8 NOISE ELEMENT

Section 65302(f) of the California Government Code requires that General Plans contain a Noise Element that can be used as a guide for establishing a pattern of land uses that minimize the exposure of community residents to excessive noise. Local governments are required to analyze and quantify noise levels and exposure to noise through field measurements or noise modeling, and to use the Noise Element to address existing and foreseeable noise problems.

Background Information

Noise is generally defined as unwanted sound. Noise consists of any sound that may produce physiological or psychological damage and/or interfere with communication, work, rest, recreation, or sleep. Noise is especially a concern in the vicinity of ***noise-sensitive uses***, which are generally defined as locations where people reside or where the presence of unwanted sound could adversely affect the use of land, such as residences, schools, and hospitals.

Fundamental Concepts

To the human ear, sound has two significant characteristics: ***pitch*** and ***loudness***. Pitch is the number of complete vibrations, or cycles per second of a sound wave (frequency), which results in the range of tone from high to low. Loudness is the strength of a sound that describes a noisy or quiet environment. It is measured by the amplitude of the sound wave. Loudness is determined by the intensity of the sound waves combined with the reception characteristics of the human ear. Sound intensity refers to how hard the sound wave strikes an object, which in turn produces the sound's effect. This characteristic of sound can be precisely measured with instruments. Table NOI-1 contains a list of typical acoustical terms and definitions.

Measurement of Sound

A ***decibel (dB)*** is a unit of measurement which indicates the relative intensity of a sound. The zero point on the dB scale is based on the lowest sound level that the healthy, unimpaired human ear can detect. Changes of 3 dB or less are only perceptible in laboratory environments.

Since the human ear is not equally sensitive to all pitches (i.e. sound frequencies) within the entire noise spectrum, a special frequency-dependent rating scale has been devised to relate noise to human sensitivity in a process called "A-weighting," expressed as "dBA." The ***dBA***, or A-weighted decibel, refers to a scale of noise measurement that approximates the range of sensitivity of the human ear to sounds of different frequencies. Table NOI-2 shows representative noise sources and their corresponding noise levels in dBA.

TABLE NOI-1 **DEFINITIONS OF ACOUSTICAL TERMS**

Term	Definitions
Decibel, dB	A unit of measurement that denotes the ratio between two quantities proportional to power; the number of decibels is 10 times the logarithm (to the base 10) of this ratio.
Frequency, Hz	Of a function periodic in time, the number of times that the quantity repeats itself in 1 second (i.e. number of cycles per second).
A-Weighted Sound Level, dBA	The sound level obtained by use of A-weighting. The A-weighting filter de-emphasizes the very low and very high frequency components of the sound in a manner similar to the frequency response of the human ear and correlates well with subjective reactions to noise. All sound levels in this report are A-weighted, unless reported otherwise.
L_{01}, L_{10}, L_{50}, L_{90}	The fast A-weighted noise levels equaled or exceeded by a fluctuating sound level for 1 percent, 10 percent, 50 percent, and 90 percent of a stated time period.
Equivalent Continuous Noise Level, L_{eq}	The level of a steady sound that, in a stated time period and at a stated location, has the same A-weighted sound energy as the time varying sound.
Community Noise Equivalent Level, CNEL	The 24-hour A-weighted average sound level from midnight to midnight, obtained after the addition of 5 decibels to sound levels occurring in the evening from 7:00 p.m. to 10:00 p.m. and after the addition of 10 decibels to sound levels occurring in the night between 10:00 p.m. and 7:00 a.m.
Day/Night Noise Level, L_{dn}	The 24-hour A-weighted average sound level from midnight to midnight, obtained after the addition of 10 decibels to sound levels occurring in the night between 10:00 p.m. and 7:00 a.m.
L_{max}, L_{min}	The maximum and minimum A-weighted sound levels measured on a sound level meter, during a designated time interval, using fast time averaging.
Ambient Noise Level	The all-encompassing noise associated with a given environment at a specified time, usually a composite of sound from many sources at many directions, near and far; no particular sound is dominant.
Intrusive	The noise that intrudes over and above the existing ambient noise at a given location. The relative intrusiveness of a sound depends upon its amplitude, duration, frequency, time of occurrence, and tonal or informational content, as well as the prevailing ambient noise level.

Source: Harris, C.M, 1998, Handbook of Acoustical Measurements and Noise Control.

Because sound can vary in intensity by over one million times within the range of human hearing, a logarithmic loudness scale[1] is used to keep sound intensity numbers at a convenient and manageable level. Thus, a 10 dBA increase in the level of a continuous noise represents a perceived doubling of loudness, while a 20 dBA increase is 100 times more intense, and a 30 dBA increase is 1,000 times more intense.

As noise spreads from a source, it loses energy so that the farther away the noise receiver is from the noise source, the lower the perceived noise level. Noise levels attenuate, or diminish, as distance from the source increases based on an inverse square rule, depending on how the noise source is physically configured.

[1] Unlike linear units such as inches or pounds, decibels are measured on a logarithmic scale, representing points on a sharply rising curve. The logarithmic decibel scale allows an extremely wide range of acoustic energy to be characterized in a manageable notation.

