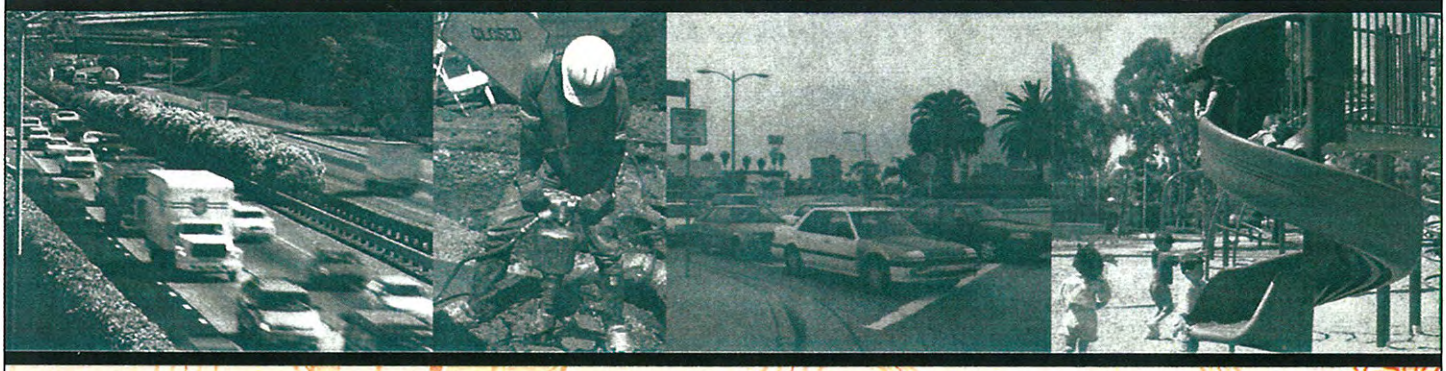
NOISE ELEMENT

of the



THOUSAND OAKS GENERAL PLAN

May 2000

City of Thousand Oaks
Department of Planning and
Community Development

COTTON/BELAND/ASSOCIATES, INC.

NOISE ELEMENT

of the

THOUSAND OAKS GENERAL PLAN

May, 2000

City of Thousand Oaks
Department of Planning and Community Development
2100 Thousand Oaks Boulevard
Thousand Oaks, CA 91362

Adopted by City Council May 16, 2000

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THOUSAND OAKS GENERAL PLAN
NOISE ELEMENT

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CONTENTS

Tables

Figures

1. Introduction

People consider noise an important factor in the quality of life in any community. Based on information contained in this Noise Element, the City of Thousand Oaks finds that achieving and maintaining a quiet environment is important to maintaining the character and quality of the City, and is an appropriate subject for City policy, City programs, and the establishment of local regulations.

Legislative Requirements

The State of California requires that each city and county prepare a noise element as part of its general plan. The California Government Code, Section 65302 (f), requires the general plan to include:

A noise element which shall identify and appraise noise problems in the community. The noise element shall recognize the guidelines established by the Office of Noise Control in the State Department of Health Services and shall analyze and quantify, to the extent practicable, as determined by the legislative body, current and projected noise levels for all of the following sources:

1. *Highways and freeways.*
2. *Primary arterials and major local streets.*
3. *Passenger and freight on-line railroad operations and ground rapid transit systems.*
4. *Commercial, general aviation, helicopter, helistop, and military airport operations, aircraft overflights, jet engine test stands, and all other ground facilities and maintenance functions related to airport operation.*
5. *Local industrial plants, including, but not limited to, railroad classification yards.*
6. *Other ground stationary noise sources identified by local agencies as contributing to the community noise environment.*

Updated Element

This Noise Element is a comprehensive update of the Noise Element of the Thousand Oaks General Plan. The Noise Element of the Thousand Oaks General Plan was adopted in 1974, and the current version of the Noise Element was adopted by the City Council in September, 1987. In preparing the Noise Element update, the City involved the public in workshops to identify noise issues and review draft policies. Consultants were engaged to conduct noise monitoring, evaluate noise problems (including updating existing and projected noise contours) and to recommend changes to the policies of the Noise Element and the City's Noise Ordinance. City staff from the Community Development Department and Public Works Department participated extensively with the consultant team in preparation of the draft revised Noise Element prior to its release for public review. The Draft Element was reviewed by the public prior to action by the Planning Commission and City Council.

1. Issues, Problems and Opportunities

1.1. Noise as a Public Policy Issue in Thousand Oaks.

Thousand Oaks is a suburban community that seeks to maintain a high quality of life for its residents. A noisy environment detracts from this quality of life.

The City's General Plan states the following goal for environmental quality:

- To provide a high quality environment, healthful and pleasing to the senses, which values the relationship between maintenance of ecological systems and the people's general welfare. (Council Resolution 97-8)

Minimizing noise is an important aspect of achieving an environment that is both healthful and pleasing to the senses.

By far the most important noise source in Thousand Oaks, based both on residents' expressed concerns and on the number of people exposed to the highest average noise levels, is motor vehicle traffic on the City's arterial streets and freeways. Because the City is at a substantial distance from the airports serving the region, it is not substantially affected by aircraft noise. Although the Federal Aviation Administration (FAA) has established helicopter routes along local freeways, these routes are not heavily used, and overflights are not normally at low altitude. No rail line traverses the City, and rail noise is not an issue in Thousand Oaks.

Other noise problems that have arisen occasionally in the City include noise at the interface between residential and commercial or industrial land uses. These problems typically result from deliveries, especially at unusual hours, or manufacturing or repair processes involving noisy equipment.

Noise problems also result from people's daily activities. Such noise sources as amplified sound (radios, stereos, television, particularly outdoors or between units in multifamily structures), use of loud equipment such as lawn mowers, leaf blowers, power tools; residential equipment such as air conditioner compressors, pool pumps and fans; and nuisance noises on private property, such as shouting, use of vehicles, alarms, and so on, all have the potential to result in noise problems.

Noise becomes a public policy issue of concern to the City when noise affects the public health and welfare, or when noise results from actions by the City. Examples of such cases include:

> *Noise which results directly or indirectly from the construction and operation of new residential, commercial and industrial projects which are approved by the City, the construction of public facilities, or operation of public services.*
>
> *Private actions which result in noise on other properties sufficient to cause substantial annoyance or disruption of activities.*
>
> *Noise sources which have a substantial adverse impact on the quality of life for City residents.*

Depending on the potential for noise regulation to affect interstate or international commerce, some noise problems may be regulated by other levels of government. For example, in order to minimize the potential problems that might result if each state established standards for newly manufactured aircraft, the federal government has preempted the establishment of such standards by states and local agencies.

Similarly, noise standards for protection of employee health have typically been set by the state and federal governments in order to ensure that such standards protect the entire population.

The existing structure of the regulatory scheme for various noise sources is outlined in Appendix A, Noise Standards and Guidelines of Other Agencies, of this Noise Element.

