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Plan Topics

Noise Management in Mixed-Use Urban Environments

Noise management in mixed-use urban environments

Noise is an environmental effect that has the potential to cause adverse effects, annoyance and affect health. It is often identified as a nuisance in the local environment and is a frequent cause of complaints, often related to reverse sensitivity and conflict between incompatible activities.

This guidance note contains advice on noise management in mixed-use urban areas. It emphasises that a balance needs to be achieved between providing for legitimate commercial activities while controlling potential adverse noise effects to reasonable levels.

Guidance note

Effects of Noise in Mixed-Use Environments

Noise management in mixed-use urban environments: the context

'Mixed-use' urban environments often contain both commercial premises (entertainment, retail, office, hospitality or light manufacturing) and residential uses such as apartments.

As with many countries overseas, urban population densities are increasing. At the same time many commercial activities now want to operate both during the day and at night. Commercial operations may enhance the vitality and culture of urban areas, but they can also create noise problems. These can include sounds from fixed plant and equipment, mobile vehicles and machinery, or worn out (or poorly maintained) equipment such as fans and pumps.

Outdoor activities and noise from car parks can also have significant adverse effects on those living nearby. In some cases the applicable district plan noise limits are not being met by existing activities.

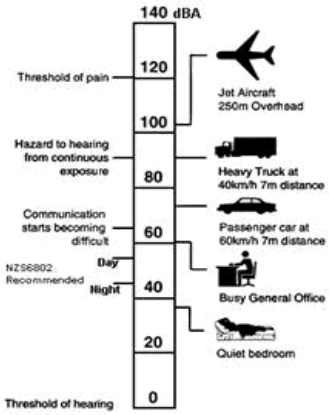
The key parties involved in the generation and management of noise are:

- those whose activities or property generate the noise
- those who are or may be affected by noise
- local authorities.

This guidance note focuses on the obligations to control noise emissions at or near the source, as well as the need for local authorities to adopt sound land use planning practices to monitor and manage noise in mixed-use urban environments. While not addressed in this note, there are also wider planning matters relating to compatible land use planning that are relevant for the management of noise.

What is noise?

Noise is defined as 'unwanted' sound. Humans are very sensitive to sound and can hear sounds that vary in acoustic energy from the whining of a mosquito's wings to the racket of a jackhammer. Sound levels vary so greatly in magnitude that it is impractical to describe their sound pressures in familiar linear units. Sound pressures are therefore measured on a logarithmic 'decibel' (dB) scale. A 'weighting' of the sound level is widely used in measurements of environmental sound to ensure electronic instruments match the sensitivity of the human ear across the audible spectrum. Hence the notation 'dBA '.



Text description of figure
If the dBA scale is applied to everyday activities then 0 dBA would be so quiet that the human ear would have problems detecting any noise. A quiet bedroom by contrast would generally have a noise level of a little under 40 dBA and a busy office 60 dBA. At around 65 dBA verbal communication starts to become difficult. A heavy truck travelling along a road close to where the noise is being measured may produce 90 dBA, a level of noise that may present a hazard to hearing if people are continuously exposed to it. Older style, or large jet aircraft may produce more than 100 dBA, while 120 dBA represents the threshold of pain.

Noise from land use activities is measured and assessed for its potential impact using the measurement units Lmax, L10, L90, and Leq,T (all expressed in dBA values). These units are defined in NZS 6801: 2008 Acoustics - Measurement of environmental sound.

Maximum permissible noise levels are specified in terms of the L10 criteria in most district plans and in the 1991 New Zealand Standards (NZS) dealing with noise (eg NZS 6802: 2008 Acoustics - Environmental noise). The L10 unit is used as it is seen as a good predictor of human annoyance at sounds in the environment. However, in New Zealand there has recently been a move to specify environmental sound using the Leq,T unit (which is more aligned with international practice).