TABLE NOI-2 **TYPICAL A-WEIGHTED SOUND LEVELS**

Noise Source	A-Weighted Sound Level in Decibels	Noise Environment
Near Jet Engine	140	Deafening
Civil Defense Siren	130	Threshold of pain
Hard Rock Band	120	Threshold of feeling
Accelerating Motorcycle at a Few Feet Away	110	Very loud
Pile Driver; Noisy Urban Street/Heavy City Traffic	100	Very loud
Ambulance Siren; Food Blender	95	Very loud
Garbage Disposal	90	Very loud
Freight Cars; Living Room Music	85	Loud
Pneumatic Drill; Vacuum Cleaner	80	Loud
Busy Restaurant	75	Moderately loud
Near Freeway Auto Traffic	70	Moderately loud
Average Office	60	Moderate
Suburban Street	55	Moderate
Light Traffic; Soft Radio Music in Apartment	50	Quiet
Large Transformer	45	Quiet
Average Residence Without Stereo Playing	40	Faint
Soft Whisper	30	Faint
Rustling Leaves	20	Very faint
Human Breathing	10	Very faint

Source: LSA Associates, Inc., 2009.

There are many ways to rate noise for various time periods, but an appropriate rating of ambient noise affecting humans also accounts for the annoying effects of sound. The predominant rating scales for communities in California are the equivalent continuous sound level (L_{eq}), the community noise equivalent level (CNEL), and the day-night average level (L_{dn}), which are all defined in Table NOI-1. L_{eq} represents an average of the sound energy occurring over a specified period. This descriptor is useful because sound levels can vary markedly over a short period of time. The most common averaging period for L_{eq} is hourly, but it can be of any duration. CNEL is the energy average of the A-weighted sound levels occurring during a 24-hour period, with 10 dB added to the A-weighted sound levels occurring between 10:00 p.m. and

7:00 a.m. (defined as sleeping hours) and 5 dB added to the A-weighted sound levels occurring between 7:00 p.m. and 10:00 p.m. (defined as relaxation hours), in order to adjust for the fact that noise during these hours is more disruptive than noise during the day. L_{dn} is similar to the CNEL scale, but without the adjustment for events occurring during the evening relaxation hours. CNEL and L_{dn} are normally exchangeable.

The noise environments discussed in this Element are specified in terms of maximum levels, denoted by L_{max}. L_{max} is the highest exponential time averaged sound level that occurs during a stated time period. L_{max} reflects peak operating conditions, and addresses the annoying aspects of intermittent noise.

Effects of Noise

According to the US Department of Housing and Urban Development's 1985 Noise Guidebook, permanent physical damage to human hearing can occur at prolonged exposure to noise levels higher than 85 to 90 dBA. Exposure to high noise levels affects our entire system, with prolonged noise exposure in excess of 75 dBA increasing body tensions, and thereby affecting blood pressure, functions of the ear and the nervous system, and triggering emotional reactions like anger, depression, and anxiety. In comparison, extended periods of noise exposure above 90 dBA would result in permanent cell damage. When the noise level reaches 120 dBA, a tickling sensation occurs in the human ear, even with short-term exposure. This level of noise is called the threshold of feeling. For avoiding adverse effects on human physical and mental health in the workplace or in communities, the US Department of Labor, Occupational Health and Safety Administration requires the protection of workers from hearing loss when the noise exposure equals or exceeds an 8-hour time-weighted average of 85 dBA.

Unwanted community effects of noise occur at levels much lower than those that cause hearing loss and other health effects. Annoyance occurs when noise interferes with sleeping, conversation, or noise-sensitive work, including learning or listening to the radio, television, or music. According to the World Health Organization, during daytime hours, few people are seriously annoyed by activities with noise levels below 55 dBA, or moderately annoyed with noise levels below 50 dBA.

Existing Noise Levels

This section summarizes existing noise levels in Vacaville, including mobile noise sources and stationary noise sources.

The primary source of noise in Vacaville is vehicle traffic from highways and major roadways. Additional noise sources include the Union Pacific Railroad, Nut Tree Airport, and Travis Air Force Base. In addition, industrial areas within Vacaville are a source of stationary noise.

Mobile Noise Sources

This section describes existing mobile noise sources, including traffic, railroads, and aircraft.

Traffic

Motor vehicles have distinctive noise characteristics and are a dominant noise source in Vacaville. The amount of noise varies according to many factors, such as the volume of traffic, vehicle mix (i.e. percentage of cars and trucks), average traffic speed, and distance from the receptor. Major contributing roadway noise sources include Interstate 80, Interstate 505, Leisure Town Road, Vaca Valley Parkway, Monte Vista Avenue, Peabody Road, Elmira Road, Alamo Drive, and other arterial and collector roadways throughout the city.

Existing traffic-related noise conditions along roadways within the city are shown in Figure NOI-1.

