*, Section 2.4, Table 2.3), including general observations of the noise environment and its dominant sources (such as transportation, industry, and natural sources).

2. Determine existing noise levels

Acoustic monitoring instrumentation was deployed at a single location deemed representative of the residential area for a full week. The main information required at this stage of the assessment is the rating background noise levels. However, the existing industrial noise levels may be needed if the project amenity noise levels cannot be met. Therefore, to avoid any duplication, the instrument was programmed to record all relevant acoustic parameters, including sample audio data.

The monitoring location was also visited by the acoustic practitioner during the day, evening and night periods to make observations about the acoustic environment, including the general noise sources that are audible.

Meteorological data for the monitoring period was available from a Bureau of Meteorology monitoring station well within 30 km from the monitoring site.

The rating background noise levels were determined to be:

- daytime: 45 dB(A)
- evening: 42 dB(A)
- night-time: 36 dB(A).

3. Determine residential receiver category

The residential area is zoned R4 High Density Residential. The noise in the area is dominated by traffic noise due to main roads, and some industrial noise was audible for all assessment periods. The land zoning, the subjective assessment of the acoustic

environment in the area, and the acquired background noise levels would support an urban residential land-use category with reference to Table 2.3 in the *Noise Policy for Industry.*

4. Determine project noise trigger levels

The amenity and intrusiveness noise levels were determined as shown in Table E1.1.

Table E1.1: Project noise trigger levels.

Period	Intrusiveness noise level[1]	Project amenity noise level[2]
Daytime	50 dB $L_{Aeq,15min}$ (45 + 5)	58 $L_{Aeq,5min}$ (60 – 5 + 3)
Evening	47 dB $L_{Aeq,15min}$ (42 + 5)	48 $L_{Aeq,15min}$ (50 – 5 + 3)
Night-time	41 dB $L_{Aeq,15min}$ (36 + 5)	43 $L_{Aeq,15min}$ (45 – 5 + 3)

Notes:

1. Intrusiveness noise level is $L_{Aeq,15min} \leq$ RBL + 5 (Section 2.1).
2. Project amenity noise level (ANL) is urban ANL (Table 2.1) minus 5 dB(A) plus 3 dB(A) to convert from a period level to a 15-minute level (dB = decibel; dB[A] = decibel [A-weighted]; RBL = rating background noise level).

The project noise trigger level is the lower (that is, the most stringent) value of the intrusiveness and amenity noise levels. Therefore the project noise trigger levels are as follows:

- daytime: $L_{Aeq,15min}$ 50 dB(A)
- evening: $L_{Aeq,15min}$ 47 dB(A)
- night-time: $L_{Aeq,15min}$ 41 dB(A).

5. Predict/measure level of noise and determine impact

The proponent chose to adopt the noise-enhancing meteorological conditions outlined in Fact Sheet D without an assessment of how often these conditions occur, which is acceptable under the policy.

Table E1.2: Assessment of meteorological conditions.

Period	Meteorological conditions
All assessment periods	Daytime/evening: stability categories A–D with light winds up to 3 m/s. Night-time: stability categories A–D with light winds up to 3 m/s and stability category F with winds up to 2 m/s.

Note: m/s = metres per second.

Noise modelling was undertaken for the project using the above meteorological parameters. Relevant details provided in the assessment included all matters outlined in Section 3 of the *Noise Policy for Industry*.

The following noise levels were predicted for the day, evening and night-time period:

- daytime: $L_{Aeq,15min}$ 49 dB(A)
- evening: $L_{Aeq,15min}$ 49 dB(A)
- night-time: $L_{Aeq,15min}$ 46 dB(A).

Based on an analysis of the predicted noise levels and previous monitoring undertaken near similar facilities, it was determined that no correction factors for annoying noise characteristics were applicable.

The predicted noise levels exceed the evening project noise trigger level by 2 dB(A) and the night-time project noise trigger level by 5 dB(A). Consideration of noise mitigation is therefore required.

The proponent demonstrated that a three-metre high solid barrier on the northern boundary of the premises and the acoustic enclosure of a compressor would reduce noise levels by 5–7 dB(A) at the residential location. These measures were determined to be both feasible and reasonable and were proposed to be adopted by the proponent. With these measures incorporated, the following revised noise predictions were made:

- daytime: $L_{Aeq,15min}$ 42 dB(A)
- evening: $L_{Aeq,15min}$ 42 dB(A)
- night-time: $L_{Aeq,15min}$ 41 dB(A).

