11 NOISE

11.1 INTRODUCTION

This background report creates a foundation for updating the goals, policies, and programs of the noise section of the Community Health Chapter of the *City of Citrus Heights General Plan*. The Community Health Chapter provides a basis for comprehensive local policies to control and abate environmental noise and to protect the residents of Citrus Heights from excessive noise exposure.

Unregulated noise can cause stress and strain on the general well-being of the City's residents. With proper planning, mitigation, and cooperation, unwanted noise can be managed to preserve the overall well-being of people within the City.

The City's responsibility is to "analyze and quantify" noise levels and the extent of noise exposure through actual measurement and/or modeling. To do this, technical data relating to mobile and point sources must be collected, synthesized, and mapped. These data are used to develop a set of noise control policies and programs that minimizes incompatible land use and serves as a basis for land use decisions. The element must include implementation measures and possible solutions to existing and foreseeable noise problems. Furthermore, the policies and standards must be sufficient to serve as a guideline for compliance with control requirements for sound transmission and directly correlate to the land use, circulation, and housing elements.

The noise section of the Community Health Chapter is used to guide decisions concerning land use and the location of new roads and transit facilities since these are common sources of excessive noise levels. Noise levels from existing land uses, including commercial and light industrial activities, must be closely analyzed to ensure compatibility.

11.2 REGULATORY SETTING

Various private and public agencies have established noise guidelines and standards to protect people from potential hearing damage and other adverse physiological and social effects associated with noise. The following federal, state, and local regulations discussed below are applicable to the proposed project regarding noise and vibration standards.

FEDERAL

The U.S. Environmental Protection Agency's (EPA's) Office of Noise Abatement and Control was originally established to coordinate federal noise control activities. After its inception, EPA's Office of Noise Abatement and Control issued the Federal Noise Control Act of 1972, establishing programs and guidelines to identify and address the effects of noise on public health, welfare, and the environment. In 1981, EPA administrators determined that subjective issues such as noise would be better addressed at lower levels of government.

Consequently, in 1982 responsibilities for regulating noise control policies were transferred to state and local governments. However, noise control guidelines and regulations contained in EPA rulings in prior years remain in place by designated federal agencies, allowing more individualized control for specific issues by designated federal, state, and local government agencies.

STATE

The State of California has adopted noise standards in areas of regulation not preempted by the federal government. State standards regulate noise levels of motor vehicles, sound transmission through buildings, occupational noise control, and noise insulation.

Title 24 of the California Code of Regulations, also known as the California Building Standards Code, establishes building standards applicable to all occupancies throughout the state. The code provides acoustical regulations for both exterior-to-interior sound insulation as well as sound isolation between adjacent spaces of various occupied units. Title 24 regulations state that interior noise levels generated by exterior noise sources shall not exceed 45 dB L_{dn}, with windows closed, in any habitable room for general residential uses.

Though not adopted by law, the *State of California General Plan Guidelines 2003*, published by the California Governor's Office of Planning and Research (OPR), provides guidance for the compatibility of projects within areas of specific noise exposure. Table 11-1 presents acceptable and unacceptable community noise exposure limits for various land use categories. These guidelines also present adjustment factors that may be used to arrive at noise acceptability standards that reflect the noise control goals of the community, the particular community's sensitivity to noise, and the community's assessment of the relative importance of noise pollution.

REGIONAL/LOCAL

CITRUS HEIGHTS GENERAL PLAN

The City of Citrus Heights General Plan Noise Element establishes acceptable noise levels for proposed development projects (Table 11-2). If it appears that a proposed project may exceed the limits established in Table 11-2, an acoustical analysis is required to identify potential noise levels and attenuation measures.

The General Plan also requires that new residential development projects be designed and constructed to meet acceptable exterior noise level standards, as follows:

- The maximum exterior noise level of 60 dBA L_{dn} shall be applied in residential areas where outdoor use is a major consideration (such as backyards in single family housing developments and recreation areas in multi-family housing projects). Where the City determines that providing a L_{dn} of 60 dBA or lower is not feasible, the noise level in outdoor areas shall be reduced to as close to the standard as feasible through project design.

Table 11-1
Land Use and Noise Compatibility Guidelines

Land Use Category	Community Noise Exposure (CNEL/L_{dn}, dB)			
	Normally Acceptable[1]	Conditionally Acceptable[2]	Normally Unacceptable[3]	Clearly Unacceptable[4]
Residential-Low Density Single Family, Duplex, Mobile Home	<60	55–70	70–75	75+
Residential-Multiple Family	<65	60–70	70–75	75+
Transient Lodging, Motel, Hotel	<65	60–70	70–80	80+
School, Library, Church, Hospital, Nursing Home	<70	60–70	70–80	80+
Auditorium, Concert Hall, Amphitheater		<70	65+	
Sports Arenas, Outdoor Spectator Sports		<75	70+	
Playground, Neighborhood Park	<70		67.5–75	72.5+
Golf Courses, Stable, Water Recreation, Cemetery	<75		70–80	80+
Office Building, Business Commercial and Professional	<70	67.5–77.5	75+	
Industrial, Manufacturing, Utilities, Agriculture	<75	70–80	75+	

Notes: CNEL = Community Noise Equivalent Level; dB = A-weighted decibels; L_{dn} = day-night average noise level.

[1] Specified land use is satisfactory, based on the assumption that any buildings involved are of normal conventional construction, without any special noise insulation requirements.

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

[3] New construction or development should generally 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. Outdoor areas must be shielded.

[4] New construction or development should generally not be undertaken.

Source: OPR 2003:244-254

Table 11-2
City of Citrus Heights Acceptable Noise Levels

Land Use Category	Community Noise Exposure L_{dn} or CNEL, dBA			
	Normally Acceptable [1]	Conditionally Acceptable [2]	Normally Unacceptable[3]	Clearly Unacceptable [4]
Residential: Low-Density Single Family, Duplex, Mobile Homes	60	65	75	85
Residential: Multiple Family	65	70	75	85
Transient Lodging: Motels, Hotels	65	70	80	85
Schools, Libraries, Churches, Hospitals, Nursing Homes	70	70	80	85
Auditoriums, Concert Halls, Amphitheaters	--	70	--	85
Sports Arena, Outdoor Spectator Sports	--	75	--	85
Playgrounds, Neighborhood Parks	70	--	75	85
Golf Courses, Riding Stable, Water Recreation, Cemeteries	75	--	80	85
Office Buildings, Business Commercial and Professional	70	75	85	--
Industrial, Manufacturing, Utilities, Agriculture	75	80	85	--

Notes:

[1] Specific land use is satisfactory, based upon the assumption that any buildings involved are of normal conventional construction, without any special noise insulation requirements

[2] New construction or development should be undertaken only after a detailed analysis of the noise reduction requirement is made and 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.