Railroad

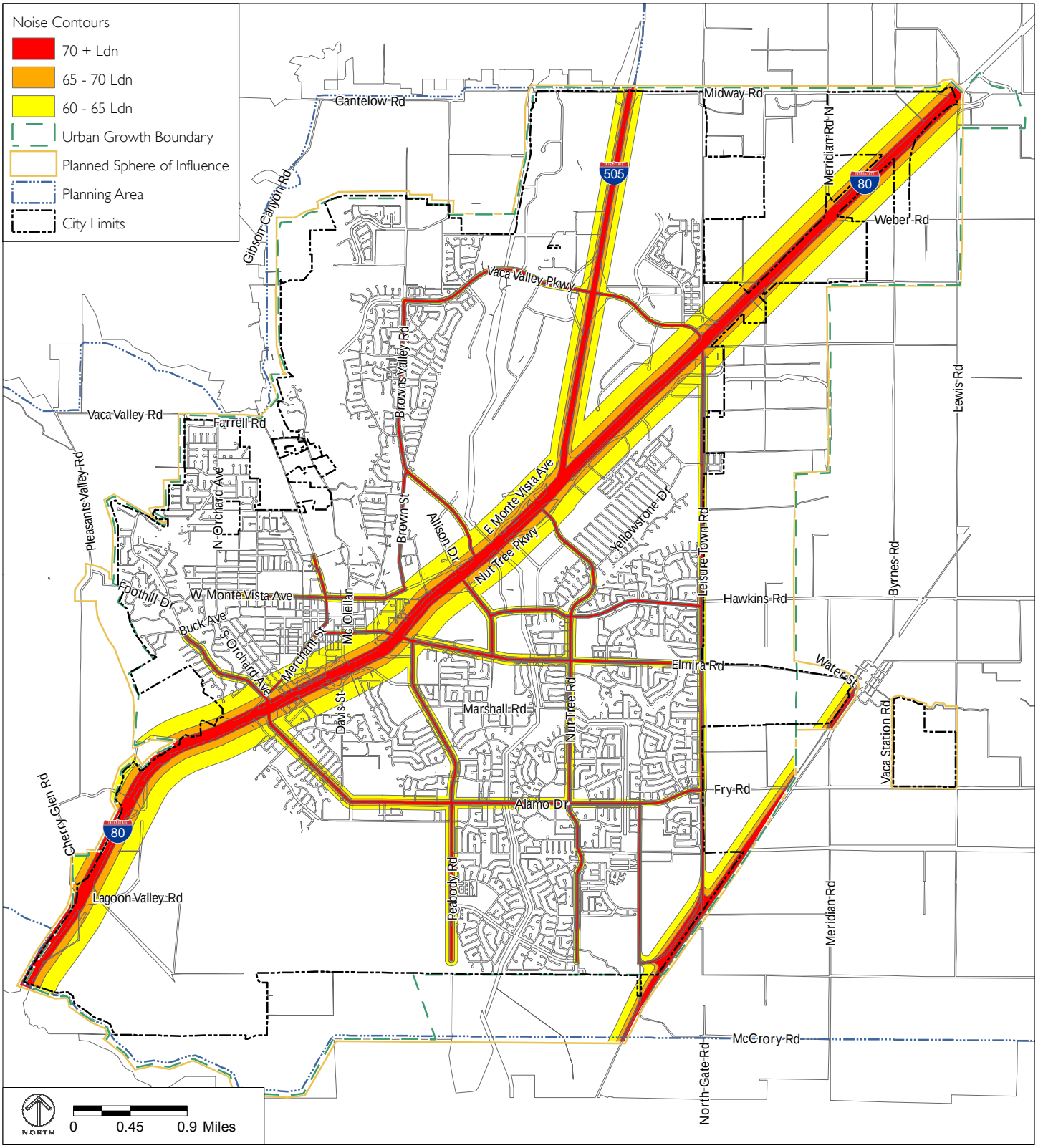
Rail operations are a source of noise in Vacaville. Factors that influence the overall impact of railroad noise on adjacent uses include the distance of buildings from the tracks, surrounding land topography, frequency of train operations, and the lack or presence of sound walls or other barriers between the tracks and adjacent uses.

The train activity along the Union Pacific rail line bordering the southeast portion of the city includes Amtrak passenger trains and freight trains. Noise from existing train operations are estimated to be up to 76 dBA L_{dn} at 50 feet from the railroad centerline without warning horns, and up to approximately 91 dBA L_{dn} at 50 feet from at-grade railroad crossings when warning horns are sounded. The contributions to the existing noise contours from current rail operations are shown in Figure NOI-1.