With the proposed noise mitigation measures incorporated, noise impacts are not expected.

6. Monitor performance

Suitable noise level limits were placed in the consent/environment protection licence based on achieving the project noise trigger level under the noise-enhancing conditions used in the assessment, as these were demonstrated to be achievable. Noise limits required to be met under very noise-enhancing conditions were applied based on the limits for noise-enhancing conditions plus 5 dB.

E2 High traffic noise case study

This case study aims to highlight the high traffic noise level amenity provisions of the policy.

Situation: New major development proposal near an urban residential area

A major development is proposed in an existing industrial area with a residential area located across a major highway from the facility. Apart from the site in question, the industrial area is fully developed. The noise impact of the proposed development needs to be assessed. The development is proposed to operate during daytime and evening hours, six days per week.

Main assessment steps

1. Preliminary site investigation

The site and surrounds were visited to determine relevant information for a noise assessment including:

- the physical relationship between the industrial site and the residential area
- the nature of the acoustic environment at the residential area, including the amount of traffic noise, and the number of acoustic monitoring locations that may be needed to characterise the noise environment
- information to assist in determining the residential receiver category (*Noise Policy for Industry*, Section 2.4, Table 2.3) including general observations of the noise environment and its dominant sources (for example, transportation, industry, or natural sources).

2. Determine existing noise levels

Acoustic monitoring instrumentation was deployed at a single location, deemed representative of the residential area, for a full week. During deployment of the monitoring instrument the acoustician undertaking the assessment noted that road traffic noise was the only audible source of noise at the monitoring location.

The main information required at this stage of the assessment is the rating background noise levels and the level of road traffic noise for the daytime and evening period. However, the existing industrial noise levels may be needed if the default amenity trigger levels cannot be met. Therefore, to avoid any duplication, the instrument was programmed to record all relevant acoustic parameters, including sample audio data.

The monitoring location was also visited by the acoustic practitioner several times during the monitoring period to make observations about the acoustic environment, including the general noise sources that are audible, and to confirm that road traffic noise is the dominant source of noise.

The rating background noise levels and $L_{Aeq,traffic}$ for the daytime and evening period were determined as follows.

Table E2.1: Rating background noise levels (RBLs) and $L_{Aeq,traffic}$ levels.

Period	RBL, dB(A)	$L_{Aeq,traffic}$, dB(A)
Daytime	62	71
Evening	60	68

3. Determine residential receiver category

The residential area is zoned R4 High Density Residential. The noise in the area is dominated by traffic noise, due to main roads, for the day and evening periods. The land zoning, the subjective assessment of the acoustic environment in the area, and the acquired background noise levels would support an urban residential land-use category with reference to Table 2.3 in the *Noise Policy for Industry*. However, for the purposes of deriving the project amenity trigger level, the acoustician confirmed, through attended and unattended monitoring, that:

- traffic noise is the dominant source of noise at the receiver location
- the existing traffic noise level is 10 dB(A) or more above the ANL for the area
- it is highly unlikely that traffic noise will reduce over time.

Therefore the high traffic noise provisions in the *Noise Policy for Industry,* Section 2.4.1 were adopted to derive the project amenity trigger levels.

4. Determine project noise trigger levels

The amenity and intrusiveness noise levels were determined as shown in Table E2.2.

Table E2.2: Project noise trigger levels.

Period	Intrusiveness noise level[1]	High traffic project amenity noise level[2]
Daytime	67 dB $L_{Aeq,15\ min}$ (62 + 5)	59 $L_{Aeq,15min}$ (71 – 15 + 3)
Evening	65 dB $L_{Aeq,15\ min}$ (60 + 5)	56 $L_{Aeq,15min}$ (68 – 15 + 3)

Notes:

1. Intrusiveness noise level is $L_{Aeq,15\ min} \leq$ RBL + 5 (Section 2.1).

2. High traffic project amenity noise level is existing traffic levels minus 15 dB(A) plus 3 dB(A) to convert from a period level to a 15-minute level.

The project noise trigger level is the lower (that is, the more stringent) value of the intrusiveness and amenity noise levels. Therefore the project noise trigger levels are as follows:

- daytime: $L_{Aeq,15min}$ 59 dB(A)

- evening: $L_{Aeq,15min}$ 56 dB(A).

5. Predict/measure level of noise and determine impact

The proponent chose to adopt the noise-enhancing meteorological conditions outlined in Fact Sheet D of the *Noise Policy for Industry* without an assessment of how often these conditions occur.