[3] New construction or development should generally 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.

[4] New construction or development should generally not be undertaken.

Source: City of Citrus Heights General Plan Noise Element, February 2002, Adapted from the Office of Planning and Research, State of California General Plan Guidelines. Appendix A: Guidelines for the Preparation and Content of the Noise Element of the General Plan, 1990.

- Indoor noise levels shall not exceed a L_{dn} of 45 dBA in new residential housing units.
- Noise levels in new residential development exposed to an exterior L_{dn} of 60 dBA or greater shall be limited to a maximum instantaneous noise level (e.g., trucks on busy streets, train warning whistles) in bedrooms of 50 dBA. Maximum instantaneous noise levels in all other habitable rooms shall not exceed 55 dBA.

CITY OF CITRUS HEIGHTS CODE, ARTICLE III NOISE CONTROL

The City's Noise Ordinance establishes the following standards.

Sec. 34-86. Exterior Noise Standards

(a) The following noise standards, unless otherwise specifically indicated in this article, shall apply to all properties within a designated noise area:

Noise Area	City Zoning Districts	Time Period	Exterior Noise Standard
1	RD-1, RD-2, RD-3, RD-4, RD-5, R-7, RD-10, R15, RD-20, R-25, RD-30, MH	7:00 a.m. to 10:00 p.m. 10:00 p.m. to 7:00 a.m.	55 dBA 50 dBA
Source: City of Citrus Heights Municipal Code, 2009			

(b) It is unlawful for any person at any location within the city to create any noise which causes the noise levels on an affected property, when measured in the designated noise area, to exceed, for the duration of time set forth following, the specified exterior noise standards in any one hour by:

Cumulative Duration of the Intrusive Sound	Allowance Decibels
1) Cumulative period of 30 minutes per hour	0.
2) Cumulative period of 15 minutes per hour	+ 5
3) Cumulative period of five minutes per hour	+10
4) Cumulative period of one minute per hour	+15
5) Level not to be exceeded for any time per hour	+20
Source: City of Citrus Heights Municipal Code, 2009	

(c) Each of the noise limits specified in subsection (b) of this section shall be reduced by five dBA for impulsive or simple tone noises or for noises consisting of speech or music.

(d) If the ambient noise level exceeds that permitted by any of the first four noise limit categories specified in subsection (b) of this section, the allowable noise limit shall be increased in five-dBA increments in each

category to encompass the ambient noise level. If the ambient noise level exceeds the fifth noise level category, the maximum ambient noise level shall be the noise limit for that category.

(Ord. No. 97-01, § 2(6.68.070), 1-2-1997; Ord. No. 97-13, § 2, 3-26-1997; Ord. No. 97-17, § 2, 9-24-1997)

Sec. 34-87. Interior Noise Standards

(a) In any apartment, condominium, townhouse, duplex or multiple-dwelling unit, it is unlawful for any person to create any noise from inside his or her unit that causes the noise level, when measured in a neighboring unit during the periods 10:00 p.m. to 7:00 a.m., to exceed the following:

(1) Forty-five dBA for a cumulative period of more than five minutes in any hour.
(2) Fifty dBA for a cumulative period of more than one minute in any hour.
(3) Fifty-five dBA for any period of time.

(b) If the ambient noise level exceeds that permitted by any of the noise level categories specified in subsection (a) of this section, the allowable noise limit shall be increased in five-dBA increments in each category to encompass the ambient noise level.

(Ord. No. 97-01, § 2(6.68.080), 1-2-1997; Ord. No. 97-13, § 2, 3-26-1997; Ord. No. 97-17, § 2, 9-24-1997)

Sec. 34-88. Exemptions

The following activities shall be exempted from this article:

(1) School bands, school athletic and school entertainment events.

(2) Outdoor gatherings, public dances, shows and sporting and entertainment events, provided the events are conducted pursuant to a license or permit by the city.

(3) Activities conducted on parks, public playgrounds and school grounds, provided such parks, playgrounds and school grounds are owned and operated by a public entity or private school.

(4) Any mechanical device, apparatus or equipment related to or connected with emergency activities or emergency work.

(5) Noise sources associated with construction, repair, remodeling, demolition, paving or grading of any real property, provided the activities do not take place between the hours of 8:00 p.m. and 6:00 a.m. on weekdays and Friday commencing at 8:00 p.m. through and including 7:00 a.m. on Saturday, Saturdays commencing at 8:00 p.m. through and including 7:00 a.m. on the next following Sunday, and on each Sunday after the hour

of 8:00 p.m. However, when an unforeseen or unavoidable condition occurs during a construction project and the nature of the project necessitates that work in process be continued until a specific phase is completed, the contractor or owner shall be allowed to continue work after 8:00 p.m. and to operate machinery and equipment necessary until completion of the specific work in progress can be brought to conclusion under conditions which will not jeopardize inspection acceptance or create undue financial hardships for the contractor or owner.

(6) Noise sources associated with agricultural operations, provided such operations do not take place between the hours of 8:00 p.m. and 6:00 a.m.

(7) Any mechanical device, apparatus or equipment which is utilized for the protection or salvage of agricultural crops during periods of adverse weather conditions or when the use of mobile noise sources is necessary for pest control.

(8) Noise sources associated with maintenance of residential area property, provided the activities take place between the hours of 6:00 a.m. and 8:00 p.m. on any day except Saturday or Sunday, or between the hours of 7:00 a.m. and 8:00 p.m. on Saturday or Sunday.

(9) Any activity, to the extent provisions of 42 USC 65 and Public Utilities Code §§ 21661--21669.6 and 21670--21679.5 preempt local control of noise regulations and land use regulations related to noise control of airports and their surrounding geographical areas; any noise source associated with the construction, development, manufacture, maintenance, testing or operation of any aircraft engine or of any weapons system or subsystems which are owned, operated or under the jurisdiction of the United States; or any other activity to the extent regulation thereof has been preempted by state or federal law or regulation.

(10) Any noise sources associated with the maintenance and operation of aircraft or airports which are owned or operated by the United States.