Aircraft

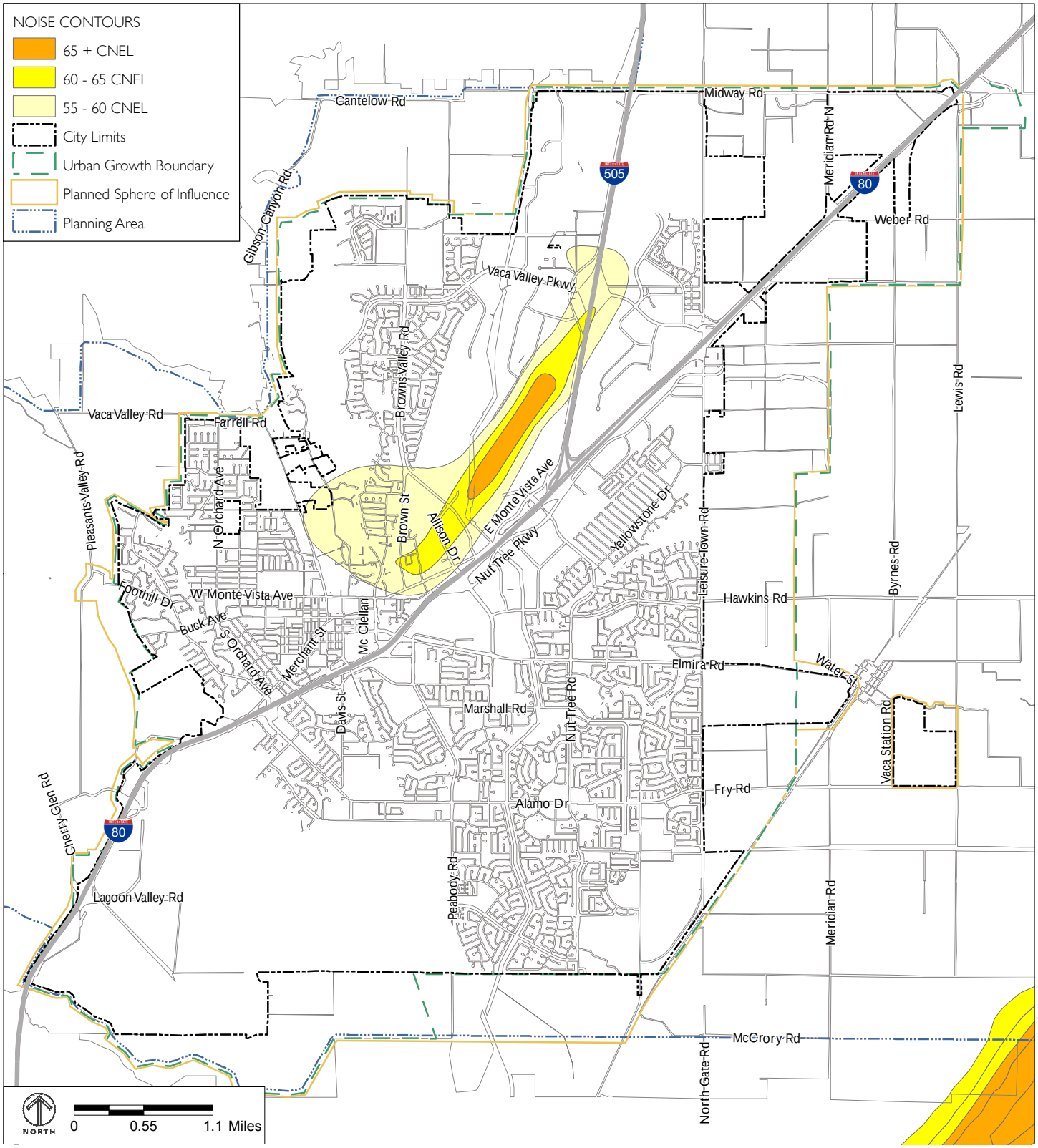
Aircraft overflights contribute to the ambient noise levels in Vacaville. The Nut Tree Airport is located in the north central portion of Vacaville, and Travis Air Force Base is located southeast of the city limits. The existing noise contours for each of these airports are provided in Figure NOI-2; Figure NOI-3 provides a zoomed in view of the Nut Tree Airport Noise Contours.

This Noise Element includes Policy NOI-P1.4 prohibiting new residential land uses in locations where the exterior noise associated with aircraft operations at Nut Tree Airport or Travis Air Force Base exceeds 60 dB CNEL, which is commonly accepted throughout California as the maximum noise exposure level that is compatible with low-density, single-family residential development. Existing land uses in the portions of the city that lie within the 60 dBA CNEL noise contour of the Nut Tree Airport include open space, business park, and industrial land uses, and a few residential land uses in the area north of Monte Vista Avenue between Brown Street and Browns Valley Parkway. The City has also adopted a Policy Plan for the Nut Tree Ranch property allowing the future development of a mixed-use commercial, residential, office, and entertainment development on this site, portions of which lie within the 60 dBA CNEL noise contour. Residential land uses are also located adjacent to, but outside of, the 60 dBA CNEL noise contour for Nut Tree Airport.