In addition, Lmax limits are applied during night-time in residential areas to control loud single events that can interrupt sleep. While noise limits may vary slightly among the towns and cities of New Zealand, these types of noise rules are widely adopted and represent current practice.

How is noise measured?

The units used in New Zealand for measuring and assessing sounds in the environment are set out in NZS 6801: 2008 Acoustics - Measurement of environmental sound. In summary, these units are:

Lmax The single highest sampled level of sound. Used in night-time emission limits as a means of ensuring sleep protection. Short duration, high-level sounds such as audible warning devices, pressure relief valves have a significant effect on Lmax values.

L10 or L_{10} The level of sound exceeded for no more than 10% of the monitoring period. This level of sound therefore equates to an average maximum sound and is used widely in emission limits as the L10 correlates well with the subjective reaction to sound

L90 or L_{90} The level of sound exceeded for 90% of the monitoring period. This level of sound can be used to define the **background sound level**, and is influenced by constant sources such as industrial equipment and constant background city sounds, eg from air handling equipment. Noise emission limits are not generally specified in terms of an L90 level.

Leq,T or $L_{eq,T}$ The time-averaged sound level (or equivalent sound level) over the measurement period, T, that has the same mean square sound pressure level as the time-varying sound level under consideration. Commonly referred to as an 'energy average' measure of sound exposure.

All the above units are measured using 'dBA' values.

How does noise affect people?

Noise can be thought of as unwanted sound and can vary greatly in volume. The definition of noise in the RMA includes vibration, which in most cases is associated with high levels of noise. In environmental assessments, it is usually the noise effects that are of most concern. However, specific vibration effects can arise from some types of commercial activities and these may require specialist investigation which is outside the scope of this guidance note.

The effects of environmental noise are usually expressed in terms of:

- annoyance
- speech interference - high levels of noise can make normal speech difficult to hear
- performance - some noises can make concentration difficult and interfere with tasks such as learning, checking fine details (such as any job with a large mathematical component or where the meaning of words is critical) or work where small, precise, movements or intense concentration is required
- mental health (including noise-induced stress-related effects)
- sleep disturbance - in addition to fatigue and mental health effects, disrupted sleep patterns can leave people irritable, change their behaviour, and reduce their ability to work or perform tasks.

Managing noise in mixed-use urban environments

Under s31, territorial authorities have the primary responsibility for managing the effects of land uses and noise (including the mitigation of noise). Territorial authorities also have responsibility under the RMA to achieve integrated management of the effects of the use, development, or protection of land associated with natural and physical resources. This includes effects on amenity values that may be affected by noise.

As noise is a specific adverse effect identified in the RMA, district plans must include objectives, policies and (generally) rules to manage the effects of noise within their district.

Regional councils have responsibility for the control of noise within the coastal marine area. Noise may be managed in the coastal marine area by objectives, policies and rules in regional coastal plans.

Factors affecting receipt of noise

Noise from commercial premises can be a dominant source for nearby residential and other noise-sensitive activities, especially at night. Natural sounds, traffic sounds, and other non-target sounds are also present in the urban environment. Methods for measuring and assessing the impact of specific nuisance sounds within the context of an urban ambient noise environment are covered by the New Zealand Standards NZS 6801 and NZS 6802. These are available from the Standards New Zealand website.

Difficulties often arise where noise-sensitive land uses (such as residential activities) move into, or close to, established commercial areas or major infrastructural assets such as ports or airports. This is often referred to as 'reverse sensitivity'. Reverse sensitivity describes the effect that development of one kind may have on activities already occurring in an area. It usually results from the people involved in an activity that is newly established, complaining about the effects of existing activities in an area.

One technique for dealing with the issue of reverse sensitivity is to ensure people are fully informed of the existing effects of the environment which they are proposing to move into. For example, the City of Sydney Council in Australia provides suggestions to residents thinking of moving into the inner-city on what to expect and how they can judge for themselves whether they will be able to cope with issues like noise before they take up residence (see What to Expect on the City of Sydney website).