(Ord. No. 97-01, § 2(6.68.090), 1-2-1997; Ord. No. 97-13, § 2, 3-26-1997; Ord. No. 97-17, § 2, 9-24-1997)

Sec. 34-90. Schools, Hospitals and Churches

It is unlawful for any person to create any noise which causes the noise level at any school, hospital or church, while the school, hospital or church is in use, to exceed the noise standards specified in section 34–86 or to create any noise which unreasonably interferes with the use of such institution or unreasonably disturbs or annoys patients in the hospital. In any disputed case, interfering noise which is ten dBA or more, greater than the ambient noise level at the building, shall be deemed excessive and unlawful.

(Ord. No. 97-01, § 2(6.68.110), 1-2-1997; Ord. No. 97-13, § 2, 3-26-1997; Ord. No. 97-17, § 2, 9-24-1997)

Sec. 34-91. Machinery, Equipment, Fans and Air Conditioning

(a) It is unlawful for any person to operate any mechanical equipment, pump, fan, air conditioning apparatus, stationary pumps, stationary cooling towers, stationary compressors, similar mechanical devices, or any combination thereof installed after July 1, 1976 in any manner so as to create any noise which would cause the maximum noise level to exceed the following:

(1) Sixty dBA at any point at least one foot inside the property line of the affected residential property and three to five feet above ground level.

(2) Fifty-five dBA in the center of a neighboring patio three to five feet above ground level.

(3) Fifty-five dBA outside of the neighboring living area window nearest the equipment location. Measurements shall be taken with the microphone not more than three feet from the window opening but at least three feet from any other surface.

(b) Equipment installed five years after July 1, 1976, must comply with a maximum limit of 55 dBA at any point at least one foot inside the property line of the affected residential property and three to five feet above ground level.

(c) Equipment installed before December 17, 1970, must comply with a limit of 65 dBA maximum in sound level at any point at least one foot inside the affected property line and three to five feet above ground level by January 1, 1977. Equipment installed between December 16, 1970, and July 1, 1976, must comply with a limit of 65 dBA maximum sound level at any point at least one foot inside the property line of the affected residential property and three to five feet above ground level.

(Ord. No. 97-01, § 2(6.68.120), 1-2-1997; Ord. No. 97-13, § 2, 3-26-1997; Ord. No. 97-17, § 2, 9-24-1997)

AIRPORT NOISE REGULATIONS

Airports that are either public or serve a scheduled airline are required to have a comprehensive land use plan (CLUP) prepared by the airport land use commission (ALUC). The purpose of ALUC is to:

- Protect public health, safety, and welfare through the adoption of land use standards that minimize the public's exposure to safety hazards and excessive levels of noise.
- Prevent the encroachment of incompatible land uses around public-use airports, thereby preserving the utility of these airports into the future.

The adoption and implementation of a CLUP embodies the land use compatibility guidelines for height, noise, and safety. The Sacramento Area Council of Governments (SACOG) is the ALUC for Sacramento, Sutter, Yolo, and Yuba Counties.

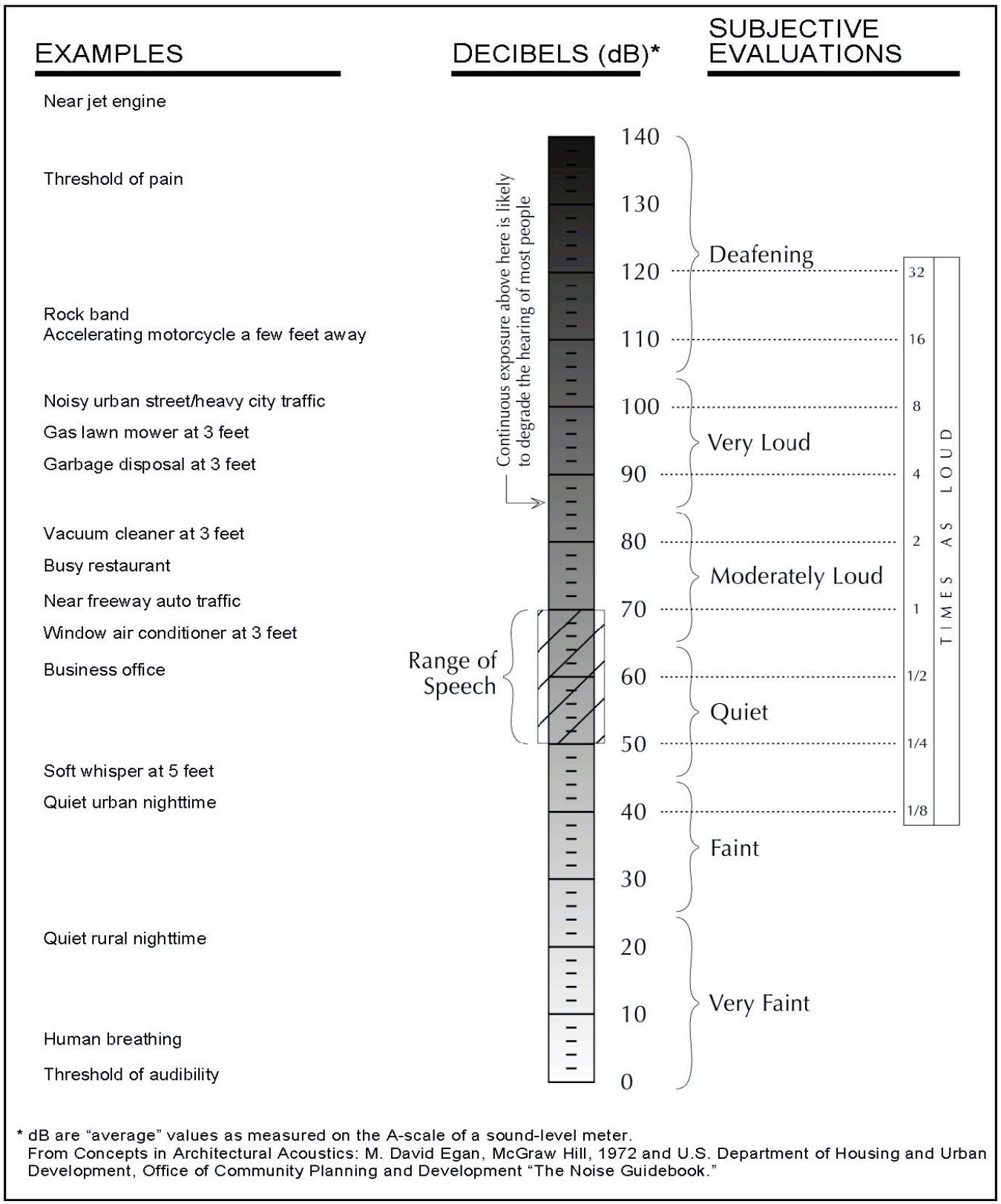
11.3 ACOUSTIC FUNDAMENTALS

Acoustics is the scientific study that evaluates perception, propagation, absorption, and reflection of sound waves. Sound is a mechanical form of radiant energy, transmitted by a pressure wave through a solid, liquid, or gaseous medium. Sound that is loud, disagreeable, unexpected, or unwanted is generally defined as noise; consequently, the perception of sound is subjective in nature, and can vary substantially from person to person. Common sources of environmental noise and noise levels are presented in Figure 11-1.