1.2. Describing the Noise Environment.

Noise is often defined as annoying or unwanted sound. In order to define noise problems and to establish a regulatory scheme to deal with noise that is both fair and effective, it is necessary to understand some of the basic characteristics of sound and how it affects people and their activities. Some of the most important characteristics are identified briefly in Table 1 on page 5. This table also provides general comments about how these characteristics are considered in planning.

While sound levels can be easily measured, the variability in subjective and physical response to sound complicates the analysis of its impact on people.

Sound is created when an object vibrates and radiates part of its energy as acoustic pressure waves through a medium such as air, water, or a solid. The ear, the hearing mechanism of humans and most animals, receives these sound pressure waves and converts them to neurological impulses which are transmitted to the brain for interpretation. The interpretation by the auditory system and the brain depends on the characteristics of the sound, and on the characteristics of the person hearing it.

There are two parameters that are used technically to describe the sound environment at any instant in time: amplitude (or sound power) and frequency (or pitch). These two characteristics affect the way people respond to sound.

Amplitude of a sound is a measure of the pressure or force that a sound can exert. Subjectively, we say a sound is louder if it has a greater amplitude than another sound. Thus the amplitude of sounds can be described either in measurable magnitude or in relative terms of loudness.

Physically, sound pressure is measured in units of decibels (dB). The sound pressure scale is based on the ratio of the energy of the sound energy to a reference pressure which is approximately the least sound pressure that people can perceive. Zero dB means the lowest level normally audible, but does not mean zero sound pressure.

Frequency of a sound is expressed in units of cycles per second, or Hertz (Hz), referring to the number of times per second the acoustic pressure wave peaks. Subjectively, a sound that has more cycles per second than another is higher pitched. The human hearing system is not equally sensitive to sound at all frequencies, and is most sensitive to sounds in the frequency range of human speech, from 400 to 2000 cycles per second. The most sensitive people can hear sounds ranging from a little below 20 Hz to somewhat above 20,000 Hz. As people age, their sensitivity to high frequencies tends to fall. Acoustical energy at frequencies above the range of human hearing is referred to as ultrasonic, or ultrasound. At frequencies below the range of human hearing, acoustical energy is referred to as infrasonic, or infrasound, and is experienced as vibration.

Table 1. Characteristics of Noise

Noise Characteristic	What is Measured, Units of Measurement	Effects on People and Human Activities
Loudness or Sound Pressure	Energy content of sound waves in the air. Unweighted sound pressure level in decibels (dB)	Noise distracts attention from tasks, interferes with verbal communication, and prevents or disturbs sleep. At high levels or for long periods, noise causes temporary or permanent hearing loss. At very high levels, noise causes pain. Louder sounds have greater effects, subject to the further considerations below.
Frequency or Pitch	Frequency (cycles per second, or Hertz (Hz) of pressure waves. Frequency distribution by octave or 1/3 octave band. Overall sound pressure level weighted by frequency, such as A-weighting (dB(A))	The human ear is most sensitive to sounds in the range of human speech, less sensitive to high or low frequencies at the same sound energy.
Tonal content	Pure tones or energy distribution by octave or 1/3 octave frequency band. Special weightings such as Effective Perceived Noise Level in decibels (EPND8), or simple penalty weightings for pure tones.	High tonal content means identifiable whines or hums, which can be particularly annoying compared to random noise of the same sound energy.
Information content (music, voice, sirens, etc.)	Judgement that sound includes voice, music, etc. No standard measurement scheme or weighting.	Information content draws attention to sounds compared to more random noise of the same sound energy.
Impact noise	Rapid increase in sound pressure or repetitive impacts. Fast response on sound meters used to measure impact noise.	Impact noise (helicopter rotor blade noise, jackhammers, etc.) can be more annoying than other noises of the same sound energy.
Duration of noise events as percentage of 24-hour or other period.	Hourly or other time-averaged energy level (L_{eq}) or statistical sound levels identifying the level exceeded a given percentage of the time (L_{10}, L_{50})	A noise which lasts longer or is constant has more impact than one of the same sound energy that occurs only occasionally or for a short period of time.
Degree of intrusion of noise events over background noise levels	Difference between peak and ambient noise levels. Statistical sound levels, peak noise levels compared to average or ambient.	Individual distinct noise events such as aircraft overflights or loud vehicle passby events of a given noise level are more intrusive if they occur in a quiet environment.
Time of day	24-hour or annual average level with weightings for evening and night noise such as CNEL or L_{dn}.	People and their activities are generally more sensitive to noise during the nighttime hours because (1) background noise is generally lower, making noise of a given noise level more intrusive, and (2) sleep is easily interrupted by noise.
Importance of noise source	Judgement of social value of noise source.	People are generally willing to accept more disturbance from noise they consider necessary, such as from trash collection, emergency vehicle sirens, police helicopters, etc.

1.2.1. Descriptors of Instantaneous Sound Level.

The simplest measures of sound are those that measure the loudness or energy content of sound at any given instant. These measures include the Sound Pressure Level, which is unweighted for frequency, and various weighted noise level measures intended to better reflect the response of the human ear and brain. Most agencies using noise descriptors to establish community noise standards, including the State of California, the U.S. Environmental Protection Agency, Caltrans, and other agencies throughout the world, use the A-weighted sound level as the basis for these standards.

The A-weighted sound level scale has been developed to measure sound in a manner similar to the way the human hearing system responds. The use of the A-weighted scale is often indicated by using the abbreviation "dB(A)" for expressing the units of the sound level. Typical A-weighted sound levels measured for various common noise sources are provided in Table 2 on page 7.

Adding noise values. Because the units describing sound levels are logarithmic, they cannot be added arithmetically. For example, two noise sources, each of which results in a noise level of 60 dB(A), when combined result in a doubling of the amount of acoustical energy in the environment. This doubling results in an increase of only approximately three decibels in the sound level, to 63 decibels. Because of the large difference in energy represented by a small change in noise level, adding two noise sources of substantially different levels has little impact on the level determined by the louder of the two sources. For example, adding one noise source at 70 decibels to a source at 60 decibels produces a total noise level of 70.4 decibels. Table 10 on page 61 provides a quick shortcut to adding noise levels from multiple noise sources, and estimating the change in noise level that results from a change in intensity of a noise source (such as traffic noise) composed of a number of individual noise sources.

Significance of changes in noise level. Acousticians have determined that individuals cannot reliably tell the difference between the noise level of two sounds heard close to each other in time unless the sound levels differ by three decibels or more. People generally find that an approximately 10-decibel increase in sound level is necessary before the sound is judged to be twice as loud.