Period	Meteorological conditions
All assessment periods	Daytime/evening: stability categories A–D with light winds up to 3 m/s. Night-time: stability categories A–D with light winds up to 3 m/s and stability category F with light winds up to 2 m/s.

Note: m/s = metres per second.

Noise modelling was undertaken for the project. Relevant details provided in the assessment included all matters outlined in Section 3 of the *Noise Policy for Industry*.

The following noise levels were predicted for the day and evening periods:

- daytime: $L_{Aeq,15min}$ 53 dB(A)
- evening: $L_{Aeq,15min}$ 53 dB(A).

Based on an analysis of the predicted noise levels and previous monitoring undertaken near similar facilities, it was determined that no correction factors for annoying noise characteristics were applicable.

The predicted noise levels satisfy the project noise trigger level by 6 dB(A) for the daytime and 3 dB(A) for the evening period. On that basis, unacceptable noise impacts are not expected.

6. Monitor performance

Suitable noise level limits were placed in the consent/environment protection licence based on achieving the project noise trigger level under the noise-enhancing conditions used in the assessment, as these were demonstrated to be achievable. Noise limits required to be met under very noise-enhancing conditions were applied based on the limits for noise-enhancing conditions plus 5 dB.

E3 Extractive industry proposed for quiet rural area (significance of meteorological assessment)

This case study aims to highlight the assessment of an extractive industry in a quiet rural location with consideration of the significance of noise-enhancing meteorology.

Situation: New major extractive industry proposed near isolated rural residential locations

A major extractive industry is proposed in a quiet rural location with isolated rural residential locations potentially affected by noise from the development. The noise impact of the proposed development needs to be assessed. The development is proposed to operate 24 hours a day, seven days per week.

Main assessment steps

1. Preliminary site investigation

The site and surrounds were visited to determine relevant information for a noise assessment including:

- the physical relationship between the industrial site and the residential area
- the nature of the acoustic environment at the residential area, including the amount of traffic noise, and the number of acoustic monitoring locations that may be needed to characterise the noise environment
- information to assist in determining the residential receiver category (*Noise Policy for Industry*, Section 2.4, Table 2.3) including general observations of the noise environment and its dominant sources (such as transportation, industry, or natural sources).

2. Determine existing noise levels

Acoustic monitoring instrumentation was deployed at a single location, deemed representative of the isolated residential locations, for a full week.

The main information required at this stage of the assessment is the rating background noise levels. However, the existing industrial noise levels may be needed if the project amenity noise trigger levels cannot be met. Therefore, to avoid any duplication, the instrument was programmed to record all relevant acoustic parameters, including sample audio data.

The monitoring location was also visited by the acoustic practitioner several times during the monitoring period to make observations about the acoustic environment.

The rating background noise levels for the daytime, evening and night period were determined as shown in Table E3.1.

Table E3.1: Rating background noise levels.

Period	RBL, dB(A)
Daytime	35[1] (Actual 27)
Evening	30[1] (Actual 26)
Night-time	30[1] (Actual 25)

Note: RBL = rating background noise level.

1. Actual RBLs are below assumed policy minimums; therefore adopt assumed minimums.

3. Determine residential receiver category

The residential area is zoned RU1 Primary Production. The noise in the area is dominated by natural sounds. The land zoning, the subjective assessment of the acoustic environment in the area, and the acquired background noise levels would support a rural residential land-use category with reference to Table 2.3 in the *Noise Policy for Industry.*

4. Determine project noise trigger levels

The amenity and intrusiveness noise levels were determined as follows.

Table E3.2: Project noise trigger levels.

Period	Intrusiveness noise level[1]	Project amenity noise level[2]
Daytime	40 dB $L_{Aeq,15min}$ (35 + 5)	48 $L_{Aeq,15min}$ (50 – 5 + 3)
Evening	35 dB $L_{Aeq,15min}$ (30 + 5)	43 $L_{Aeq,15min}$ (45 – 5 + 3)
Night-time	35 dB $L_{Aeq,15min}$ (30 + 5)	38 $L_{Aeq,15min}$ (40 – 5 + 3)

Notes:

1. Intrusiveness noise level is $L_{Aeq,15\ min} \leq$ RBL + 5 (section 2.1).

2. Project amenity noise level is Rural ANL minus 5 dB(A) plus 3 dB(A) to convert from a period level to a 15-minute level.