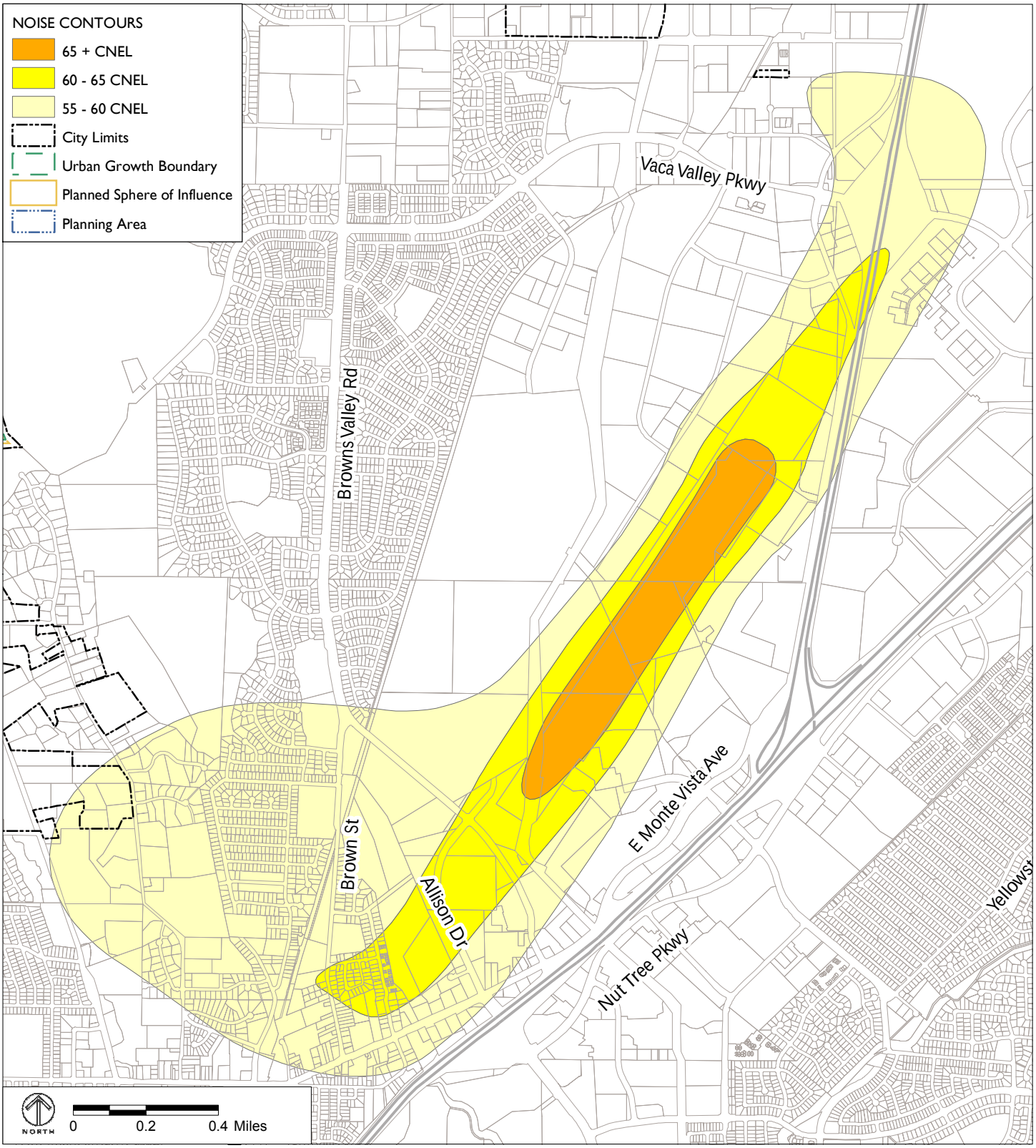
Source: LSA Associates, 2012.

FIGURE NOI-1
EXISTING NOISE LEVEL CONTOURS



Source: Nut Tree Airport, 2012. Depiction: The Planning Center/DC&E, 2012. Travis AFB: City of Vacaville, 2012.

FIGURE NOI-2
AIRPORT NOISE CONTOURS



Source: Nut Tree Airport, 2012. Depiction: The Planning Center/DC&E, 2012.

FIGURE NOI-3
NUT TREE AIRPORT NOISE CONTOURS

As shown on Figure NOI-2, no portion of Vacaville lies within the 60 dBA CNEL noise contour of the Travis Air Force Base airfield.

Stationary Noise Sources

Existing stationary noise sources throughout most of the city include heating ventilation and conditioning (HVAC) mechanical systems, delivery truck idling and loading/unloading activities, and recreational and parking lot activities, such as slamming car doors and talking. Of these noise sources, noise generated by delivery truck activity typically generates the highest maximum noise levels. Delivery truck loading and unloading activities can result in maximum noise levels ranging from 75 dBA to 85 dBA L_{max} at 50 feet. Typical parking lot activities, such as people conversing or doors slamming, generates approximately 60 dBA to 70 dBA L_{max} at 50 feet. Other noise sources specific to commercial centers and industrial zones of the city include light and medium industrial land uses, which can vary in noise levels.

Future Noise Sources

Noise contours for 2035 are shown in Figure NOI-4. These noise contours are based on projected land uses in 2035, the General Plan horizon year.