These findings based on single short individual noise events in a laboratory situation cannot be applied to community noise environment situations which are made up of millions of such individual noise events over a typical year. A three-decibel increase in the energy-averaged noise level means twice as many noise events in the environment, or louder events, so that noise has a higher probability of disrupting noise-sensitive activities over a day or year. The following additional factors must be considered in evaluating the impacts of small numeric changes in annual average noise levels:

1. Even a small increase in average noise level such as by 1 to 3 decibels may mean that speech and other activities are disrupted more often, or for more people, over any given period of time.

2. In some instances, a small increase in average noise level may mean that people and noise-sensitive land uses in a substantially larger area are exposed to noise levels exceeding a threshold of significant effect.

Table 2. Noise Levels for Common Noise Sources

Peak Noise Level (dB(A))	Common Indoor Noise Sources	Common Outdoor Noise Sources
Greater than 110	Rock Band	
105-110		
100-105		Military jet flyover at 1,000 feet
95-100	Inside subway train	Gas lawn mower at 3 feet
90-95		Diesel truck at 50 feet
85-90	Food blender at 3 feet	Trash truck load/compact cycle at 50 feet
80-85	Garbage disposal at 3 feet	Noisy urban daytime
75-80	Shouting at 3 feet	
70-75	Vacuum cleaner at 10 feet Inside automobile on freeway	Gas lawn mower at 100 feet Car accelerating at 50 feet
65-70	Normal speech at 3 feet	Commercial area
60-65		Heavy traffic at 300 feet
55-60	Large business office	Dogs barking at 150 feet
50-55	Dishwasher in next room	Birds singing at 150 feet
45-50	Small theater, conference room (background noise level)	Quiet urban daytime
40-45	Small theater, conference room (background noise level)	
35-40		Quiet urban nighttime
30-35	Library	
25-30	Bedroom at night, ventilation off Concert hall (background noise level)	Quiet rural nighttime
20-25		
15-20	Broadcast and recording studio (background noise level)	
10-15		
5-10		
0-5	Threshold of hearing	

Source: Caltrans Noise Manual, March, 1980, p. 1-1-4, supplemented by CBA from noise monitor data for various projects.

1.2.2. Energy-averaged Noise Descriptors.

Many studies have been conducted over the years in an effort to identify the best single noise environment descriptor which would predict people's reaction to the widely varying and different noise environments in urban areas. Such studies have found that noise descriptors which average the instantaneous noise levels over the time period of analysis result in the best correlation with people's assessment of the impact of noise on their environment and quality of life for most typical urban noise environments. The energy-average noise level is the constant noise level that would result if the total sound energy received over the measurement period from varying noise levels was received as a constant level over the entire measurement period. The energy-average noise level has the advantage that it considers all the principal factors that result in annoyance in a single number:

1. The energy-average noise level is strongly dependent on the noise level of the few loudest noise events, which are likely to cause the greatest interference with normal day-to-day activities and cause the greatest annoyance.

2. The energy-average noise level increases both with the number of noise events of the same noise level, and with the loudness of individual noise events.

3. The energy-average noise level has been found to correlate well with people's overall reaction to noise environments, consistently comparing people's responses to environments with a few noise events of high noise level to their response to environments with a large number of noise events of lower noise level.

Equivalent Noise Level. (L_{eq}) The equivalent noise level is the average noise level averaged over any reference period of time. The most common averaging period is one hour, sometimes denoted $L_{eq(1)}$. $L_{eq(24)}$ is also often used to represent the average noise level over a 24-hour day. Unless otherwise indicated, the L_{eq} is typically assumed to be based on the A-weighted noise level.

Single Event Level (SEL). The Single Event Level is the energy-averaged noise level of a noise event such as a vehicle passby or an aircraft overflight, normalized to a time of one second. This is level that would be measured in one second if all the sound energy of the noise event, from the time it rises above the background noise level until the time it fades into the background again, were concentrated in one second. This convention allows the convenient logarithmic adding and multiplying of SEL values to calculate total daily noise exposure from a variety of noise events.

1.2.3. Time-of-Day Weighted Noise Descriptors.

People and their activities are more sensitive to noise at night, both because more people are at home involved in quiet activities or sleeping, and because background noise levels are lower, making intrusive noises more obvious. The attempt to find a single noise level which represents all aspects of the noise environment that affect people has therefore resulted in the definition of time-weighted noise levels. These noise measurement schemes add a weighting to the energy-averaged noise level for noise during periods of higher noise sensitivity.

Community Noise Equivalent Level (CNEL) and Day-Night Level (L_{dn}). Two different time-weighted noise measures are important for assessing noise in Thousand Oaks. The first is the Day-Night level, or L_{dn}, used by the Environmental Protection Agency, other federal agencies and most states in regulating community noise. Second is the Community Noise Equivalent Level, or CNEL, which is used in California regulations and guidelines related to noise impact and sound insulation.

Both the CNEL and L_{dn} include a 10-decibel penalty for noise that occurs between 10:00 P.M. and 7:00 A.M. The CNEL includes an additional 5-decibel penalty for noise that occurs between 7:00 P.M. and 10:00 P.M.

1.3. Noise Standards and Guidelines

This section of the Noise Element provides technical background on the nature of noise problems, provides the justification for establishment of noise standards and regulation of noise sources, and establishes specific noise guidelines for land use compatibility

Variation in Human Response to Noise Environments. The use of any single noise descriptor to regulate noise must be considered in light of a wide variation in people's response to the character of the noise environment. In any given situation of noise impact, there is likely to be found a wide range of response, including both people who do not consider the noise to be at all important, and people who consider the noise to be unusual and severe. Regardless of the noise situation, there may be 10 to 20% of the total population in each of these extreme categories. In establishing noise standards, acousticians and social scientists have used the point where a substantial part of the population begins to shift out of the group that considers noise not to be an issue as the point where noise should be considered to have an adverse effect on people and their activities. They have used that point where a substantial portion of the population begins to shift into the group considering the noise to be unusual and severe as the point at which the noise environment should be considered unacceptable for residential areas.

Noise Standards and Guidelines of Other Agencies. Table 3 on the following page summarizes U.S. Environmental Protection Agency health and welfare noise guidelines. Standards and guidelines of a number of other agencies are listed and discussed in Appendix A.

Table 3. EPA Health and Welfare Criteria for Noise

Effect	Noise Level Needed to Protect the Public Health and Welfare with an Adequate Margin of Safety	Area
Hearing Loss	Leq (24) $\leq$ 70 dB	All areas.
Outdoor activity interference and annoyance	Ldn $\leq$ 55 dB	Outdoors in residential areas and farms and other outdoor areas where people spend widely varying amounts of time and other places in which quiet is a basis for use.
	Leq (24) $\leq$ 55 dB	Outdoor areas where people spend limited amounts of time, such as school yards, playgrounds, etc.
Indoor activity interference and annoyance	Leq $\leq$ 45 dB	Indoor residential areas.
	Leq (24) $\leq$ 45 dB	Other indoor areas with human activities such as schools, etc.