The project noise trigger level is the lower (that is, the most stringent) value of the intrusiveness and amenity noise levels. Therefore the project noise trigger levels are as follows:

- daytime: $L_{Aeq,15min}$ 40 dB(A)
- evening: $L_{Aeq,15min}$ 35 dB(A)
- night-time: $L_{Aeq,15min}$ 35 dB(A).

5. Predict/measure level of noise and determine impact

The proponent elected to determine the percentage occurrence of noise-enhancing meteorological conditions in accordance with the policy. It was determined that F and G class stability category occurred for more than 30% of winter nights and was therefore determined to be a significant feature of the area. Light source-to-receiver winds up to 3 m/s were also identified as a significant feature of the area for all assessment periods. Therefore the noise-enhancing meteorological conditions outlined below were adopted for impact assessment purposes.

Period	Meteorological conditions
All assessment periods	Daytime/evening: stability categories A–D with light winds (0.5–3 m/s). Night-time: stability categories A–D with light winds (0.5–3 m/s) and stability category F with light winds up to 2 m/s.

Note: m/s = metres per second.

Noise modelling was undertaken for the project. Relevant details provided in the assessment included all matters outlined in Section 3 of the *Noise Policy for Industry.*

The following noise levels were predicted for the day, evening and night-time periods at the nearest most-affected receiver:

- daytime: $L_{Aeq,15min}$ 38 dB(A)
- evening: $L_{Aeq,15min}$ 38 dB(A)
- night-time: $L_{Aeq,15min}$ 40 dB(A).

Based on an analysis of the predicted noise levels and previous monitoring undertaken near similar facilities, it was determined that no correction factors for annoying noise characteristics were applicable, however, careful design of the coal handling preparation plant would be required to control possible low-frequency emissions.

The predicted noise levels satisfy the project noise trigger level by 2 dB(A) for the daytime and exceed the project noise trigger level for the evening and night by 3 and 5 dB, respectively. On that basis, noise mitigation measures need to be considered to seek to achieve the project noise trigger level.

The proponent correctly started by identifying the mitigation measures that would be needed to satisfy the project noise trigger level, and they consisted of:

- fully enclosing the coal handling preparation plant
- partially enclosing the rail load-out facility
- selecting noise-mitigated haul trucks.

The measures were subsequently analysed in terms of whether they were both feasible and reasonable. The analysis indicated that full enclosure of the coal handling preparation plant

was not feasible due to access requirements; however, a partial enclosure, and the partial enclosure of the load-out facility and noise-mitigated haul trucks were both feasible and reasonable.

With these measures adopted, noise from the facility was predicted at the nearest most-affected receiver as:

- daytime: $L_{Aeq,15min}$ 35 dB(A)
- evening: $L_{Aeq,15min}$ 35 dB(A)
- night-time: $L_{Aeq,15min}$ 36 dB(A).

The proponent supplied sufficient information to enable the decision maker to conclude that the mitigated noise levels represented the best achievable outcome. The 1 dB residual noise level was deemed to represent a negligible impact and was adopted as an acceptable performance benchmark for the facility in the consent and environment protection licence.

6. Monitor performance

Suitable noise level limits were placed in the consent/environment protection licence based on achieving the project noise trigger level under the noise-enhancing conditions used in the assessment, as these were demonstrated to be achievable. Noise limits required to be met under very noise-enhancing conditions were applied based on the limits for noise-enhancing conditions plus 5 dB.

The conditions included requirements to apply corrections for annoying characteristics in accordance with Fact Sheet C of the policy.

E4 Existing intensive primary industry

This case study outlines the assessment of an existing intensive primary industry in a quiet rural/suburban environment that has been the subject of noise complaint.

Situation: Both existing and proposed residential developments are located close to an existing intensive poultry facility that has been in operation for a considerable time. Ruralville Shire Council is both the consent and regulatory authority for the premises.

An intensive poultry farm operating under a development consent has been the subject of noise complaints relating to on-site vehicle movements associated with night-time bird collection activities. Birds are picked up at night because of animal welfare reasons as they are calmer. Night-time collection of birds is an essential component of the business and is standard industry practice. The facility has been in operation for many years, employs three people and has an estimated value of $1.3 million at the farm gate. It is complying with the conditions of the development consent, however, the consent did not include objective noise performance requirements. The council suspects the operation may not be applying all practicable means as may be necessary to prevent, control or minimise noise pollution and has issued a Prevention Notice pursuant to s.96 of the *Protection of the Environment Operations Act 1997* requiring the proponent to undertake a noise impact assessment against the *Noise Policy for Industry*.