A similar publication is available from the Ministry for the Environment website (see Living in the inner city).

Assessing noise effects in mixed-use urban areas

Different factors should be considered when assessing noise from commercial or trade premises in mixed-use zones. These include:

- **Time of day**: There is less tolerance of noise by residents when it occurs at night. Therefore district plan noise limits are typically lower for night.

- **Level of sound**: Sound levels can range from loud (exceeding the normally occurring or existing background sound level by 10 dBA or more) through to relatively low level with bass or beat components. District plan provisions should allow for some noise to be emitted, but only up to allowable limits measured at the residential location (often around 45-55 dBA).
- **Type of sound**: Some sounds have a special audible character that can cause additional annoyance. For example, some music sounds contain both tonal and beat (impulsive) qualities, both of which attract an assessment penalty under noise assessment procedures set out in the relevant New Zealand Standards. Tones, screeches, and hums are examples of sounds from commercial premises that often require special consideration during the assessment process.
- **Location of premises**: Commercial and industrial areas located close to residential sites will often have more noise issues than those occupying sites well within commercial or industrial zones (further from residential sites). District plan noise provisions usually allow higher levels of noise (day and night) within commercial and industrial zones. Distance, and the placement of barriers between the source of the noise and those receiving are mitigating factors but the ability to use these can be limited in mixed-use environments. Where residential activities locate in established commercial or industrial areas, it is more practical for the new residential use to insulate itself from noise than it is for existing commercial uses to comply with acceptable residential noise levels.
- **Body corporate and private undertakings**: Complaints can arise where noise-sensitive residences are located in the same premises as a noise-making commercial activity. Clauses within leases or body corporate constraints covering noise nuisance often place such complaints beyond the scope of territorial authority action. However, many territorial authorities successfully deal with these matters in the same way as if the parties were located within separate buildings.

Managing noise at source

Generally, the overriding requirement is for control of noise 'at source'. As well as the wider duty under s17 to avoid, remedy or mitigate adverse effects, noise makers need to recognise the general duty to avoid unreasonable noise (s16) by containing as much of the sound as possible. Usually this means considering the following factors to avoid unreasonable noise:

- the building's location, orientation and design
- the specification, selection, and operation of equipment (machinery such as air conditioning units and waste disposal systems) that emit low levels of noise
- managing operations on site so noise activities may be located as far as possible away from boundaries with noise sensitive neighbours, and/or choosing times of the day to operate noise generating equipment when noise is less likely to be an issue
- barriers to control or reduce noise (insulation, bunding and double glazing for example).

Distance as a mitigation measure

For new noise generating activities, control can be achieved by incorporating appropriate buffer distances. New noise generating activities need to consider the distance to the nearest neighbours, traffic routes and other relevant factors when determining the

layout, design and operation of their activities. However, buffer distances are often not practical in inner-city areas where differing land uses tend to be located in close proximity. In such circumstances, measures such as the use of noise barriers or insulation may present a more realistic management method.

Noise barriers

Barriers to mitigate noise may include such features as:

- solid walls or fences to stop or deflect sound
- bunds
- other non-noise sensitive structures
- topography (locating activities in depressions or behind hills for example).

Barriers to control noise emission or to reduce noise received can be effective, but the effects of reflected sound need to be considered within the design and orientation of barriers. Factors such as orientation and materials used in the construction of barriers should be considered. Acoustic consultants can provide detailed guidance to match the specifics of individual sites.

Vegetation is not considered a good sound barrier as it will not block noise emissions unless plantations are very dense. Within inner-city mixed-use environments there are few opportunities to provide planting capable of mitigating noise.

Building design and construction

Commercial activities may attempt to reduce sound emissions through building design and making sure the building is suitable for containing the levels of sound likely to be generated within it. Distance between the noise source and boundaries helps, so premises with larger land areas will be better placed to internalise the noise effects, keeping adverse effects within the site.