Response to noise	Threshold of effect
Hearing Loss	Leq(24) not to exceed 65 for long periods (minimum 1 year) for 100% confidence
Communication Interference	Varies with background sound level. For normal speaking voice at 3 feet to achieve 70% word intelligibility, the background level should be 65 dBA or less.
Sleep Interference	Maximum levels should not exceed 70 dBA. The differential with the ambient should not exceed 10 dBA. for probability of 70% that waking will not occur.
Stress Factors	No clear criteria to date.
Annoyance	Threshold for "highly annoyed" in residential areas at Leq(24) = 55dBA
Significant change in sound level for individual noise events	3 to 5 dBA
Audibility	Generally, the onset is 5 dBA below the instantaneous ambient

Source: U.S. Environmental Protection Agency, *Report on Levels of Environmental Noise Requisite to Protect the Public Health and Welfare with an Adequate Margin of Safety*, 1974.

Noise Standards for Land Uses in Thousand Oaks. Figure 1 on page 12 is a summary of noise standards and guidelines for acceptability of outdoor environmental noise levels for various land uses based on a large number of these studies over the years. The standards are generally consistent with the findings and recommendations of the EPA Levels Document, standards of the U.S. Department of Housing and Urban Development, the California Airport Noise Standards and the California standards for sound insulation of residential units. The standards are based closely on the recommended standards of acceptability included in the California Health Department Office of Noise Control's guidelines for noise elements, which were used without change in the City's 1987 Noise Element. Some adjustments have been made in those recommendations to eliminate ambiguities and to tailor the guidelines for the City of Thousand Oaks, as described below under "Changes from Standards of the 1987 Noise Element."

These standards are established by this Noise Element as the appropriate standards for different types of land use in the City of Thousand Oaks. Where noise problems exist, appropriate strategies should be applied to reduce noise problems.

Noise-Sensitive Land Uses. The term "noise-sensitive land uses" is used throughout the Noise Element to refer to land uses that are particularly sensitive to noise at levels commonly found in the urban environment. Within the Noise Element, the term "noise-sensitive land use" is considered to include all uses in Figure 1 for which the "normally unacceptable" impact category begins at a noise level of 70 dB CNEL or less. This category includes all residential uses, schools, hospitals, churches, outdoor spectator sports facilities, performing arts facilities, and hotels and motels.

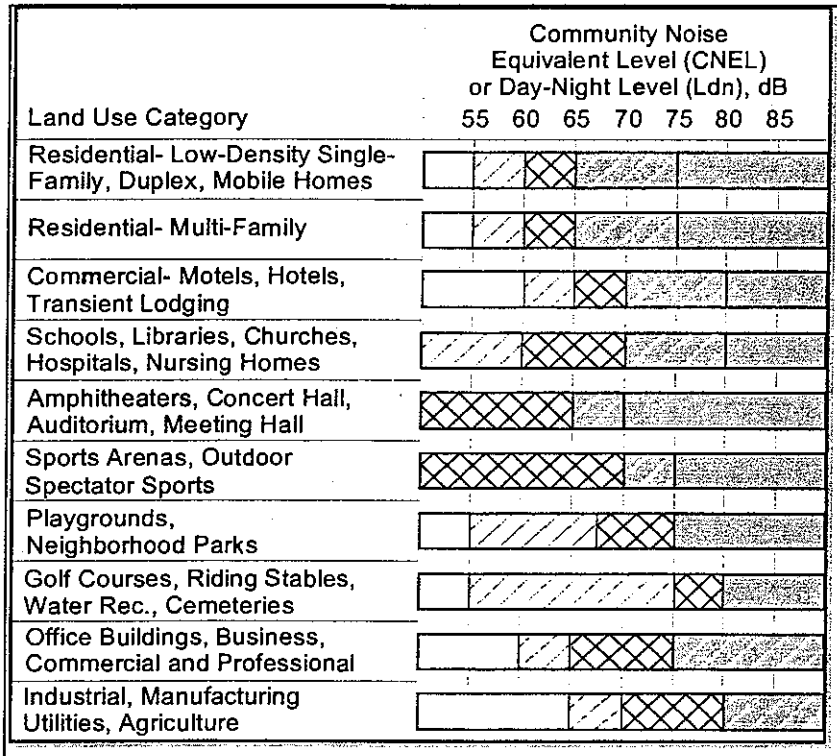
Changes from Standards of 1987 Noise Element. Adopted standards established in the 1987 Noise Element have been modified in the following ways:

The ambiguity caused by the overlap between the category of "normally acceptable" and "conditionally acceptable" in the 1987 Noise Element has been eliminated. A specific noise level above which the noise environment is considered "normally unacceptable" is established for most land uses, and the "clearly acceptable" category is added to include those noise levels below which the noise environment would normally be considered to present no problems for the specified land uses.

The noise level considered "normally unacceptable" for residential development has been reduced to 65 dB CNEL for all categories of residential land use. The previous Noise Element considered 70 dB CNEL to be the threshold of the "normally unacceptable" area for residential land uses. This change reflects a concern for the quality of the outdoor noise environment in all residential areas, and is the City's current practice in reviewing development projects.

Limitations on Use of Land Use Compatibility Standards. These new standards are intended to be used for land use planning at the citywide, specific plan, or project planning level. They indicate the sensitivity of land uses to the overall noise environment from all sources, which is typically dominated by urban transportation noise sources. These standards have limited applicability to noise problems that result from individual noise events or individual noise sources on adjacent properties such as amplified sound, mechanical equipment, dogs barking, or other common community noise sources. They should be used together with additional information about the noise sensitivity of specific activities and the characteristics of individual noise sources to develop regulations which apply to such noise events. The Noise Ordinance is the appropriate place for establishment of such standards.

Because the standards are based on a single number that is intended to represent all aspects of the noise environment, they may also need to be supplemented by special studies or special standards in unusual or unique situations. Such special studies or standards are appropriate where the noise environment includes unique conditions such as impact noise, noise with a high percentage of pure tones, noise that occurs only or primarily at night, amplified sound including music and voice, or alarms and sirens. Such noise problems tend to be focused on particular locations or situations, and are less an issue when planning the overall arrangement of land uses in the General Plan.



Nature of the noise environment where the CNEL or Ldn level is:

Below 55 dB
Relatively quiet suburban or urban areas, no arterial streets within 1 block, no freeways within 1/4 mile.

55-65 dB
Most somewhat noisy urban areas, near but not directly adjacent to high volumes of traffic.

65-75 dB
Very noisy urban areas near arterials, freeways or airports.

75+ dB
Extremely noisy urban areas adjacent to freeways or under airport traffic patterns. Hearing damage with constant exposure outdoors.

Clearly Acceptable
The noise environment is suitable for this use.

Normally Acceptable
Noise may be considered a problem by some people, but normal building construction will usually provide adequate protection of interior spaces.

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

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

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

All categories: These guidelines assume typical urban noise environments and typical activities associated with these land uses. For unique noise-sensitive activities, unusual noise conditions, or for individuals unusually sensitive to noise, special conditions may apply at any average noise level.