Where the assessment identifies the need to consider noise mitigation, strategies to limit noise impacts will be determined following consultation between regulators and farm operators to achieve reasonable and feasible reductions in noise impacts on nearby sensitive receptors.

Main assessment steps

1. Preliminary site investigation

An acoustical practitioner was commissioned to undertake the noise impact assessment. A visit to the site and surrounds was undertaken to determine relevant information for the noise assessment including:

- the physical relationship between the site and surrounding residential land uses
- the nature of the acoustical environment at the residential area, including the number of monitoring locations that may be needed to characterise the noise environment
- information to assist in determining the residential receiver category (*Noise Policy for Industry*, Section 2.4, Table 2.3), including general observations of the noise environment and its dominant sources (such as transportation, industry, or natural sources).

2. Determine existing noise levels

Noise logging instruments were deployed at two locations. Monitoring location 1 was to the west of the site, where land-use patterns are typically sparse with isolated dwellings. The second monitor was located to the east where land-use patterns included large-lot residential subdivisions with typically denser residential land-use patterns closer to sub-arterial roads servicing the area.

The main information required at this stage of the assessment is the rating background noise levels. However, the existing industrial noise levels may be needed if the project amenity trigger levels cannot be met. Therefore, to avoid any duplication, the instrument was programmed to record all relevant acoustic parameters, including audio data for later analysis, if necessary.

The monitoring locations were also visited by the acoustic practitioner several times during the monitoring period, to make observations about the acoustic environment.

The rating background noise levels for the daytime, evening and night period were determined as shown in Table E4.1.

Table E4.1: Rating background noise levels.

Period	**RBL, dB(A)**	
	Location 1 (west)	Location 2 (east)
Daytime	35[1] (Actual 33)	37
Evening	33 (Actual 33)	35
Night-time	30[1] (Actual 29)	32

Note: RBL = rating background noise level.

1. Actual RBLs are below assumed policy minimums; therefore adopt assumed minimums.

The acoustical practitioner noted that there were no other sources of industrial noise in the adjoining residential areas.

3. Determine residential receiver category

The residential area to the west is zoned RU1 Primary Production. The noise in the area is dominated by natural sounds with some distant traffic noise. The residential area to the east is zoned R5 Large Lot residential, consistent with a recent re-zoning by Council. The eastern residential area has slightly higher traffic noise levels.

Based on the land-use zoning and the existing background noise levels, residences to the west have been classified as rural/residential noise amenity area, and residences to the east

have been classified as suburban/residential noise amenity area with reference to Table 2.3 in the *Noise Policy for Industry.*

4. Determine project noise trigger levels

The amenity and intrusiveness noise levels were determined as follows.

Table E4.2: Project noise trigger levels.

Period	Intrusiveness noise level[1]	Project amenity noise level[2]
Location 1 – residences to the west of the site		
Daytime	**40 dB $L_{Aeq,15min}$ (35 + 5)**	48 $L_{Aeq,15min}$ (50 – 5 + 3)
Evening	**38 dB $L_{Aeq,15min}$ (33 + 5)**	43 $L_{Aeq,15min}$ (45 – 5 + 3)
Night-time	**35 dB $L_{Aeq,15min}$ (30 + 5)**	38 $L_{Aeq,15min}$ (40 – 5 + 3)
Location 2 – residences to the east of the site		
Daytime	**42 dB $L_{Aeq,15min}$ (37 + 5)**	53 $L_{Aeq,15min}$ (55 – 5 + 3)
Evening	**40 dB $L_{Aeq,15min}$ (35 + 5)**	43 $L_{Aeq,15min}$ (45 – 5 + 3)
Night-time	**37 dB $L_{Aeq,15min}$ (32 + 5)**	38 $L_{Aeq,15min}$ (40 – 5 + 3)

Notes:

1. Intrusiveness noise level is $L_{Aeq,15\ min} \leq$ RBL + 5 (section 2.1).
2. Project amenity noise level is Rural ANL minus 5 dB(A) plus 3 dB(A) to convert from a period level to a 15-minute level.

The project noise trigger level is the lower (that is, the most stringent) value of the intrusiveness and project amenity noise levels. The relevant project noise trigger levels are bolded in Table E4.2.