A sound wave is initiated in a medium by a vibrating object (e.g., vocal chords, the string of a guitar, the diaphragm of a radio speaker). The wave consists of minute variations in pressure, oscillating above and below the ambient atmospheric pressure. The number of pressure variation cycles occurring per second is referred to as the frequency of the sound wave and is expressed in hertz (Hz), which is equivalent to one complete cycle per second.

Directly measuring sound pressure fluctuations would require the use of a very large and cumbersome range of numbers. To avoid this, and have a more useable numbering system, the decibel (dB) scale was introduced. A sound level expressed in decibels is the logarithmic ratio of two like pressure quantities, with one pressure quantity being a reference sound pressure. For sound pressure in air, the standard reference quantity is generally considered to be 20 micropascals, which directly corresponds to the threshold of human hearing. The use of the decibel is a convenient way to handle the million-fold range of sound pressures to which the human ear is sensitive. A decibel is logarithmic; it does not follow normal algebraic methods and cannot be directly added. For example, a 65 dB source of sound, such as a truck, when joined by another 65 dB source results in a sound amplitude of 68 dB, not 130 dB (i.e., doubling the source strength increases the sound pressure by 3 dB). A sound level increase of 10 dB corresponds to 10 times the acoustical energy, and an increase of 20 dB equates to a 100 fold increase in acoustical energy.

The loudness of sound perceived by the human ear depends primarily on the overall sound pressure level and frequency content of the sound source. The human ear is not equally sensitive to loudness at all frequencies in the audible spectrum. To better relate overall sound levels and loudness to human perception, frequency-dependent weighting networks were developed. The standard weighting networks are identified as A through E. There is a strong correlation between the way humans perceive sound and A-weighted sound levels (dBA). For this reason the dBA can be used to predict community response to noise from the environment, including noise from



Source: Data compiled by EDAW in 2009

Common Noise Sources and Levels **Figure 11-1**

transportation and stationary sources. Sound levels expressed as dB in this section are A-weighted sound levels, unless noted otherwise.

Noise can be generated by a number of sources, including mobile sources (transportation noise sources) such as automobiles, trucks, and airplanes and stationary sources (non-transportation noise sources) such as construction sites, machinery, and commercial and industrial operations. As acoustic energy spreads through the atmosphere from the source to the receiver, noise levels attenuate (decrease) depending on ground absorption characteristics, atmospheric conditions, and the presence of physical barriers (e.g., walls, building façades, berms). Noise generated from mobile sources generally attenuate at a rate of 4.5 dB per doubling of distance. Stationary noise sources spread with more spherical dispersion patterns that attenuate at a rate of 6 to 7.5 dB per doubling of distance.

Atmospheric conditions such as wind speed, turbulence, temperature gradients, and humidity may additionally alter the propagation of noise and affect levels at a receiver. Furthermore, the presence of a large object (e.g., barrier, topographic features, and intervening building façades) between the source and the receptor can provide significant attenuation of noise levels at the receiver. The amount of noise level reduction or "shielding" provided by a barrier primarily depends on the size of the barrier, the location of the barrier in relation to the source and receivers, and the frequency spectra of the noise. Natural barriers such as berms, hills, or dense woods, and human-made features such as buildings and walls may be used as noise barriers.

NOISE DESCRIPTORS

The intensity of environmental noise fluctuates over time, and several different descriptors of time-averaged noise levels are used. The selection of a proper noise descriptor for a specific source depends on the spatial and temporal distribution, duration, and fluctuation of both the noise source and the environment. The noise descriptors most often used to describe environmental noise are defined below.

L_{max} (Maximum Noise Level): The highest A/B/C weighted integrated noise level occurring during a specific period of time.

L_{min} (Minimum Noise Level): The lowest A/B/C weighted integrated noise level during a specific period of time.

Peak: The highest weighted or unweighted instantaneous peak-to-peak value occurring during a measurement period.

L_n (Statistical Descriptor): The noise level exceeded n% of a specific period of time, generally accepted as an hourly statistic. An L_{10} would be the noise level exceeded during 10% of the measurement period.

L_{eq} (Equivalent Noise Level): The energy mean (average) noise level. The steady-state sound level that, in a specified period of time, contains the same acoustical energy as a varying sound level over the same time period.

L_{dn} (Day-Night Noise Level): The 24-hour L_{eq} with a 10-dB "penalty" applied during nighttime noise-sensitive hours, 10 p.m. through 7 a.m. The L_{dn} attempts to account for the fact that noise during this specific period of time is a potential source of disturbance with respect to normal sleeping hours.

CNEL (Community Noise Equivalent Level): Similar to the L_{dn} described above, but with an additional 5-dB "penalty" for the noise-sensitive hours between 7 p.m. to 10 p.m., which are typically reserved for relaxation, conversation, reading, and other similar activities. If the same 24-hour noise data are used, the CNEL is typically 0.5 dB higher than the L_{dn}.

SEL (Sound Exposure Level): The cumulative exposure to sound energy over a stated period of time.

EFFECTS OF NOISE ON HUMANS

Excessive and chronic exposure to elevated noise levels can result in auditory and non-auditory effects on humans. Auditory effects of noise on people are those related to temporary or permanent hearing loss caused by loud noises. Non-auditory effects of exposure to elevated noise levels are those related to behavioral and physiological effects. The non-auditory behavioral effects of noise on humans are associated primarily with the subjective effects of annoyance, nuisance, and dissatisfaction, which lead to interference with activities such as communications, sleep, and learning. The non-auditory physiological health effects of noise on humans have been the subject of considerable research attempting to discover correlations between exposure to elevated noise levels and health problems, such as hypertension and cardiovascular disease. The mass of research infers that noise-related health issues are predominantly the result of behavioral stressors and not a direct noise-induced response. The extent to which noise contributes to non-auditory health effects remains a subject of considerable research, with no definitive conclusions.