Noise control is most effectively achieved on smaller sites by paying particular attention to design before constructing any buildings. The layout of premise the location and orientation of openings, loading bays, doors, windows, and car parks and on-site vehicle circulation patterns are all important for good noise control.

To mitigate noise effects, acoustic weak points (loading bays, doors and windows for example) may be orientated to face away from noise sensitive areas, or provided with measures to reduce noise escaping (for example, using two sets of doors with seals or double glazed windows or glass laminates that reduce noise).

The floor, walls and roof form a building envelope and need to be of a certain minimum mass (kilograms per square metre) to adequately contain high levels of sound. Many lightweight timber-framed structures are not suited to noisy commercial uses as they are only capable of reducing noise by modest amounts.

Improved technology means better control of noise emission through lower sound output from modern mechanical sources (such as compressors, pumps, motors and fans).

Improvements in materials and methods mean sound can be more effectively contained within buildings and purpose-built structures.

Noise and the Building Regulations 1992

The New Zealand Building Code requires all structural and non-structural components of a building that are shared between owners or occupiers (such as walls), shall be constructed to prevent undue noise transmission to the habitable spaces of dwellings contained in the building. Clause G6 of the Building Code specifies the following performance standards:

- the Sound Transmission Class of walls, floors and ceilings, shall be no less than a rating of 55.
- the Impact Insulation Class of floors shall be no less than a rating of 55.

As defined in the Building Code:

- The **Sound Transmission Class (STC)** is a single number rating derived from measured values of transmission loss in accordance with classification "ASTM E413, Determination of Sound Transmission Class". It provides an estimate of the performance of partitions in certain common sound insulation situations. The **Impact Insulation Class (IIC)** is a single number rating derived from measured values of normalised sound pressure impact levels in accordance with "Method ASTM E492, Annex A1. Laboratory Measurement of Impact Sound Transmission Through Floor-Ceiling Assemblies Using the Tapping Machine". It provides an estimate of the 'impact sound ' insulating performance of a floor-ceiling assembly.

The Relationship between the Building Act and Resource Management Act

The Building Act 2004 and Resource Management Act 1991 have differing functions in relation to noise and neither has primacy over the other. Controls in district plans under the RMA relating to noise insulation or control do not override regulations made under the Building Act 2004, Regulations made under the Building Act 2004 also do not restrain local authorities from providing stricter controls in their district plans provided those district plan controls are made for resource management reasons.

Noise management plans

A noise management plan usually contains:

- the identification of the range of potential noise sources
- specific steps that will be taken to ensure compliance with specified noise limits (these may be linked to a resource consent or district plan limits)
- a written undertaking from the author (either an acoustic engineer or noise consultant) that the methods in the noise management plan will be adequate to ensure compliance with the noise limits specified in the conditions
- a programme of noise measurement to check that compliance has been achieved through monitoring and testing.

Noise management plans may be incorporated into a district plan through permitted activity standards associated with particular (usually known) land uses, or the formulation and compliance with noise management plans may be made as a condition on a resource consent. Some district plans actually specify that a noise guidance plan must be prepared to comply with rules.

As with any reference to an external document that is incorporated into a plan by way of a rule, is important that the name of the document, year of publication and the publisher is included in the rule or resource consent (e.g. 'management of noise generating activities on the site shall be in accordance with the Cacophony Acoustic Consultants "Mammoth Mall On-site Noise Management Plan" (2004) version 3)'. The 2005 amendments to the RMA introduced specific requirements as to how external documents are to be incorporated into plans and the availability of those documents for public inspection (see Schedule 1, Part 3, clauses 30-35).

Other RMA options, such as designations for airports, may also refer to noise management plans as a way managing noise.

It is good practice for key stakeholders, such as transport operators, adjoining residents and site users, to be consulted in the preparation of noise management plans to allow a wide range of options to be explored and help assess what is practicable.