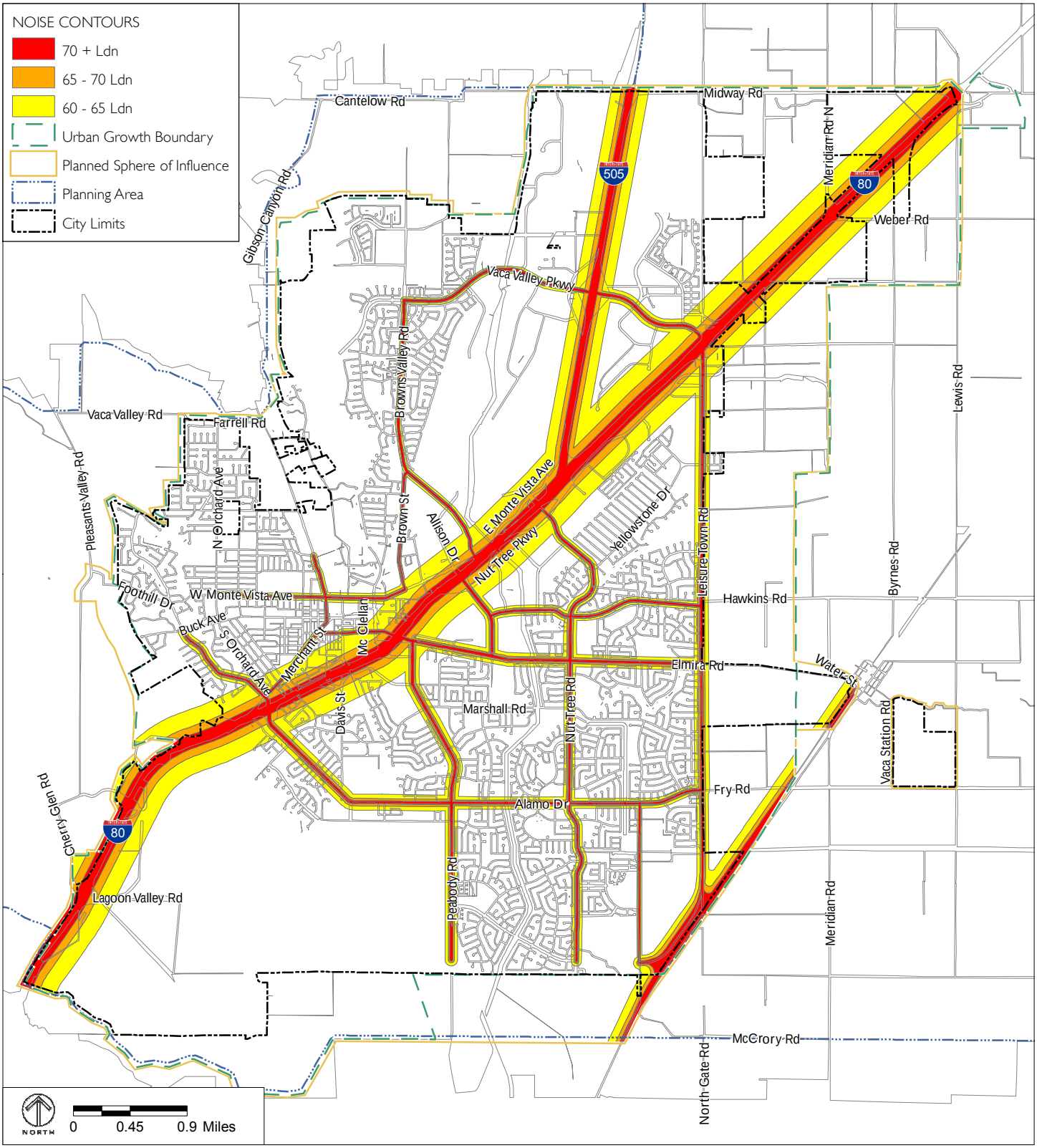
A new commuter rail station, the Vacaville/Fairfield Multi-Modal Rail Station, is planned to be constructed in northeast Fairfield along Amtrak's Capitol Corridor. Although the construction of the station itself will not result in a direct increase in the number of train trips, it is possible that trips will be expanded in the future, which could increase noise from railroad operations.

The Nut Tree Airport also intends to conduct several improvements to its facility, including adding more hangars and expanding the aircraft parking areas. These proposed changes, along with the ability to accommodate additional aircraft, will likely increase noise from the airport.

Noise and Land Use Compatibility Guidelines

The objective of the noise and land use compatibility guidelines is to provide the community with a means of judging the noise environment that it deems to be generally acceptable and to minimize noise-related complaints from residents. The compatibility policies shown in Table NOI-3 should be used in conjunction with the future noise exposure levels in Figure NOI-4 to identify locations that may require special treatment to minimize noise exposure.

If ambient noise levels in the area of a proposed project would exceed "normally acceptable" thresholds for the proposed land use category as shown in Table NOI-3, the City shall require a detailed analysis of feasible noise reduction requirements. As needed, noise insulation features shall be included in the design of such projects in order to reduce exterior noise levels to meet the acceptable thresholds, or, for uses with no active outdoor use areas, to ensure maintenance of acceptable interior noise levels for the proposed land use.



