

A P P E N D I X H

N O I S E A S S E S S M E N T R E P O R T



Noise Background Information

Noise

CHARACTERISTICS OF SOUND

Sound is a pressure wave transmitted through the air. When an object vibrates, it radiates part of its energy as acoustical pressure in the form of a sound wave. Sound can be described in terms of amplitude (loudness), frequency (pitch), or duration (time). The standard unit of measurement of the loudness of sound is the decibel (dB). The human hearing system is not equally sensitive to sound at all frequencies. Sound waves below 16 Hz are not heard at all and are "felt" more as a vibration. Similarly, while people with extremely sensitive hearing can hear sounds as high as 20,000 Hz, most people cannot hear above 15,000 Hz. In all cases, hearing acuity falls off rapidly above about 10,000 Hz and below about 200 Hz. Since the human ear is not equally sensitive to sound at all frequencies, a special frequency-dependent rating scale is usually used to relate noise to human sensitivity. The A-weighted decibel scale (dBA) performs this compensation by discriminating against frequencies in a manner approximating the sensitivity of the human ear.

Because of the physical characteristics of noise transmission and noise perception, the relative loudness of sound does not closely match the actual amounts of sound energy. Table 1, *Change in Sound Pressure Level, dB*, presents the subjective effect of changes in sound pressure levels. Typical human hearing can detect changes of approximately 3 dBA or greater under normal conditions. Changes of 1 to 3 dBA are detectable under quiet, controlled conditions and changes of less than 1 dBA are usually indiscernible. A change of 5 dBA or greater is typically noticeable to most people in an exterior environment and a change of 10 dBA is perceived as a doubling (or halving) of the noise.

Table 1 Change in Sound Pressure Level, dB

Change in Apparent Loudness	
± 3 dB	Threshold of human perceptibility
± 5 dB	Clearly noticeable change in noise level
± 10 dB	Half or twice as loud
± 20 dB	Much quieter or louder

Source: Bies and Hansen, *Engineering Noise Control*, 2009.

POINT AND LINE SOURCES

Noise may be generated from a point source, such as a piece of construction equipment, or from a line source, such as a road containing moving vehicles. Because noise spreads in an ever-widening pattern, the given amount of noise striking an object, such as an eardrum, is reduced with distance from the source. This

is known as "spreading loss." The typical spreading loss for point source noise is 6 dBA per doubling of the distance from the noise source.

A line source of noise, such as vehicles proceeding down a roadway, would also be reduced with distance, but the rate of reduction is affected by both distance and the type of terrain over which the noise passes. Hard sites, such as developed areas with paving, reduce noise at a rate of 3 dBA per doubling of the distance while soft sites, such as undeveloped areas, open space and vegetated areas reduce noise at a rate of 4.5 dBA per doubling of the distance. These represent the extremes and most areas would actually contain a combination of hard and soft elements with the noise reduction placed somewhere in between these two factors. Unfortunately the only way to actually determine the absolute amount of attenuation that an area provides is through field measurement under operating conditions with subsequent noise level measurements conducted at varying distances from a constant noise source.

Objects that block the line of sight attenuate the noise source if the receptor is located within the "shadow" of the blockage (such as behind a sound wall). If a receptor is located behind the wall, but has a view of the source, the wall would do little to reduce the noise. Additionally, a receptor located on the same side of the wall as the noise source may experience an increase in the perceived noise level, as the wall would reflect noise back to the receptor compounding the noise.

NOISE METRICS

Several rating scales (or noise "metrics") exist to analyze adverse effects of noise, including traffic-generated noise, on a community. These scales include the equivalent noise level (L_{eq}), the community noise equivalent level (CNEL) and the day/night noise level (L_{dn}). L_{eq} is a measurement of the sound energy level averaged over a specified time period.

The CNEL noise metric is based on 24 hours of measurement. CNEL differs from L_{eq} in that it applies a time-weighted factor designed to emphasize noise events that occur during the evening and nighttime hours (when quiet time and sleep disturbance is of particular concern). Noise occurring during the daytime period (7:00 AM to 7:00 PM) receives no penalty. Noise produced during the evening time period (7:00 to 10:00 PM) is penalized by 5 dB, while nighttime (10:00 PM to 7:00 AM) noise is penalized by 10 dB. The L_{dn} noise metric is similar to the CNEL metric except that the period from 7:00 to 10:00 PM receives no penalty. Both the CNEL and L_{dn} metrics yield approximately the same 24-hour value (within 1 dB) with the CNEL being the more restrictive (i.e., higher) of the two.