The degree to which noise results in annoyance and interference is highly subjective and may be influenced by several non-acoustic factors. The number and effect of these non-acoustic environmental and physical factors vary depending on individual characteristics of the noise environment such as sensitivity, level of activity, location, time of day, and length of exposure. One key aspect in the prediction of human response to new noise environments is the individual level of adaptation to an existing noise environment. The greater the change in the noise levels that are attributed to a new noise source, relative to the environment an individual has become accustomed to, the less tolerable the new noise source will be.

With respect to how humans perceive and react to changes in noise levels, a 1dB increase is imperceptible, a 3 dB increase is barely perceptible, a 6 dB increase is clearly noticeable, and a 10-dB increase is subjectively perceived

as approximately twice as loud (Egan 1988). These subjective reactions to changes in noise levels was developed on the basis of test subjects' reactions to changes in the levels of steady-state pure tones or broad-band noise and to changes in levels of a given noise source. It is probably most applicable to noise levels in the range of 50 to 70 dB, as this is the usual range of voice and interior noise levels. For these reasons, a noise level increase of 3 dB or more is typically considered substantial in terms of the degradation of the existing noise environment.

VIBRATION

Vibration is the periodic oscillation of a medium or object with respect to a given reference point. Sources of vibration include natural phenomena (e.g., earthquakes, volcanic eruptions, sea waves, landslides) and those introduced by human activity (e.g., explosions, machinery, traffic, trains, construction equipment). Vibration sources may be continuous, (e.g., operating factory machinery or transient in nature, explosions). Vibration levels can be depicted in terms of amplitude and frequency, relative to displacement, velocity, or acceleration.

Vibration amplitudes are commonly expressed in peak particle velocity (PPV) or root-mean-square (RMS) vibration velocity. PPV is defined as the maximum instantaneous positive or negative peak of a vibration signal. PPV is typically used in the monitoring of transient and impact vibration and has been found to correlate well to the stresses experienced by buildings (Federal Transit Administration [FTA] 2006: **7**-1 – 7-8, California Department of Transportation [Caltrans] 2004: 5-7). PPV and RMS vibration velocity are normally described in inches per second (in/sec).

Although PPV is appropriate for evaluating the potential for building damage, it is not always suitable for evaluating human response. The response of the human body to vibration relates well to average vibration amplitude; therefore, vibration effects on humans are evaluated in terms of RMS vibration velocity. Similar to airborne sound, vibration velocity can be expressed in decibel notation as vibration decibels (VdB). The logarithmic nature of the decibel serves to compress the broad range of numbers required to describe vibration.

Typical outdoor sources of perceptible groundborne vibration include construction equipment, steel-wheeled trains, and traffic on rough roads. Although the effects of vibration may be imperceptible at low levels, effects may result in detectable vibrations and slight damage to nearby structures at moderate and high levels, respectively. At the highest levels of vibration, damage to structures is primarily architectural (e.g., loosening and cracking of plaster or stucco coatings) and rarely results in damage to structural components. The range of vibration that is relevant to this analysis occurs from approximately 50 VdB, which is the typical background vibration-velocity level, to 100 VdB, which is the general threshold where minor damage can occur in fragile buildings (FTA 2006:8-1 – 8-8).

ROADWAY TRAFFIC SOURCE NOISE

Traffic noise is the dominant noise source in the City and is influenced by Interstate 80 (I-80) and major roads such as Greenback Lane, Sunrise Boulevard, Antelope Road, Auburn/Old Auburn, San Juan Avenue, and Sylvan Road. Existing vehicle traffic noise levels in the planning area were modeled using the Federal Highway Administration (FHWA) Highway Traffic Noise Prediction Model (FHWA-RD-77-108) and traffic data provided by the project traffic consultant. The FHWA model is based on CALVENO reference noise factors for automobiles, medium trucks, and heavy trucks, with consideration given to vehicle volume, speed, roadway configuration, distance to the receptor, and ground attenuation factors.

Table 11-3 summarizes the modeled traffic noise levels, provides noise levels at 100 feet from the centerline of each major roadway within the planning area, and lists distances from the roadway centerlines to the 60 dB, 65 dB, and 70 dB L_{dn} traffic noise contours. Figure 11-2 shows the traffic noise contours for roadways within the City. These traffic noise modeling results are based on existing average daily traffic (ADT) volumes. As shown in Table 11-3, the location of the 60 dB L_{dn} contour ranges from 30 to 1,603 feet from the centerline of the modeled roadways. The extent to which existing land uses in the planning area are affected by existing traffic noise depends on their respective proximity to the roadways and their individual sensitivity to noise.

NOISE WALLS AND BARRIERS

Roadway noise is significantly influenced by intervening noise walls and barriers. Noise walls, constructed of heavy dense material can attenuate roadway noise to varying degrees of efficiency dependent upon noise wall location and design. In the simplest terms, an effective noise barrier must break line-of-sight between the noise source (roadway) and noise receiver (residence). If line-of-sight is broken, the intervening noise wall can provide a fair amount of attenuation, on the order typically ranging from 5 to 15 dB. Noise walls in the Citrus Heights range from approximately 6 feet to 10 feet in height. All are of masonry construction; those of short length likely provide limited acoustical benefit only to those residences situated immediately behind the wall.

Noise barriers, including earthen berms, intervening structures (homes or office buildings), raised or depressed topography can provide substantial attenuation. Again, the degree to which these line-of-sight breaking barriers may attenuate noise largely depends on barrier orientation and design.