The Community Noise Equivalent Level (CNEL) and Day-Night Noise Level (Ldn) are measures of the 24-hour noise environment. They represent the constant A-weighted noise level that would be measured if all the sound energy received over the day were averaged. In order to account for the greater sensitivity of people to noise at night, the CNEL weighting includes a 5-decibel penalty on noise between 7:00 p.m. and 10:00 p.m. and a 10-decibel penalty on noise between 10:00 p.m. and 7:00 a.m. of the next day. The Ldn includes only the 10-decibel weighting for late-night noise events. For practical purposes, the two measures are equivalent for typical urban noise environments.

Source: Cotton/Beland/Associates, based on State of California and U.S. Department of Housing and Urban Development standards and guidelines and U.S. Environmental Protection Agency, *Report on Levels of Environmental Noise Requisite to Protect the Public Health and Welfare with an Adequate Margin of Safety*, 1974.

Figure 1. Standards for Land Use Compatibility with Urban Noise Environments

1.4. Existing and Potential Future Noise Problems in Thousand Oaks

This section describes existing noise sources in the City that have the potential to result in noise conflicts with existing or proposed land uses.

Noise sources and the extent of noise impacts were determined based on community comments at Noise Element workshops, noise monitoring at various points throughout the City, and computer modeling of freeway and arterial noise.

1.4.1. Community Noise Concerns

Table 4 on page 17 summarizes the issues raised at community meetings held during the development of the Noise Element. Although a number of noise sources and noise problems were identified in the workshops, arterial roadway and freeway noise was by far the greatest concern of workshop participants, and occupied most of workshop discussion time. Retail area noise such as auto repair work and retail delivery noise at specific locations was the second source in terms of number of people commenting and commonality of concern.

Other noise problems identified were largely isolated incidents or comments by only one workshop participant, showing that the City has been successful in avoiding noise problems through appropriate planning of land uses.

1.4.2. Community Noise Survey

A community noise survey was conducted in September, 1998 to identify existing conditions of the noise environment throughout the City. The detailed report of this survey is available separately from the City[1]. Forty-two individual monitor sites were selected for noise measurements. Monitor sites were selected considering the following criteria:

At least some monitor sites used in the 1987 Noise Element should be monitored for comparison.

Wide geographic coverage of the City should be provided, including both noisy and quiet areas, so the full range of the noise environment in the City can be identified.

Monitoring should include sites reflecting known existing problems such as arterial roadway noise in residential areas, freeway noise, noise from retail and repair facilities, and noise from industrial plants.

Of the 42 sites, 12 sites were monitored for a 24-hour period. At the remainder of the sites, a sample period of 15 minutes was used to identify typical conditions of the noise environment and to estimate 24-hour CNEL based on the field measurements for the sample period.

At each site, the maximum, various statistical noise levels (L_{10}, L_{25}, L_{50} and L_{90}) and the equivalent noise level or energy-average noise level (L_{eq}) were calculated based on the measurement history at the site. For sites monitored for 24 hours, the CNEL was calculated based on the actual hourly L_{eq} for each hour. For sites with 15-minute sample measurements, CNEL was estimated based on L_{eq} + 2 decibels, a typical value based on the 24-hour measurements.

Figure 2 on page 15 shows the noise levels recorded at each of these monitor sites. In addition, the figure shows noise levels measured in a study conducted in the same year for the Dos Vientos development project, and noise levels recorded in monitoring conducted for the 1987 Noise Element.

No unique or unusual noise problem in specific locations was identified in the survey. The survey confirmed the overriding importance of motor vehicle noise in defining the noise environment throughout the City.

[1] Gordon Bricken & Associates, *Results of the Community Noise Measurements for the City of Thousand Oaks*, October 12, 1998.

Noise Levels Measured at Thousand Oaks Noise Monitor Sites

1998 Noise Element Noise Study

Site	Type	L_{max}	L_{10}	L_{25}	L_{50}	L_{90}	L_{eq}	CNEL
1	24	86.0	68.0	55.3	65.0	59.0	69.1	60
2	ST	73.0	60.0	59.5	59.0	57.5	59.5	63
3*	ST	63.0	53.0	52.0	51.0	49.0	51.7	55F
4*	24	67.0	48.5	43.0	41.0	39.0	46.7	52
5*	24	71.0	50.0	48.0	46.0	39.0	52.6	56
6	ST	70.0	61.0	58.0	55.5	52.0	57.6	61F
7	24	85.0	78.0	76.5	75.0	69.0	77.3	80
8*	24	70.5	44.5	41.0	39.5	37.0	42.3	51
9	24	64.0	48.5	53.5	49.0	43.0	52.3	58
10	24	74.0	67.5	65.0	61.5	50.0	63.9	64
11	ST	86.0	69.0	62.5	54.5	45.5	64.4	66.0
12*	24	55.0	48.0	46.0	45.0	41.0	45.7	52.0
13	ST	79.0	64.0	60.0	55.0	43.5	59.8	62.0
14	24	80.5	66.0	61.5	55.0	39.5	62.6	62.0
15	ST	74.0	61.0	59.5	58.0	52.0	60.8	63.0
16	ST	75.0	60.0	65.0	63.0	57.0	62.7	65.0
17A*	ST	67.5	49.0	43.5	42.0	40.0	46.1	48.0
17B*	ST	67.5	50.5	49.0	46.0	41.0	48.5	52.0
18	ST	79.0	73.0	72.0	71.0	65.0	72.1	74.0
19	ST	78.0	69.5	67.5	66.5	63.0	66.7	70.0
20	24	67.5	60.5	58.5	56.5	53.5	57.4	60.0
21	24	72.0	71.5	70.0	68.5	66.0	69.2	69.0
22	ST	71.0	65.0	63.0	60.0	52.0	61.8	64.0
23	ST	66.0	58.0	57.0	57.0	54.0	56.5	58.0
24	ST	88.0	70.0	58.0	65.0	54.0	69.8	72.0
25	ST	69.0	57.0	56.5	56.0	55.0	56.9	59F
26*	24	71.0	50.5	47.0	44.5	41.0	51.0	53.0
27	ST	80.5	75.5	74.5	73.0	70.5	73.5	76.0
28	ST	73.0	62.0	60.5	59.5	58.0	59.6	62.0
29	ST	74.0	64.0	61.5	59.0	54.0	60.5	63.0
30	ST	72.0	62.5	60.0	57.0	53.0	58.8	61.0
31	ST	77.0	67.0	65.0	63.5	52.0	65.9	68.0
32	ST	84.0	67.0	64.5	62.0	50.0	64.6	67.0
33	ST	67.0	60.0	58.5	57.0	55.0	58.7	61.0
34	ST	70.5	68.0	67.0	66.0	64.0	66.1	68.0
35	ST	84.0	72.5	68.5	64.0	59.0	68.9	71.0
36*	ST	75.5	54.0	51.5	50.0	48.5	52.5	56F
37	ST	80.0	77.0	76.0	75.0	72.0	75.0	77.0
38	ST	79.0	68.5	53.5	57.5	49.0	64.1	66.0
39	ST	68.0	67.0	65.0	64.0	54.0	65.9	68.0
40	ST	62.0	58.0	53.5	48.0	41.0	51.9	54.0
41	ST	69.0	60.0	58.0	56.0	51.0	58.1	60.0
42	ST	74.0	58.0	55.0	52.0	41.0	58.1	60.0