In addition to an assessment against the above project noise trigger levels, maximum noise levels (L_{Amax}) also need to be determined for the night-time period and assessed against the maximum noise level event assessment trigger levels in Section 2.5 of the *Noise Policy for Industry*. Where one or both trigger levels are exceeded, a detailed maximum noise level event assessment is required. The trigger levels are as follows:

- $L_{Aeq,15min}$ 40 dB(A) or the prevailing RBL plus 5 dB, whichever is the greater, and/or
- L_{AFmax} 52 dB(A) or the prevailing RBL plus 15 dB, whichever is the greater.

5. Predict/measure level of noise and determine impact

The proponent elected to determine the percentage occurrence of noise-enhancing meteorological conditions in accordance with the policy. It was determined that F class stability category occurred for more than 30% of winter nights and was therefore determined to be a significant feature of the area. Light source-to-receiver winds up to 3 m/s were also identified as a significant feature of the area. Therefore the noise-enhancing meteorological conditions outlined below were adopted for impact assessment purposes.

Period	Meteorological conditions
All assessment periods	Daytime/evening: stability categories A–D with light winds up to 3 m/s. Night-time: stability categories A-D with light winds up to 3 m/s and stability category F with winds up to 2 m/s.

Note: m/s = metres per second.

Noise modelling was undertaken for the project. Relevant details provided in the assessment included all matters outlined in Section 3 of the *Noise Policy for Industry.*

In consultation with the proponent, the acoustic consultant determined that there were two operating scenarios that needed to be considered in the assessment:

1. **standard operations:** general operation of the premises without bird collection activities
2. **collection operations:** general operational noise sources plus activities associated with bird collection. For animal welfare and biosecurity reasons collection must occur during night hours.

The noise levels in Table E4.3 were predicted for the day, evening and night-time periods at the reasonably worst-affected residential locations for both operating scenarios. The prediction model was calibrated with noise levels of existing operations at a calibration point approximately 200 metres to the west of the premises.

Table E4.3: Project noise trigger levels.

Period	Predicted noise levels, dB(A) (Standard operations)		Predicted noise levels, dB(A) (Collection operations)	
	$L_{Aeq,15min}$	L_{Amax}	$L_{Aeq,15min}$	L_{Amax}
Location 1				
Daytime	36	*	-	*
Evening	36	*	**42**	*
Night-time	**38**	< 45	**42**	**50**
Location 2				
Daytime	38	*	-	*
Evening	38	*	**44**	*
Night-time	**39**	< 45	**44**	**54**

Notes: Bird collection occurs in the evening and night-time period only for animal welfare and biosecurity reasons. *Maximum noise levels assessed for night-time period only.

Based on an analysis of the predicted noise levels and previous monitoring undertaken near similar facilities, it was determined that no correction factors for annoying noise characteristics were applicable.

The predicted noise levels were observed to exceed the project noise trigger levels as follows:

- **Standard operations**: The project noise trigger levels are predicted to be marginally exceeded for assessment location 1 and negligibly exceeded for assessment location 2 for the night-time period only. The noise source causing the assessment noise levels to be exceeded was identified as the fans/blowers providing ventilation to the chicken sheds. A maximum noise level event assessment is not required as the predicted levels are below the maximum noise level event trigger levels in Section 2.5 of the *Noise Policy for Industry*.

- **Collection operations**: The project noise trigger levels are predicted to be significantly exceeded for the night-time period for both assessment locations. The noise source causing the assessment noise levels to be exceeded was identified as collections trucks on the access road on the site and forklifts involved with bird loading operations. A maximum noise level event assessment is required for collection operations as the predicted levels are above the maximum noise level event trigger levels in Section 2.5 of the *Noise Policy for Industry*.

6. Mitigation analysis

To explore how to reduce the level of noise, the proponent needed to investigate different mitigation strategies. It is up to the proponent to explore and justify which of the mitigation strategies would be the most effective, and to negotiate an acceptable compromise with regulators that is fair, reasonable and achievable. An example of a mitigation analysis follows.