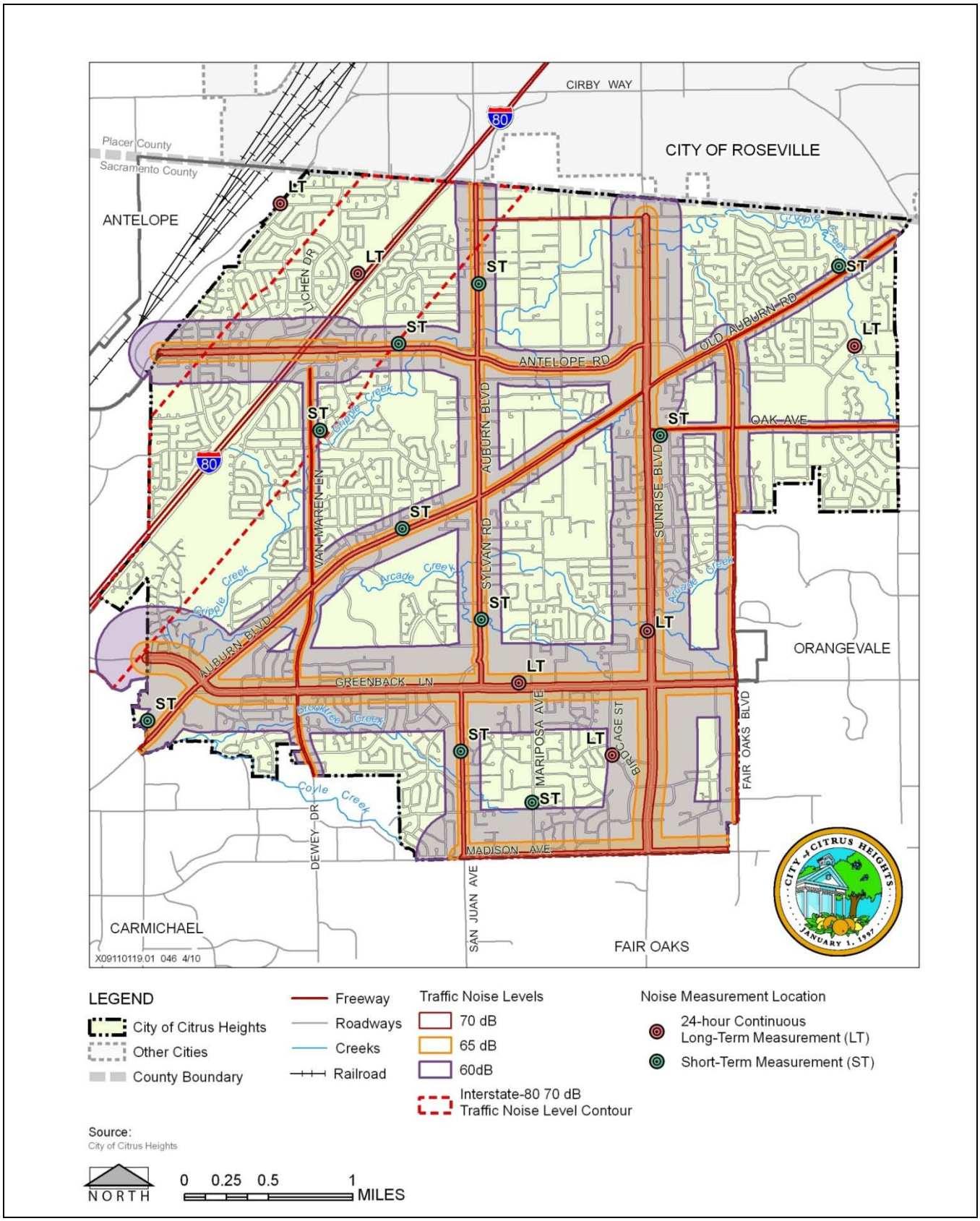
RAILROAD TRAFFIC SOURCE NOISE

A railroad switching yard is located near the northwest portion of the City adjacent to Roseville Road. An intervening open space of loose soil and grasses lies between the switching yard and Roseville Road. Switching yard activities are audible only when there is not continuous vehicle traffic along Roseville Road. Roseville Road traffic noise is the dominant noise source in this portion of the City.

Table 11-3
Summary of Modeled Levels of Existing Traffic Noise

Roadway	Segment		L_{dn} (dB) 100 Feet	Distance (feet) from Roadway Centerline to L_{dn} Contour		
	From	To		70 dB	65 dB	60 dB
Twin Oaks Ave	Sylvan Road	Sunrise Boulevard	54.8	3	9	30
Antelope Road	Roseville Road	Interstate 80	69.9	98	309	977
Antelope Road	Interstate 80	Van Maren Lane	70.1	102	324	1,024
Antelope Road	Van Maren Lane	Auburn Boulevard	68.4	69	219	692
Antelope Road	Auburn Boulevard	Mariposa Avenue	67.5	56	178	562
Antelope Road	Mariposa Avenue	Sunrise Boulevard	67.3	53	168	531
Auburn Boulevard	Manzanita Way	Greenback Lane	67.7	59	185	586
Auburn Boulevard	Greenback Lane	Van Maren Lane	67.5	57	179	567
Auburn Boulevard	Van Maren Lane	Sylvan Road	67.9	61	193	612
Auburn Boulevard	Sylvan Road	Mariposa Avenue	66.3	43	136	431
Old Auburn Road	Mariposa Avenue	Sunrise Boulevard	64.4	27	86	273
Old Auburn Road	Sunrise Boulevard	Fair Oaks Boulevard	65.8	38	121	383
Old Auburn Road	Fair Oaks Boulevard	Wachtel Way	63.9	25	78	247
Greenback Lane	Garfield Avenue	Auburn Boulevard	72.0	160	507	1,603
Greenback Lane	Auburn Boulevard	Dewey Drive	70.9	124	393	1,242
Greenback Lane	Dewey Drive	Sylvan Road	71.3	133	422	1,334
Greenback Lane	Sylvan Road	Mariposa Avenue	71.4	139	441	1,395
Greenback Lane	Mariposa Avenue	Sunrise Boulevard	71.2	133	421	1,331
Greenback Lane	Sunrise Boulevard	Fair Oaks Boulevard	70.3	107	338	1,068
Madison Avenue	San Juan Avenue	Mariposa Avenue	71.8	150	475	1,503
Madison Avenue	Sunrise Boulevard	Fair Oaks Boulevard	72.0	159	503	1,591
Oak Avenue	Sunrise Boulevard	Kenneth Avenue	62.6	18	58	183
Van Maren Lane	Auburn Boulevard	Antelope Road	63.7	23	74	235
Dewey Drive	Greenback Lane	Connemara Circle	65.0	32	101	318
San Juan Avenue	Greenback Lane	Madison Avenue	67.5	56	176	557
Sylvan Road	Greenback Lane	Auburn Boulevard	68.3	67	213	673
Sylvan Road	Auburn Boulevard	Antelope Road	68.0	63	200	633
Sylvan Road	Antelope Road	Twin Oaks Avenue	67.6	58	182	576
Sylvan Road	Twin Oaks Avenue	Whyte Avenue	68.1	64	202	640
Sunrise Boulevard	Madison Avenue	Greenback Lane	71.5	141	447	1,414
Sunrise Boulevard	Greenback Lane	Woodmore Oaks Drive	70.8	121	383	1,212
Sunrise Boulevard	Woodmore Oaks Drive	Oak Avenue	70.5	112	355	1,124
Sunrise Boulevard	Oak Avenue	Old Auburn Road	69.9	98	310	979
Sunrise Boulevard	Old Auburn Road	Antelope Road	70.7	118	372	1,178
Sunrise Boulevard	Antelope Road	Twin Oaks Avenue	70.4	110	346	1,096
Fair Oaks Boulevard	Madison Avenue	Greenback Lane	67.5	56	177	560
Fair Oaks Boulevard	Greenback Lane	Woodmore Oaks Drive	67.3	53	168	531
Interstate 80	Greenback Lane	Antelope Road	83.5	2,214	7,000	22,137
Interstate 80	Antelope Road	Riverside Avenue	83.1	2,039	6,448	20,390