REGULATORY ENVIRONMENT

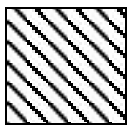
State of California Noise Compatibility Standards

Cities and counties in California are preempted by federal law from controlling noise generated from most mobile sources, including noise generated by vehicles and trucks on the roadway, trains on the railroad, and airplanes. Table 2, *Land Use Compatibility for Community Noise Environments*, presents a land use compatibility chart for community noise adopted by the California Office of Noise Control. This table provides urban planners with a tool to gauge the compatibility of land uses relative to existing and future noise levels generated by mobile sources. Land uses, such as offices and commercial, are "normally acceptable" in

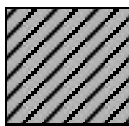
exterior noise environments up to 70 dBA CNEL and "conditionally acceptable" in areas up to 77.5 dBA CNEL.

Table 2 Land Use Compatibility for Community Noise Environments

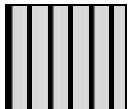
Land Uses	CNEL (dBA)					
	55	60	65	70	75	80
Residential-Low Density Single Family, Duplex, Mobile Homes	Normally Acceptable	Normally Acceptable	Normally Acceptable	Normally Acceptable	Normally Unacceptable	Clearly Unacceptable
Residential- Multiple Family	Normally Acceptable	Normally Acceptable	Normally Acceptable	Normally Unacceptable	Clearly Unacceptable	Clearly Unacceptable
Transient Lodging, Motels, Hotels	Normally Acceptable	Normally Acceptable	Normally Acceptable	Normally Unacceptable	Clearly Unacceptable	Clearly Unacceptable
Schools, Libraries, Churches, Hospitals, Nursing Homes	Normally Acceptable	Normally Acceptable	Normally Acceptable	Normally Unacceptable	Clearly Unacceptable	Clearly Unacceptable
Auditoriums, Concert Halls, Amphitheaters	Conditionally Acceptable	Conditionally Acceptable	Conditionally Acceptable	Conditionally Acceptable	Clearly Unacceptable	Clearly Unacceptable
Sports Arena, Outdoor Spectator Sports	Conditionally Acceptable	Conditionally Acceptable	Conditionally Acceptable	Conditionally Acceptable	Clearly Unacceptable	Clearly Unacceptable
Playgrounds, Neighborhood Parks	Normally Acceptable	Normally Acceptable	Normally Acceptable	Conditionally Acceptable	Clearly Unacceptable	Clearly Unacceptable
Golf Courses, Riding Stables, Water Recreation, Cemeteries	Normally Acceptable	Normally Acceptable	Normally Acceptable	Normally Unacceptable	Clearly Unacceptable	Clearly Unacceptable
Office Buildings, Businesses, Commercial and Professional	Normally Acceptable	Normally Acceptable	Normally Acceptable	Conditionally Acceptable	Normally Unacceptable	Clearly Unacceptable
Industrial, Manufacturing, Utilities, Agricultural	Normally Acceptable	Normally Acceptable	Normally Acceptable	Conditionally Acceptable	Normally Unacceptable	Clearly Unacceptable



Normally Acceptable:
Specified land use is satisfactory based upon the assumption that any buildings involved are of normal conventional construction, without any special noise insulation requirements.



Normally Unacceptable:
New construction or development should generally be discouraged. If new construction does proceed, a detailed analysis of the noise reduction requirements must be made and needed noise insulation features included in the design.



Conditionally Acceptable:
New construction or development should be undertaken only after a detailed analysis of the noise reduction requirements is made and the needed noise insulation features included in the design. Conventional construction, but with closed windows and fresh air supply systems or air conditioning will normally suffice.



Clearly Unacceptable:
New construction or development generally should not be undertaken.

Source: Office of Noise Control, Guidelines for the Preparation and Content of Noise Elements of the General Plan, February 1976. Included in the Governor's Office of Planning and Research, California, General Plan Guidelines, Appendix C, October 2003.

A "conditionally acceptable" designation implies that new construction or development should be undertaken only after a detailed analysis of the noise reduction requirements for each land use type is made and needed noise insulation features are incorporated in the design. By comparison, a "normally acceptable" designation indicates that standard construction can occur with no special noise reduction requirements.

California Building Code

California Building Code, Title 24, Part 2

The State of California establishes exterior sound transmission control standards for new hotels, motels, dormitories, apartment houses, and dwellings other than detached single-family dwellings as set forth in the 2010 California Building Code (Chapter 12, Section 1207.11). Interior noise levels attributable to exterior environmental noise sources shall not exceed 45 dBA L_{dn} in any habitable room. When exterior noise levels (the higher of existing or future) where residential structures are to be located exceed 60 dBA L_{dn} , a report must be submitted with the building plans describing the noise control measures that have been incorporated into the design of the project to meet the noise limit.