- Compliance with all criteria could be achieved for standard operations by fitting speed controllers to blowers and fans and adjusting their operation at night. This mitigation measure was determined to be feasible and reasonable and would not compromise the welfare of the birds.
- The proposed controls to the blowers and fans was determined to have a negligible effect on collection operation noise levels, as the principal noise sources during these operations were mobile plant operating on the site.
- An assessment of the potential for bird collection during daytime hours was made to achieve full compliance, however, animal welfare issues mandate the need for collection during night hours to avoid bird clumping and death.
- The detailed maximum noise level event assessment identified that maximum noise level events during bird collection activities were within the range of other non-premises-related maximum noise level events in the area.
- Council considered imposing a collection curfew of 10 pm, however, the proponent demonstrated that collections started after sunset, were part of a coordinated collection from several farms, and that collections were timed and scheduled to reduce biosecurity risks. Collections also needed to consider mandatory lairage (collection to processing) time limits based on animal welfare codes of practice.
- Council required the proponent to prepare a noise management plan that outlined all practical measures that could be applied to bird collection operations, including an achievable curfew.
- The noise management plan identified that minor noise reduction could be achieved through driver training, revised loading practices, access road-surface upgrades, forward drive in/out arrangements to reduce reversing beeper noise, and the erection of localised noise barriers adjacent to the collection forecourt. A voluntary collection curfew of 3 am was included in the noise management plan as an achievable practice. The noise management plan included seven days prior notification to surrounding residents of collection nights.
- The Council agreed to implement and formalise the noise management plan provisions through a prevention notice, which included a requirement to monitor and report the noise levels experienced at the nearest affected residents for the first three collection operations to determine the effectiveness of the noise management plan and whether other opportunities to reduce noise impacts could be developed.
- The noise management plan (or more simply, the adopted procedures to minimise night-time noise), was a simple and practical ‘how-to document’ that reflected the size of the operation, drawn largely from the Department of Primary Industry’s *Best Practice Management for Meat Chicken Production in NSW, Manuals 1 & 2* (NSW Government, 2012) and the mitigation measures outlined in the *Noise Policy for Industry*.

- Further, the Council's strategic planning area is investigating the feasibility of including notifications on EP&A Act, Section 149 certificates and planning controls for rezoned residential land that may encroach on existing primary industry operations, advising that night-time noise operations may periodically impact night-time amenity of the area.
- As a result of implementing these mitigation strategies, the current noise complaints have reduced. The council will take into account the noise management plan when reviewing future noise complaints. This noise management plan reflects the needs of the enterprise and the best achievable noise levels from well-managed bird collection activities. Implementing these noise mitigation strategies has allowed the poultry enterprise to continue to conduct night-time pickups with the least possible impact on surrounding residences.

E5 Modifications to existing industrial premises co-located with existing urban residential land uses

This case study outlines the assessment of an existing industrial premises that is proposing the introduction of a new, fixed-plant process to augment existing operations.

Situation: The industrial facility is a 24/7 operation located in an industrial zone, however, urban residential land uses are located opposite the site on Industry Road, a four-lane road with heavy traffic during the day, but light and intermittent traffic at night. The facility and residential development have co-existed since the 1950s. The facility is proposing the installation of a heat exchanger facility to use hot exhaust furnace gases to pre-heat boiler water used to produce process steam at the facility. The installation of the heat exchanger plant will require development consent.

The facility has been in operation for many years and is complying with the conditions of the development consent, however, the consent requirements are old and do not include objective noise performance requirements. The premises are subject to an environment protection licence issued by the EPA, which includes noise limits that were set following a pollution reduction program. The noise limits are based on what was achievable through the application of feasible and reasonable mitigation. The consent authority has required a noise impact assessment in accordance with the *Noise Policy for Industry* (NSW EPA, 2017).

Main assessment steps

1. Preliminary site investigation

An acoustical practitioner was commissioned to undertake the noise impact assessment. A review of existing statutory instruments (development consent and environment protection licence) and a visit to the site was undertaken to determine relevant information for the noise assessment including:

- the physical relationship between the site and surrounding residential land uses
- the on-site location of the proposed new plant
- the noise requirements contained in the statutory instruments and any relevant compliance assessment reports
- whether noise monitoring needs to be undertaken as part of the noise impact assessment.

2. Existing noise requirements in statutory instruments

The environment protection licence for the premises includes noise limits that were established through a pollution reduction program. The noise limits are based on current operations, and operations in the future following the implementation of noise mitigation works, on an agreed schedule. The works and implementation time frames were agreed through the pollution reduction program.

The premises noise limits are outlined in Table E5.1.

Table E5.1: Existing environment protection licence noise limits.