Notes: dB = A-weighted decibels; L_{dn} = day-night average noise level.
Source: Data modeled by AECOM in 2009



Noise Measurement Sites and Traffic Contours **Figure 11-2**

AIRCRAFT FLYOVER NOISE

Two airports are located in the vicinity of the City of Citrus Heights. McClellan Park is located approximately 4 miles west of the City's western boundary and Sacramento Mather Air Base is located approximately 7 miles to the south of the City's southern boundary. McClellan Park is a converted air force base that now serves industrial, manufacturing and office uses with hotel accommodations, parks and other facilities on site. McClellan Park maintains an active airfield on the premises and the 60 dB CNEL noise contour is located approximately 3.5 miles from the nearest City boundary (Sacramento County Airport System 2005). Sacramento Mather Airport is a converted air force base that now serves warehouse, air cargo sorting facilities, hangar space, and office uses. Mather Airport maintains an active airfield on the premises and the 60 dB CNEL noise contour is located approximately 5 miles from the nearest City boundary (Sacramento County Department of Airports 2003).

STATIONARY SOURCE NOISE

No large stationary sources of noise exist in the Citrus Heights area. The City does include commercial corridors and some areas of light industrial uses. The Sunrise Mall and Market at Birdcage are located at the intersection of Sunrise Boulevard and Greenback Lane. There are also large box stores (Sam's Club and Ross Dress for Less) located at the intersection of Greenback Lane and San Juan Avenue and a Wal-Mart Supercenter/Costco located south of Auburn Boulevard west of Sylvan Road. Several smaller commercial centers are located along most main roads in Citrus Heights. Noise sources associated with these uses include rooftop heating, ventilation, and air conditioning units, parking lot movements and loading dock activities. A small pocket of light industrial uses are located along Auburn Boulevard south of Greenback Lane.

COMMUNITY NOISE SURVEY

In Citrus Heights, the primary noise source is vehicle traffic. Ambient noise levels in the area are influenced by traffic on I-80 and major roads such as Greenback Lane, Sunrise Boulevard, Antelope Road, Auburn/Old Auburn, San Juan Avenue, and Sylvan Road. A community noise survey was conducted to document existing ambient noise within noise-sensitive communities. Noise-sensitive receptors were defined as residential land uses, churches, theaters, and schools.

A community noise survey was conducted on November 11 through November 19, 2009, to document the existing noise environment at noise-sensitive receptors within the City and existing noise sources. The dominant noise source identified during the ambient noise survey was traffic from the local area roadway network. Measurements of noise levels were taken in accordance with ANSI standards at 10 locations using a Larson Davis Laboratories (LDL) Model 820 precision integrating sound-level meter. Continuous 24-hour, long-term monitoring of noise levels was conducted at six locations within the City using an LDL Model 820 sound-level meter. The sound-level meters were calibrated before and after use with an LDL Model CAL200 acoustical

calibrator to ensure that the measurements would be accurate. The equipment used meets all pertinent specifications of the ANSI for Type 1 sound-level meters (ANSI S1.4-1983[R2006]).

Community noise survey locations are shown in Figure 11-2. The L_{eq}, L_{max}, L_{10}, L_{50}, and L_{90} values were taken at each short-term ambient noise measurement location presented in Table 11-4. During the survey, average daytime ambient noise levels ranged from 51.6 dB to 72.0 dB L_{eq}, with maximum noise levels that ranged from 62.5 dB to 82.4 dB L_{max}.

Table 11-4
Summary of Monitored Short Term Daytime Ambient Noise Levels

Site	Location	Date/Time	Noise Sources	Traffic Counts			A-Weighted Sound Level (dBA)				
				Autos	MT	HT	L_{eq}	L_{max}	L_{10}	L_{50}	L_{90}
ST-1	Van Maren Lane north of Calvin Drive in New Hope Baptist Church parking lot	November 11, 2009 / 11:05–11:20 a.m.	Traffic, dog barking, aircraft overflights	175	3	-	51.6	62.5	55	49	46
ST-2	San Juan Avenue north of Westgate Drive in Advent Lutheran Church parking lot	November 19, 2009 / 1:55–2:10 p.m.	Traffic, landscape maintenance activities	457	8	4	72.0	78.3	76	71	61
ST-3	Sylvan Road south of Woodside Drive, at Creative Frontiers School	November 19, 2009 / 3:10–3:25 p.m.	Traffic	566	1	1	70.8	80.0	74	69	63
ST-4	Auburn Blvd at Coachman Way	November 19, 2009 / 3:45–4:00 p.m.	Traffic, landscape maintenance activities	-	-	-	69.9	82.4	73	68	63
ST-5	Antelope Road, east of Rosswood Drive in Rusch Park	November 11, 2009 / 9:35–9:50 a.m.	Traffic, landscape maintenance activities, aircraft overflights	348	4	2	62.0	72.5	65	61	54
ST-6	Sunrise Blvd at Oak Avenue, at Sunrise Tech Center	November 18, 2009 / 5:25–5:40 p.m.	Traffic, parking lot activity, people talking	146	2	-	55.7	74.1	58	54	52
ST-7	Old Auburn Road northeast of Wintergreen Drive, at Allene Creek Court	November 18, 2009 / 4:50–5:05 p.m.	Traffic, landscape maintenance activities, neighborhood activities	-	-	-	55.2	68.1	58	49	45
ST-8	Auburn Blvd northeast of Manzanita Avenue, in Imperial Manor mobile home park	November 19, 2009 / 1:10–1:25 p.m.	Traffic, neighborhood activities, people talking, heavy equipment operation	-	-	-	52.9	64.2	56	51	49
ST-9	Mariposa Avenue at Northeast Circle, at Skycrest Elementary School	November 19, 2009 / 2:35–2:50 p.m.	Traffic, playground noise, neighborhood activities	32	1	-	59.5	78.8	61	52	48
ST-10	Auburn Blvd south of Rollingwood Blvd, at Baird Way	November 18, 2009 / 6:20–6:35 p.m.	Traffic	355	1	-	70.2	80.4	73	69	63