Management of noise in the receiving environment

Many district plans now require specific precautions to be taken by the noise receiver to avoid adverse noise effects. Precautions include:

- requiring buffer zones between new noise sensitive activities (such as residential dwellings) and commercial premises
- placing restrictions on dwelling numbers and density in some areas
- requiring acoustic insulation of new buildings, or retrofitting insulation into buildings being converted to residential use
- specifying the types of sound absorbing materials new buildings may constructed from.

Where new noise sensitive activities are locating in mixed-use environments, buffer zones or restricting the location of dwellings may not always be desirable or practicable. Insulation or the use of noise deflecting or absorbing barriers (or a combination of both) between activities may be the best option. Requirements for such insulation or barriers could form either standards for permitted activities or be imposed as conditions on a resource consent.

Providing indoor living spaces in mixed-use areas with a reasonable standard of acoustic protection is emerging as an effective method of addressing reverse sensitivity. To help ensure this is effective, it is useful to specify the standard required for acoustic insulation (for example the materials to be used, or the level of sound reduction to be achieved).

It can be difficult to keep a list of specified materials up-to-date with what is available in the market. Product brand names should be avoided, and plan provisions written in such

a way as to allow for the use of other materials with the same insulation performance (or else the provisions should be periodically reviewed to keep them up-to-date).

Ventilation is an important consideration. Indoor sound targets will not be achieved in rooms with open windows whether they are acoustically insulated or not. Some plans specifically require that acoustic protection be provided when openable windows are used as the main ventilation method. This does not replace any mandatory requirement for ventilation under the Building Code (refer Clause G4), but ensures an alternative source of air is provided for bedrooms with openable windows. The Building Code requires mechanical ventilation for habitable rooms without openable windows. This approach provides a useful balance between allowing for activities which create noise and allowing noise-sensitive activities within a noisy receiving environment.

Setting noise limits in district plans and consent conditions

District plan provisions

Generally, there are two types of noise rules that can be included in plans:

- **noise emission** rules, which apply noise limits at the site from which the noise is being emitted
- **noise immission** rules, which apply (lower) noise limits at sensitive receiving positions.

The specific level of noise controls in district plans is usually set out in detail in **noise rules**. These are usually included in the plan's performance standards for each zone or class of land use. In some cases district-wide noise rules may apply. The definitions section of the plan is often used to clarify the types of noise to which rules apply, and the relevant technical standards and procedures that apply when assessing noise under district plan criteria.

NZS 6802:2008 Acoustics - Environmental noise gives a range of noise levels as a guideline for the reasonable protection of health and amenity for land used for residential purposes. The recommended range of noise limits for residentially zoned sites is:

Day	45-55 dBA Leq
	35-45 dBA Leq
Night	
	70-75 dBA Lmax.

In inner-city areas, night-time noise limits are usually set at 55 to 60 dBA. This exceeds normally acceptable noise limits for residential areas. Planning restrictions for inner-city areas recognise the need to provide for a wide range of activities. Councils often see this as contributing to a vibrant and culturally diverse city centre, while at the same time ensuring a business-friendly environment. Higher permissible noise limits in city centres is a key reason why new residential premises need to be acoustically insulated.

Setting noise limits at the site boundary is often the best way to minimise adverse noise effects on sensitive land use activities. However, it may not be sustainable to set the actual level above residential limits if residential uses are also permitted within the zone.

Setting district plan noise limits higher than the guidelines for areas that are primarily used for residential purposes needs to be accompanied by a parallel requirement for acoustic insulation of all new buildings housing noise-sensitive activities. In the long term, this will lead to a more balanced outcome whereby both noise generators and receivers share the mitigation measures required to allow them to locate in mixed-use areas.

Indoor sound level targets (e.g. World Health Organisation (WHO) sleep protection measures) should be considered when setting both noise limits and acoustic insulation standards. Indoor sound level guideline values set by WHO for bedrooms are 30 dBA Leq for continuous noise and 45 dBA Lmax for single sound events. Standards to reduce noise inside residential dwellings in mixed-use environments could use these as a target.