Location	$L_{Aeq,15min}$ dB(A)		
	Day	Evening	Night
Any residence on Industry Road before 30 June 2017	65	55	50
Any residence on Industry Road after 1 July 2017	61	51	46

3. Relevant project noise trigger levels

The acoustical consultant correctly identified that provisions exist in the *Noise Policy for Industry* to establish project noise trigger levels that relate to a discrete process proposed to be introduced to existing premises under certain circumstances:

> 'Where a development proposal involves a discrete process and premises-wide mitigation, has or is to be considered outside of the development proposal, a project noise trigger level for noise from new/modified components (not the whole site) of the operation may be set at 10 dB(A) or more below existing site noise levels or requirements. This approach means that the increase in noise from the whole site is minimised and provides scope for existing components to achieve noise reductions over time.' *(Noise Policy for Industry, Section 6.1; EPA, 2017)*

Based on these provisions, the acoustical consultant proposed the project noise trigger levels in Table E5.2, which are based on levels 10 dB lower than the premises noise limits applicable after 1 July 2017.

Table E5.2: Project noise trigger levels.

Location	$L_{Aeq,15min}$ dB(A)[1]		
	Day	Evening	Night
Any residence on Industry Road	51	41	36

Note: [1]The project noise trigger levels relate only to contribution noise from the heat exchanger facility.

4. Predict/measure level of noise and determine impact

Noise modelling was undertaken for the project. Relevant details provided in the assessment included all matters outlined in Section 3 of the *Noise Policy for Industry*.

The noise levels were predicted for the day, evening and night-time periods at the reasonably worst-affected residential location for the residences opposite the site on Industry Road. The predicted noise levels are outlined in Table E5.3.

Table E5.3: Predicted contribution noise levels from the heat exchanger facility.

Location	$L_{Aeq,15min}$ dB(A)		
	Day	Evening	Night
Any residence on Industry Road	35	35	35

The predicted noise levels were observed to satisfy the project noise trigger levels for all assessment periods.

The acoustic consultant identified that the premises noise limits (Table E5.1) did not include maximum noise level event requirements. For assessment purposes the acoustic consultant performed an assessment of maximum noise levels from the heat exchanger (pressure relief valves) against the ‘base’ limit in the *Noise Policy for Industry* of L_{AFmax} 52 dB(A).

Predicted noise levels of the pressure release valves, when assessed to the reasonably worst-affected residential location on Industry Road, was L_{AFmax} 61 dB(A). The proponent committed to reorientating the pressure relief valve points to the shielded side of the heat exchanger and applying silencers to effectively reduce maximum noise levels from the unit to below L_{AFmax} 52 dB(A).

5. Monitoring performance

Suitable conditions were placed in the consent/environment protection licence based on achieving the project noise trigger level for the heat exchanger.

Fact Sheet F: Feasible and reasonable mitigation

'Feasible' and 'reasonable' mitigation is defined as follows.

A **feasible** mitigation measure is a noise mitigation measure that can be engineered and is practical to build and/or implement, given project constraints such as safety, maintenance and reliability requirements. It may also include options such as amending operational practices (for example, changing a noisy operation to a less-sensitive period or location) to achieve noise reduction.

Selecting **reasonable** measures from those that are feasible involves judging whether the overall noise benefits outweigh the overall adverse social, economic and environmental effects, including the cost of the mitigation measure. To make such a judgement, consider the following:

- Noise impacts:
    - existing and future levels, and projected changes in noise levels
    - level of amenity before the development, for example, the number of people affected or annoyed
    - the amount by which the triggers are exceeded.
- Noise mitigation benefits:
    - the amount of noise reduction expected, including the cumulative effectiveness of proposed mitigation measures, for example, a noise wall/mound should be able to reduce noise levels by at least 5 decibels
    - the number of people protected.
- Cost effectiveness of noise mitigation:
    - the total cost of mitigation measures
    - noise mitigation costs compared with total project costs, taking into account capital and maintenance costs
    - ongoing operational and maintenance cost borne by the community, for example, running air conditioners or mechanical ventilation.
- Community views:
    - engage with affected land users when deciding about aesthetic and other impacts of noise mitigation measures
    - determine the views of all affected land users, not just those making representations, through early community consultation
    - consider noise mitigation measures that have majority support from the affected community.

Take into account the above considerations when determining the mitigation measures proposed to be incorporated into the development. In practice, the detail of the mitigation measures applied will largely depend on project-specific factors. These are the measures that minimise, as far as practicable, the local impacts of the project. Project approval conditions that flow from this process should be achievable. They need to provide clarity and confidence for the proponent, local community, regulators and the ultimate operator that the proposed mitigation measures can achieve the predicted level of environmental protection.