2010 California Building Cal Green Code, Title 24, Part 1¹

The Green Building Standards of the State of California Code of Regulations (Title 24, Part 11) establishes mandatory exterior sound transmission control standards for new non-residential buildings as set forth in the 2010 California Green Building Standards Code Sections 5.507.4.1 and 5.507.4.2 Exterior noise transmission as follows²:

5.507.4.1 Exterior noise transmission, prescriptive method. Wall and roof-ceiling assemblies exposed to the noise source making up the building envelope shall meet a composite STC rating of at least 50 or a composite OITC rating of no less than 40, with exterior windows of a minimum STC of 40 or OITC of 30 in the following locations:

1. Within the 65 CNEL noise contour of an airport.
2. Within the 65 CNEL or L_{dn} noise contour of a freeway or expressway, railroad, industrial source or fixed-guideway noise source as determined by the Noise Element of the General Plan.

5.507.4.1.1 Noise exposure where noise contours are not readily available. Buildings exposed to a noise level of 65 dB L_{eq-1hr} during any hour of operation shall have exterior wall and roof-ceiling assemblies exposed to the noise source meeting a composite STC rating of at least 45 (or OITC 35), with exterior windows of a minimum STC of 40 (or OITC 30).

5.507.4.2 Performance method. For buildings located as defined in Sections A5.507.4.1 or A5.507.4.1.1, wall and roof-ceiling assemblies exposed to the noise source making up the building envelope shall be constructed to provide an interior noise environment attributable to exterior sources that does not exceed an hourly equivalent noise level (L_{eq-1Hr}) of 50 dBA in occupied areas during any hour of operation.

¹ Including changes effective July 1, 2012.

² Exception: Buildings with few or no occupants and where occupants are not likely to be affected by exterior noise, as determined by the enforcement authority, such as factories, stadiums, storage, enclosed parking structures and utility buildings.

5.507.4.2.1 Site features. Exterior features such as sound walls or earth berms may be utilized as appropriate to the project to mitigate sound migration to the interior.

5.507.4.2.2 Documentation of compliance. An acoustical analysis documenting complying interior sound levels shall be prepared by personnel approved by the architect or engineer of record.

California Aircraft Noise Standards

Title 21, Subchapter 6 of the California Code of Regulations (Airport Noise Standards) establishes 65 dBA CNEL as the acceptable level of aircraft noise for persons living in the vicinity of airports. Noise-sensitive land uses in locations where the aircraft exterior noise level exceeds 65 dBA CNEL are generally incompatible, unless (1) an aviation easement for aircraft noise has been acquired by the airport proprietor or (2) the residence is a high-rise apartment or condominium that has an interior CNEL of 45 dBA or less in all habitable rooms despite aircraft noise and an air circulation or air conditioning system, as appropriate. Assembly Bill (AB) 2776 requires any person who intends to sell or lease residential properties within an airport influence area to disclose that fact to the person buying the property.

City of Lafayette Noise Standards

City of Lafayette General Plan

The City of Lafayette General Plan Noise Element seeks to protect the health and welfare of the community by promoting development which is compatible with established noise standards. The following Noise Element policies are applicable to the proposed project:

Goal N-1 Ensure that all new development is consistent with the standards for noise.

Policy N-1.2 Reduce Noise Impacts: Avoid or reduce noise impacts first through site planning and project design. Barriers and structural changes may be used as mitigation techniques only when planning and design prove insufficient.

Program N-1.2.1: Use the City's Noise Ordinance in environmental review of all development proposals and incorporate project design measures to reduce noise to allowable limits.

Program N-1.2.2: Evaluate mitigation measures for projects that would cause a "substantial increase" in noise as defined by the following criteria or would generate unusual noise which could cause significant adverse community response:

- a) cause the L_{dn} in existing residential areas to increase by 3 dB or more;
- b) cause the L_{dn} in existing residential areas to increase by 2 dB or more if the L_{dn} would exceed 70 dB; or
- c) cause the L_{dn} resulting exclusively from project-generated traffic to exceed an L_{dn} of 60 dBA at any existing residence.

Policy N-1.3 Noise and Land Use Compatibility Standards: Ensure that all new noise sensitive development proposals be reviewed with respect to Table 4.9-6: Noise and Land Use Compatibility Standards. Noise exposure shall be determined through actual onsite noise measurements.