Source: Gordon Bricken & Associates, 1998

1985 Noise Element Noise Study

Site	Type	L_{max}	L_{10}	L_{25}	L_{50}	L_{90}	L_{eq}	CNEL
1		77.0	52.0		41.0	40.0	56.4	
2		62.0	55.0		52.0	51.0	52.9	
3		68.0	54.0		41.0	40.0	51.1	
4		70.0	53.0		46.0	43.0	50.5	
5		75.0	57.0		55.0	54.0	56.7	
6		64.0	55.0		51.0	50.0	53.5	
7		78.0	61.0		56.0	51.0	58.9	
8		73.0	61.0		55.0	49.0	57.6	
9		82.0	68.0		62.0	55.0	65.2	
10		65.0	54.0		43.0	40.0	50.5	
11		67.0	57.0		53.0	50.0	54.7	
12		79.0	72.0		65.0	51.0	67.7	
13		77.0	58.0		49.0	45.0	52.1	
14		70.0	63.0		56.0	44.0	58.9	
15		71.0	60.0		50.0	42.0	55.5	
16		73.0	62.0		56.0	49.0	58.1	
17		84.0	66.0		60.0	55.0	63.3	
18		70.0	54.0		45.0	40.0	51.1	
19		72.0	54.0		50.0	48.0	52.9	
20		81.0	55.0		45.0	42.0	57.5	
21		76.0	67.0		60.0	53.0	63.5	

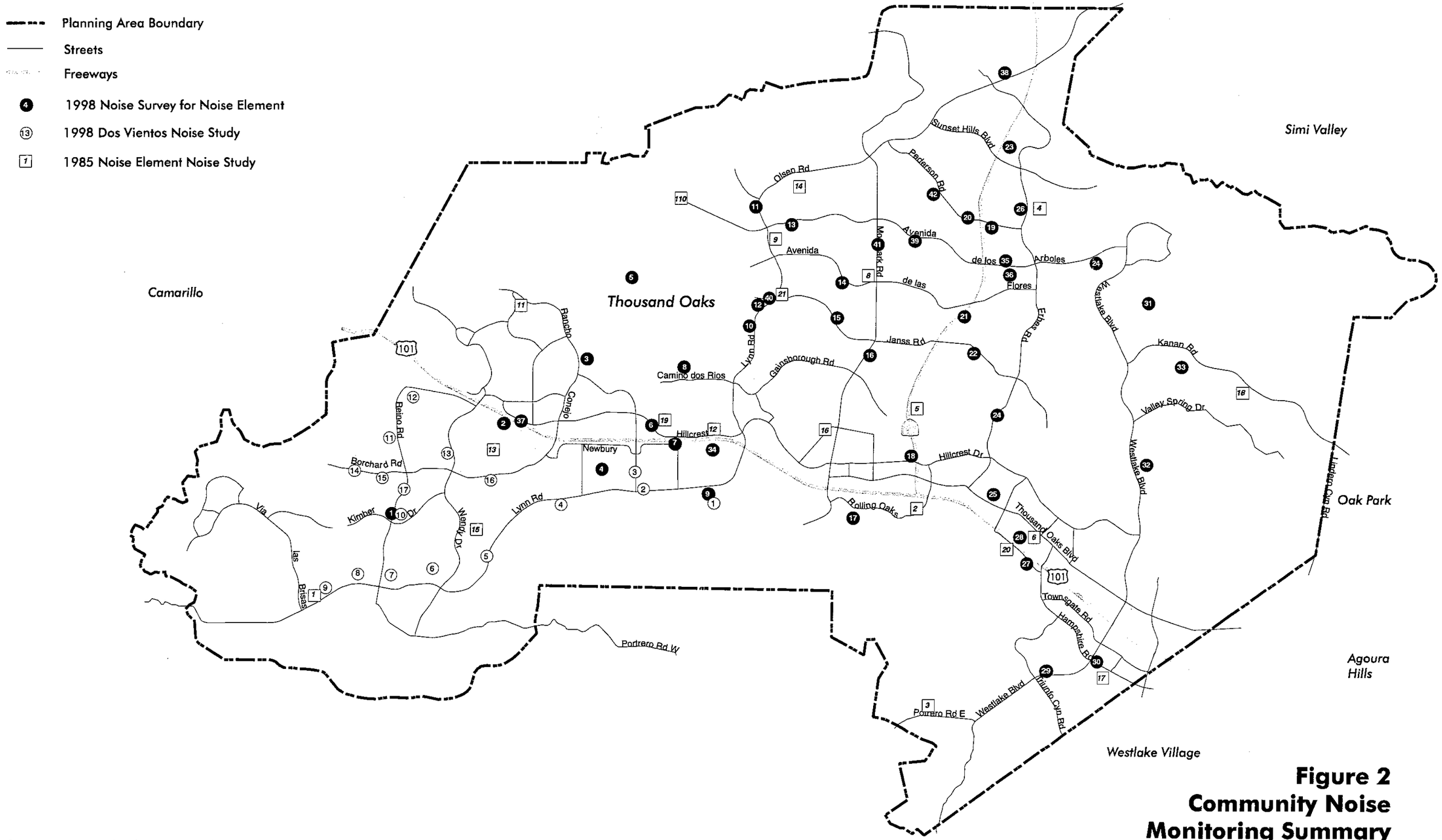
Source: Michael Brandman Associates, Inc., 1985

Dos Vientos Baseline Noise Study, 1998

Site	Type	L_{max}	L_{10}	L_{25}	L_{50}	L_{90}	L_{eq}	CNEL
1	24							72.0
2	ST	74.7	65.4	59.4	56.4	48.4	60.4	
3	ST	75.4	64.4	60.4	57.6	53.4	61.3	
4	ST	69.3	65.4	60.4	58.4	53.4	61.2	
5	24							72.3
6	ST	68.8	62.4	56.4	52.9	45.4	43.4	
7	ST	74.2	63.4	60.5	59.4	54.4	60.7	
8	ST	79.3	73.4	69.5	67.4	62.4	69.5	
9	24							69.6
10	24							77.0
11	ST	74.5	67.4	64.4	60.4	52.4	63.4	
12	ST	76.3	69.4	66.9	64.4	54.4	65.9	
13	ST	82.7	75.4	71.4	69.4	56.4	71.0	
14	ST	60.3	47.4	45.4	43.4	39.4	45.9	
15	24							74.0
16	ST	80.7	72.4	70.4	65.4	58.4	68.6	
17	ST	75.6	69.4	66.4	61.4	51.4	65.0	