Notes: dBA = A-weighted decibels; L_{eq} = equivalent noise level; L_{max} = maximum noise level; L_n = noise level exceeded n percent of a specific period of time; MT = Medium Truck; HT = Heavy Truck
Source: Data collected by AECOM 2009

The L_{dn}, L_{eq}, L_{max}, L_{50}, and L_{90} values were taken at each long-term ambient noise measurement location presented in Table 11-5. During the survey, 24-hour ambient noise levels ranged from 53.7 dB to 77.9 dB L_{dn}, with maximum noise levels that ranged from 66.8 dB to 86.5 dB L_{max}.

Table 11-5
Summary of Measured 24-hour Long Term Ambient Noise Levels

Site	Location	Date	Average Measured Hourly Noise Levels, dBA								
			L_{dn}	Daytime (7 a.m.–10 p.m.)				Nighttime (10 p.m.–7 a.m.)			
				L_{eq}	L_{max}	L_{50}	L_{90}	L_{eq}	L_{max}	L_{50}	L_{90}
LT-A	Approximately 100 yards north of Olivine Avenue, west of Feldspar Court	11/18/09 – 11/19/09	53.7	54.3	66.8	44.2	41.4	42.6	55.2	40.5	38.5
LT-B	Birdcage Street, north of Macy Plaza Drive and south of Farmgate Way	11/16/09 – 11/17/09	66.2	66.4	81.2	61.6	55.4	55.8	73.1	50.3	47.2
LT-C	Roseville Road, south of Whyte Avenue and north of Butternut Drive	11/16/09 – 11/17/09	74.6	72.8	86.5	69.5	56.6	66.6	83.9	56.8	50.8
LT-D	Interstate 80 at Westwood Park (near tennis courts)	11/16/09 – 11/17/09	77.9	74.7	80.6	74.4	72.3	70.6	79.8	69.0	63.9
LT-E	Greenback Lane, east of San Juan Avenue and 130 yards west of Mariposa Avenue	12/3/09 – 12/4/09	70.0	66.6	82.1	65.2	59.3	62.9	77.8	57.8	50.3
		12/4/09 – 12/5/09	69.6	66.9	84.5	64.5	57.1	62.1	77.1	58.3	50.2
		12/5/09 – 12/6/09	69.3	67.2	82.5	65.6	58.0	61.5	76.0	56.8	48.4
		12/6/09 – 12/7/09	70.6	67.4	81.2	65.8	58.5	63.3	77.2	58.0	50.3
		12/7/09 – 12/8/09	70.1	67.3	81.5	65.8	58.6	62.6	78.3	57.5	49.2
LT-F	Sunrise Boulevard, north of Greenback Lane and 200 yards north of Sun Hill Drive	12/3/09 – 12/4/09	62.4	58.9	73.4	57.0	52.6	55.2	66.0	52.5	47.8
		12/4/09 – 12/5/09	61.2	58.0	72.8	56.6	52.1	53.9	68.4	51.0	46.8
		12/5/09 – 12/6/09	60.8	57.8	73.3	56.2	52.3	53.5	68.6	50.2	46.2
		12/6/09 – 12/7/09	63.5	59.7	71.4	57.8	53.2	56.5	67.8	52.5	46.8
		12/7/09 – 12/8/09	62.9	59.3	72.3	57.9	53.0	55.7	68.8	51.4	46.8

Notes: dB = A-weighted decibels; L_{dn} = day-night average noise level; L_{eq} = the equivalent hourly average noise level; L_{max} = maximum noise level; L_{50} = the noise level exceeded 50% of a specific period of time; L_{90} = the noise level exceeded 90% of a specific period of time.
Monitoring locations correspond to those depicted in Figure 11-2.
Source: Data collected by AECOM 2009

NOISE-SENSITIVE LAND USES

Noise-sensitive land uses are generally considered to include those uses where noise exposure could result in health-related risks to individuals, as well as places where quiet is an essential element of their intended purpose. Residential dwellings are of primary concern given the potential for increased and prolonged exposure of individuals to both interior and exterior noise levels. Additional land uses such as parks, historic sites, cemeteries, and recreation areas are also considered sensitive to exterior noise levels. Schools, places of worship, hotels, libraries, nursing homes, retirement residences, and other places, where low interior noise levels are essential, are also considered noise-sensitive land uses. The majority of noise sensitive land uses within the planning area are residential. There are 34 learning centers including high schools, a middle school, elementary schools, and private schools with the planning area. There are approximately 40 places of worship and two cemeteries one cemetery within the planning area.

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Table of Contents

Exhibits

Tables

Acronyms

hertz (Hz
A-weighted sound levels (dBA
peak particle velocity (PPV
root-mean-square (RMS
Federal Transit Administration [FTA
inches per second (in/sec
vibration decibels (VdB
U.S. Environmental Protection Agency's (EPA's
California Governor's Office of Planning and Research (OPR
Community Noise Exposure (CNEL
dB = A-weighted decibels
L_{dn} = day-night average noise level
Federal Highway Administration (FHWA
Interstate 80 (I-80
average daily traffic (ADT
comprehensive land use plan (CLUP
airport land use commission (ALUC
Sacramento Area Council of Governments (SACOG
Larson Davis Laboratories (LDL
dBA = A-weighted decibels; L_{eq} = equivalent noise level; L_{max} = maximum noise level; L_n = noise level exceeded n percent of a specific period of time;
California Department of Transportation (Caltrans
Federal Highway Administration (FHWA
Federal Transit Administration (FTA

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