Source: LSA Associates, 2012.

FIGURE NOI-4
FUTURE NOISE LEVEL CONTOURS IN 2035

Goals, Policies, and Actions

Noise Standards

Goal NOI-1	**Maintain an acceptable noise environment in all areas of the city.**

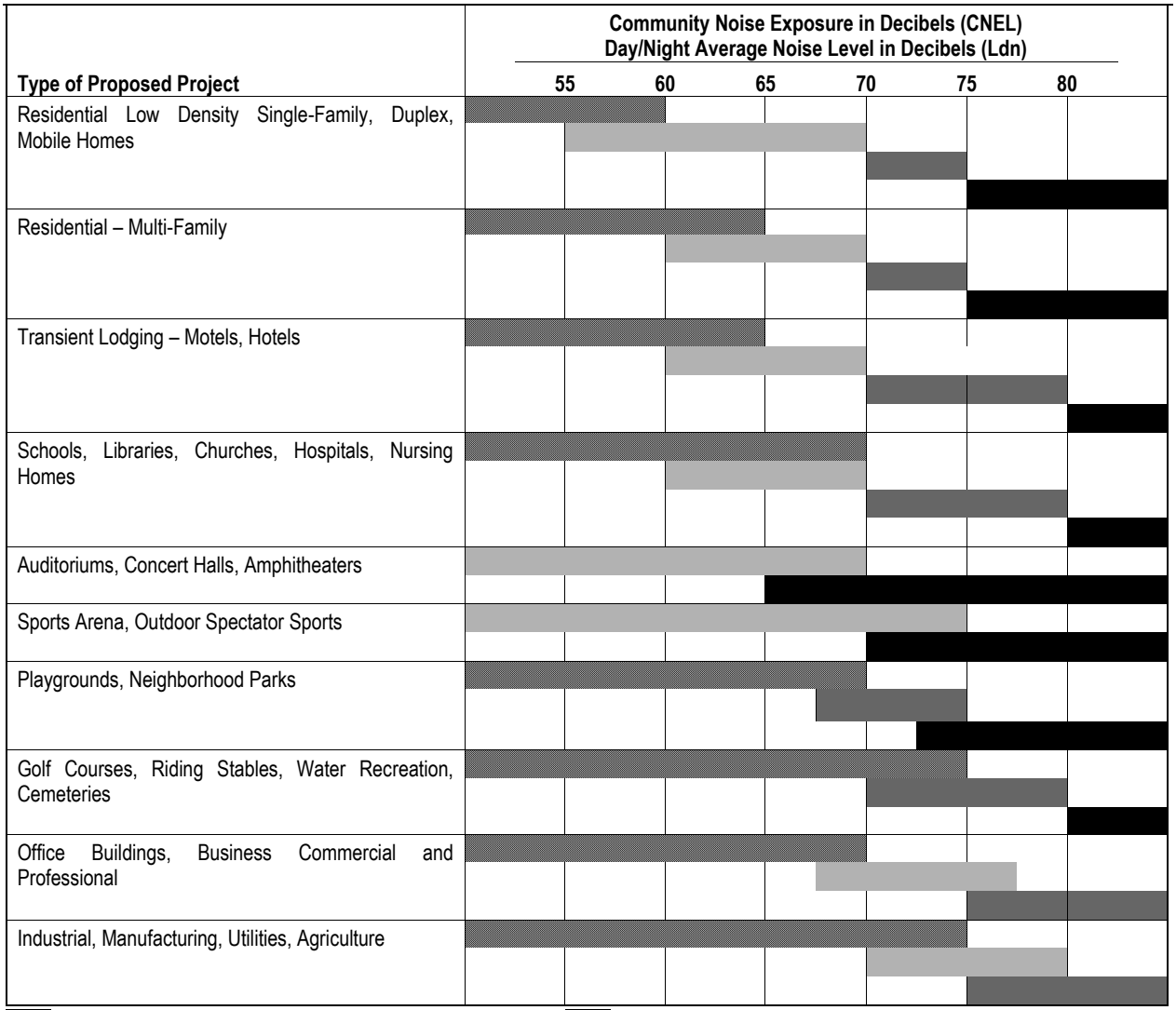
Policies

Policy NOI-P1.1 Require an acoustical analysis for all proposed projects that would locate noise sensitive land uses where the projected ambient noise level is greater than the respective ”normally acceptable” noise level as indicated on Table NOI-3, and require mitigation of noise impacts that exceed the land use compatibility standards.

Any acoustical analysis prepared pursuant to this Noise Element shall comply with the following:

- Be performed according to a scope of work that has been approved by the Director of Community Development.
- Be the financial responsibility of the applicant.
- Be prepared by a qualified person experienced in the fields of noise assessment and architectural acoustics.
- Include representative noise level measurements with sufficient sampling periods and locations to adequately describe local conditions, predominant noise sources, and peak noise sources.
- Estimate existing and projected cumulative (2035) noise levels in terms of CNEL, and compare those levels to the adopted policies of the Noise Element.
- Recommend appropriate mitigation to achieve compliance with the adopted policies and standards of the Noise Element, giving preference to proper site planning and design over the construction of noise barriers or structural modifications to buildings. Where the noise source in question consists of intermittent single events, the report must address the effects of maximum noise levels in sleeping rooms in terms of possible sleep disturbance.
- Estimate noise exposure after the prescribed mitigation measures have been implemented.
- Describe a post-project monitoring program that could be used to evaluate the effectiveness of the proposed mitigation measures.