Source: Acoustical Analysis Associates, 1998

* Neighborhood location (others influenced by adjacent arterial or freeway noise.)
24 24-hour monitoring
ST Short-term noise monitoring
F - fixed noise source nearby
CNEL for short term sites based on L_{eq} + 2



Source: Cotton/Beland/Associates, Inc., January 2000

Figure 2
Community Noise Monitoring Summary
Thousand Oaks Noise Element

Table 4. Noise Problems Identified at Public Meetings

Auto repair, pneumatic tools, tires, alarms
Delivery trucks
Leaf blowers, trash trucks
Freeway noise – can't use hearing aid in back yard
Problems selling house because of freeway noise
Completion of 23 freeway made noise go on all night
Lynn Road traffic – 6,000 vehicles per day when arrived, now 26,000
High speeds on arterials – posted for 45, travel at 55
Widening of 23 will increase noise levels
Vibration from trucks
Air pollution from trucks
Lynn Road – used to be like a river, now like a waterfall
Motorcycles
Can't use park by 101 freeway for softball because too noisy
Appraiser took $20,000 off value compared to comparables because of noise
Parks – Oak Meadows, Conejo Lake Park, too noisy to read
Dogs barking – surrounded by dogs. People go to work, let dogs out, dogs bark all day
Traffic – Thames Street – people use as a shortcut – Hendrix-Dover
Northwood – can't hear TV in bedroom without window closed
EIRs – each project treats noise as miniscule – but all add up
Dos Vientos project will increase noise.
SUVs make more noise – big tires
On 23 and 101 – midnight -- early A.M. lots of 18-wheel trucks
California Lutheran – 1,000 parking spaces

Source: Comments at Noise Element public workshop April 29, 1998

Traffic Noise

Traffic noise on arterial streets and freeways was identified as the most important noise problem in the City by residents in community workshops. This perception is validated by both community noise surveys and computer modeling of traffic noise.

Noise levels throughout the City cannot be monitored to identify the impact of traffic noise in detail. Instead, computer modeling is used to estimate traffic noise levels based on the number of vehicles on each roadway, the mix of vehicle types, percentage of vehicles using the roadway in the daytime, evening and nighttime hours, vehicle speed, and roadway configuration.

Aircraft Noise

While aircraft noise contributes to overall noise exposure in Thousand Oaks, aircraft noise is a minor problem and an occasional irritant compared to traffic noise. There are only two aircraft noise issues relevant to planning decisions in the City based on current and probable future operations. These two issues are helicopter noise near hospital helipads, and the possibility of future helicopter noise if air taxi service using helicopters is reinstituted at any local airports.

Commercial Air Traffic

While Thousand Oaks is beneath flight paths for approaches and departures from Los Angeles International Airport and Burbank Airport, its distance from these facilities means that aircraft are normally at relatively high altitude and are widely dispersed, resulting in no substantial noise impact when compared to background traffic noise. Such overflights were mentioned in public meetings but are not considered a significant problem.

Private Fixed-wing Aircraft

Other airports that result in air traffic over Thousand Oaks include Oxnard, Camarillo, Santa Monica, and Van Nuys Airports. Small private aircraft also result in noise events that contribute to overall noise exposure in Thousand Oaks, but the contribution of these events to overall noise exposure is negligible.

Helicopters

The Federal Aviation Administration has established freeway corridors as official helicopter routes for travel throughout Southern California. While helicopters often use freeways as routes through Thousand Oaks, the helicopter traffic volume is sufficiently low and altitudes are typically sufficiently high that no substantial helicopter noise impact exists in comparison to the freeway traffic noise. Helicopters also occasionally use helistops at hospitals for emergencies, at financial institutions for transportation of checks for clearing, and at public safety facilities for police helicopter operations. Only hospital helicopter flights were mentioned in community meetings as a potential noise problem. Helicopter operations produce relatively high peak noise levels at nearby residences because they operate so close to the ground and close to residential areas near hospitals.

Construction Noise

Construction noise typically involves the loudest common urban noise events. Construction equipment involves large diesel engines, operating at high power to move heavy loads. It involves extensive use of power and air tools, impact noise from hammering and use of explosive drivers for masonry nails and anchors.

Construction activity is temporary at any given location, but can be substantially disruptive to adjacent uses during the construction period. Construction results from both private land development activity, and from public agency activity to construct utiities, streets and public buildings. The City currently regulates the hours of construction activity to limit impact.

Mechanical Equipment Noise.

Mechanical equipment is used extensively in buildings to provide heating, cooling, air circulation and water supply. Mechanical equipment that produces noise includes motors, pumps and fans. Frequently, this equipment includes components of pure tone noise from the rotational frequency of motors. Although noise levels are generally low from these sources at nearby properties, the fact that such sources may operate continuously and may include pure tones that make them audible at a substantial distance makes them a potentially important noise source.

Portable Power Equipment.
Portable power equipment includes devices such as leaf blowers, lawn mowers, portable generators, electric saws and drills, and other similar equipment. The noise source may result from the motor, from the working surface of the tool on the work piece, from aerodynamic noise of blowers and fans, or a combination of these sources. Portable power equipment is ubiquitous in the modern city, and can produce very high noise levels at the location of the work.

Animals.
Animals including farm animals, dogs and cats have the potential to be an annoying noise source. Noise impact of domestic animals is commonly a matter of individual property owners and is regulated through animal control regulations which require owners to control noisy animals.

Amplified Sound.
Amplified sound includes noise from personal or home audio equipment, automotive audio equipment, loudspeakers on sound trucks or in fixed installations used for paging, and amplified sound used for music or theatrical performances. Because this sound typically includes music or speech, it is potentially more detectable and more annoying than other sounds of the same noise level.

Horns, Bells and Sirens
Sound from horns, alarms, bells and sirens used by emergency equipment, trains or standard motor vehicles may occur at any location in the City, and may be particularly disruptive to activities because their purpose is to get people's attention.

People
People talking, shouting, clapping, or stamping feet can create substantial noise levels, particularly if a large number of people is involved. This source of noise is of particular concern at private parties, or places of assembly such as entertainment facilities. Most complaints of people as a noise source result from noise of groups of people at night.

The nature and extent of each of the more significant noise problems identified in Thousand Oaks is further detailed below.

1.4.3. Motor Vehicle Noise Impact

As a result of our dependence on motor vehicles, the predominant noise source in a city is typically roadway traffic. In Thousand Oaks, traffic far outweighs all other noise sources in terms of the number of people and residential units exposed to noise exceeding "normally acceptable" noise levels. In community workshops held to identify noise problems in the City, noise from freeways and arterial streets was mentioned almost exclusively. Concern was particularly expressed over use of arterial streets as freeway bypasses when freeways are congested. In addition, the growth of outlying areas of the City which will put additional through traffic on existing arterials that pass through residential areas was commonly mentioned.