Some buildings have internal noise limits that apply through conditions on the building lease. District plans and resource consents may sometimes also include noise limits that apply to indoor areas. Setting indoor noise limits is usually a measure of last resort and is typically to protect against sleep disturbance. For rooms other than bedrooms, noise limits may be set to protect against annoyance and speech interference. These levels will typically be higher than for bedrooms.

The critical indoor design criteria will depend on the needs for each individual environment. For example, dwellings, schools and hospitals all have differing indoor design criteria. The advice of a qualified acoustic engineer or noise consultant should be obtained when setting the indoor design criteria for different environments.

Consent conditions

Consent conditions relating to noise should contain clear information about:

- why the noise condition is being imposed
- what types of activities to the noise limits apply to
- how noise is to be measured and assessed (e.g. reference to New Zealand Standards) and any numerical limits and the correct metric standards used
- where noise is to be measured from
- when the noise limits are applicable.

An example of a noise condition (adapted from a Hamilton City Council condition) is provided below:

> Activities at the Residential Centre shall not exceed the following noise levels when measured at any point at or within the boundary of any site in the Residential Zone:
>
> Monday to Saturday
>
> 0600hr-0700hr 45dBA - L10
>
> 0700hr-2000hr 50dBA - L10
>
> 2000hr-2300hr 45dBA - L10
>
> 2300hr-0600hr 40dBA L10 75dBA Lmax

Sunday and public holidays 0700hr-2300hr 45dBA - L10 2300-0700hr 40dBA L10 75dBA Lmax

Noise measurements shall be measured in accordance with NZS 6801: 2008 Acoustics - Measurement of environmental sound and assessed in accordance with NZS 6802: 2008 Acoustics - Environmental noise.

Reason: The increased number of persons and density of occupancy proposed in the application for the residential centre will be likely to cause adverse effects on the amenity values of the local established neighbourhood which has already been subject to change, and could lead to further effects on amenity values. This condition is designed to ensure activities at the residential centre do not further compromise the amenity of the neighborhood in respect to noise by setting limits that are consistent with those levels already found there.

Control of noise

Environmental noise in New Zealand is controlled under the Resource RMA and the Health Act 1956. The Health Act contains nuisance provisions, in particular, ss29-35 of the Health Act deal with nuisances including s29(ka):

'Where any noise or vibration occurs in or is emitted from any building, premises, or land to a degree that is likely to be injurious to health'.

Under the Health Act, nuisances such as noise are the responsibility of local authorities. This provides a potential alternative mandate and enforcement mechanism for the control of noise. Enforcement under the Health Act can extend to prosecution through the district court.

However, most territorial authorities have adopted the RMA as the main method for controlling environmental noise. Noise within the workplace is dealt with by the Occupational Safety and Health (OSH) Service of the Department of Labour.

Best practicable option for avoiding noise emission

Section 16 of the RMA requires all noise makers to adopt the best practicable option to avoid the emission of unreasonable noise.

As defined in s2 of the RMA, best practicable option means 'the best method for preventing or minimising the adverse effects on the environment having regard, among other things, to -

- The nature of the discharge or emission and the sensitivity of the receiving environment to adverse effects; and
- The financial implications, and the effects on the environment, of that option when compared with other options; and
- The current state of technical knowledge and the likelihood that the option can be successfully applied'.

The duty to adopt the best practicable option is in addition to the duty to comply with district plan noise limits. This duty applies to every person, company, legal entity, and the Crown, and includes persons undertaking activities on designated sites. There are no exceptions.

Enforcement tools

The enforcement tools available within the RMA to control adverse noise effects in the environment are:

- abatement notices issued by territorial local authorities subject to s322(1)(c)
- enforcement orders to avoid unreasonable noise or enforce plan rules under ss314-321
- excessive noise direction notices issued by or on behalf of a territorial authority subject to s327.