Policy N-1.4 Residential and Noise Sensitive Land Use Standards: Require a standard of 40-45 L_{dn} (depending on location) for indoor noise level for all new residential development including hotels and motels, and a standard of 55 L_{dn} for outdoor noise, except near the freeway.³ These limits shall be reduced by 5 dB for senior housing and residential care facilities.

Program N-1.4.1 Use the standards in Policy N-1.2.2 to determine the need for noise studies and require new developments to provide noise attenuation features as a condition of approving new projects.

Program N-1.4.2 Require an acoustical study for all new residential projects with a future L_{dn} noise exposure of 55 L_{dn} or greater. The study shall describe how the project will comply with the Noise and Land Use Compatibility Standards. The studies shall also satisfy the requirements set forth in Title 24, part 2 of the California Government Code, Noise Insulation Standards, for multi-family attached dwellings, hotels, motels, etc. regulated by Title 24.

Program N-1.4.3 Require that all new residential development meet the standards set forth in California Title 24.

Goal N-2 Work to reduce noise to acceptable levels where it now exceeds those standards.

Policy N-2.1 Reduce Outdoor Noise in Existing Residential Areas: Reduce outdoor noise in existing residential areas where economically and aesthetically feasible.

Program N-2.1.1 Consider sound barrier walls, grading and landscaping, and change in traffic patterns as potential measures.

Policy N-2.2 Mitigate Noise Impacts: Mitigate noise impacts to the maximum feasible extent.

Program N-2.2.7: Recommend acoustical studies for all projects that would be exposed to noise levels in excess of those deemed normally acceptable, as shown in Table 3.

Table 3: Outdoor Noise Limits

Receiving Land Use Category	Time Period	Noise Level Limit Standard, dBA
Single-Family Residential	10 p.m. — 7 a.m.	45
	7 a.m. — 10 p.m.	50
Multi-Family Residential, Schools, Libraries, Public Spaces	10 p.m. — 7 a.m.	50
	7 a.m. — 10 p.m.	55
Commercial	10 p.m. — 7 a.m.	55
	7 a.m. — 10 p.m.	60

Source: Lafayette Municipal Code, Table 5-205.

³ Though the City General Plan standards do not explicitly state what the acceptable noise environment near the freeway is, the State's Title 24 standards consider an $L_{a,}$ of 60 dBA as acceptable for residential use, thus a 60 dBA $L_{a,}$ level will be used to judge acceptability of outdoor use areas near the freeway in this assessment.

Table 4: City of Lafayette Noise Land Use Compatibility Standards

Land Use Category	Exterior Noise Exposure, L _{dn} dBA					
	55	60	65	70	75	80
Residential, Hotels and Motels						
Outdoor Sports and Recreation, Neighborhood Parks and Playgrounds						
Schools, Libraries, Museums, Hospitals, Personal Care, Meeting Halls, Churches						
Office Buildings, Business Commercial, and Professional						
Auditoriums, Concert Halls, Amphitheaters						
	Normally Acceptable: Specified land use is satisfactory, based upon the assumption that any buildings involved are of normal conventional construction, without any special insulation requirements.					
	Conditionally Acceptable: Specified land use may be permitted only after detailed analysis of the noise reduction requirements and needed noise insulation features included in the design.					
	Unacceptable: New construction or development should generally not be undertaken because mitigation is usually not feasible to comply with noise element policies.					

Source: Lafayette General Plan, Noise Element.

Federal Transit Administration Vibration Criteria

The Federal Transit Administration (FTA) provides criteria for acceptable levels of groundborne vibration related to architectural damage for various types of land uses that are sensitive to vibration. Structures amplify groundborne vibration with typical residential structures more affected by ground vibration than heavier buildings. The level at which groundborne vibration is strong enough to cause architectural damage has not been determined conclusively. The most conservative estimates are reflected in the FTA standards, shown in Table 5, *Groundborne Vibration Impact Criteria: Architectural Damage*.

Table 5 Groundborne Vibration Impact Criteria: Architectural Damage

Building Category	PPV (in/sec)
I. Reinforced concrete, steel, or timber (no plaster)	0.5
II. Engineered concrete and masonry (no plaster)	0.3
III. Non-engineered timber and masonry buildings	0.2
IV. Buildings extremely susceptible to vibration damage	0.12

Source: FTA 2006.

Sensitive Noise Receptors

Certain land uses are particularly sensitive to noise and vibration. Noise- and vibration-sensitive uses include land uses where quiet environments are necessary for enjoyment and public health and safety. Residences, schools, guest lodging, libraries, religious institutions, hospitals, nursing homes, and passive recreation areas are generally more sensitive to noise than commercial and industrial land use. The nearest off-site noise-sensitive receptors are the residences to the west and east.

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