TABLE NOI-3 LAND USE COMPATIBILITY STANDARDS FOR COMMUNITY NOISE ENVIRONMENTS



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.

CONDITIONALLY ACCEPTABLE
New construction or development should be undertaken only after a detailed analysis of the noise reduction requirements is made and needed noise insulation features included in the design.

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

CLEARLY UNACCEPTABLE
New construction or development clearly should not be undertaken.

Note: This table provides land use compatibility standards for all noise sources. While the prior General Plan established different standards for different noise sources, it has since become common practice to establish one set of land use compatibility standards for all noise sources because it is often difficult to definitively determine which portion of ambient noise levels are attributable to a particular noise source.
Source: State of California General Plan Guidelines, 2003.

Policy NOI-P1.2 Require that noise created by new transportation and non-transportation noise sources be mitigated, to the extent that is technically and economically feasible, to comply with the noise level standards of Table NOI-3.

Policy NOI-P1.3 Allow minor exceptions to the noise level design standards in Table NOI-3 in circumstances where mitigation requirements are not technically or economically feasible and not consistent with other City goals, standards, and policies.

Policy NOI-P1.4 Prohibit new residential land uses where the exterior noise associated with aircraft operations at Nut Tree Airport or Travis Air Force Base exceeds 60 dB CNEL.

Policy NOI-P1.5 When considering applications for a change in land use, follow the noise and land use compatibility guidelines in Table NOI-3.

Actions

Action NOI-A1.1 Amend the Land Use and Development Code to incorporate Policy NOI-P1.1.

Sensitive Receptors

Goal NOI-2	**Protect noise-sensitive uses from excessive noise.**

Policies

Policy NOI-P2.1 Reduce outdoor noise levels in existing residential areas, where economically and aesthetically feasible.

Policy NOI-P2.2 Discourage residential areas from directly abutting Interstate 80 or 505.

Policy NOI-P2.3 Design subdivisions to minimize the transportation-related noise impacts to adjacent residential areas.

Policy NOI-P2.4 Maintain smooth street surfaces adjacent to land uses that are sensitive to noise intrusion.

Policy NOI-P2.5 Encourage the use of open space, earthen berms, parking, accessory buildings, and landscaping to buffer new and existing development from noise. Use sound walls only when other methods are not practical or when recommended by an acoustical expert as part of a mitigation program.

Policy NOI-P2.6 Require that the effects of sound walls on noise levels in surrounding areas be considered and taken into account in the design, location, and construction of sound walls.

Policy NOI-P2.7 Require that vibration-sensitive buildings (e.g. residences) are sited at least 100 feet from the centerline of railroad tracks whenever feasible. Require a study demonstrating that groundborne vibration issues associated with rail operations have been adequately addressed prior to allowing the development of vibration-sensitive buildings within 100 feet of the centerline of railroad tracks.

Actions

Action NOI-A2.1 Request that Caltrans provide sound walls along Interstate 80 adjacent to existing residential areas where sound walls are the only practical noise mitigation.

Action NOI-A2.2 Review all non-residential development proposals for noise impacts on noise sensitive land uses, such as residences, schools, and hospitals.

Mobile Noise Sources

Goal NOI-3	**Minimize noise from mobile sources.**

Policies

Policy NOI-P3.1 Limit truck traffic to designated truck routes.

Policy NOI-P3.2 Utilize City traffic officers to enforce the use of approved truck routes.

Policy NOI-P3.3 Require increased setbacks for commercial and office development that adjoins freeways.

Policy NOI-P3.4 Work with the Solano County Airport Land Use Commission and other agencies to reduce noise generated from sources outside the City's jurisdiction.

Actions

Action NOI-A3.1 Update aircraft noise projections as future operations at the Nut Tree Airport and Travis Air Force Base are projected to change.

Stationary Noise Sources

Goal NOI-4	**Minimize noise from stationary sources.**

Policies

Policy NOI-P4.1 Preclude the generation of annoying or harmful noise through conditions of approval on stationary noise sources, such as construction and property maintenance activity and mechanical equipment.

Policy NOI-P4.2 Require the following construction noise control measures:

- Equip all internal combustion engine-driven equipment with intake and exhaust mufflers that are in good condition and appropriate for the equipment.
- Locate stationary noise-generating equipment as far as possible from sensitive receptors when sensitive receptors adjoin or are near a construction area.
- Utilize "quiet" air compressors and other stationary noise sources where technology exists.
- Limit hours of operation of outdoor noise sources through conditions of approval.

Actions

Action NOI-A4.1 Amend the Land Use and Development Code to incorporate Policy NOI-P4.2.