Vehicle noise levels vary depending on type of vehicle, engine size, speed, tires, roadway grade, pavement, and other factors.

Figure 3 on page 23 shows an estimate of existing traffic noise levels in the City. Potential noise impacts were estimated using the Federal Highway Administration's Highway Traffic Noise Prediction Model. In locations where major barriers or terrain effects would be expected to result in reduced noise levels compared to those estimated by computer modeling, freeway noise contours are shaded. This analysis does not consider in detail the effect of noise barriers and terrain, or the barrier effect of other buildings, on the width of the noise contours. However, it does provide an indication of the extent of potential noise impact of traffic for a site with direct line-of-sight exposure to a substantial segment of the roadway. The actual noise levels that would be measured at a given location depend strongly on such factors as small local variations in topography, and the presence of barrier walls and buildings between the roadway and the measurement point. Therefore, the noise levels in this figure should only be considered an approximation of the maximum potential sound levels and their lateral limits extending beyond the edge of the

pavement and an indication of where additional analysis may be appropriate. A detailed noise monitoring survey or computer modeling that considers the details of noise path conditions at each point in the City is not feasible.

For freeway noise impact areas, the map gives an indication of where terrain and barriers are likely to provide a substantial reduction in noise level compared to the model prediction for unshielded sites. Either an effective noise barrier wall or a row of intervening structures will typically provide a minimum of 5 decibels and often 10 or more decibels of noise reduction. Thus, field conditions will often limit the lateral extent of the noise contours if measured in the field.

Table 5 on page 21 provides an estimate of the area of land within the noise contours of Figures 3 and 4. As indicated above, this table indicates the area exposed to these levels assuming that no barriers or other structures exist between the noise source and receiver. The table also includes the areas within the public right-of-way, which may be as much as half of the area within the 65 dB CNEL noise contours for arterial roadways. The right-of-way area is a much smaller percentage of the 60 dB CNEL noise impact area for arterial roadways. It is also a very small percentage of the noise impact area for freeways.

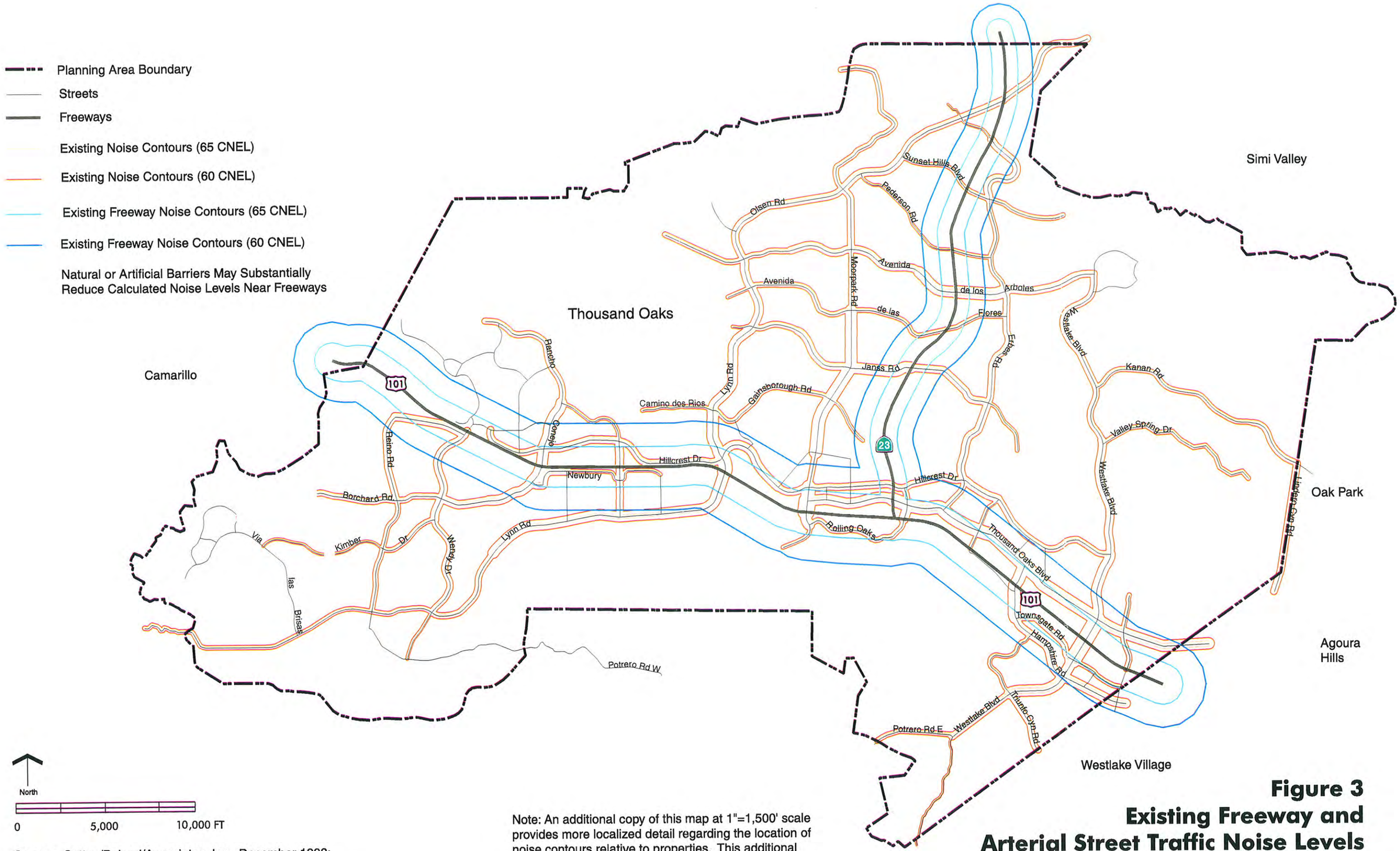
The threshold of adverse impact of noise on residential uses is approximately 55 dB CNEL. Because terrain, existing development and other factors make the location of the 55 dB CNEL contour nearly totally dependent on field conditions, computer models used to estimate the location of the 55 dB CNEL contour may provide misleading results. Therefore the 55 dB CNEL contour was not calculated and is not illustrated on the figures.

Table 5. Existing and Proposed Land Use in Traffic Noise Impact Areas

General Plan Land Use Category	Land Area in Acres by Noise Level								
	Existing			Projected			Change from Existing		
	60-65 dB	>65 dB	Total	60-65 dB	>65 dB	Total	60-65 dB	>65 dB	Total
Residential									
Residentially developable	34.6	26.7	61.4	41.0	42.3	83.3	6.4	15.6	22.0
Very Low Density	529.3	342.0	871.3	581.1	425.5	1,006.6	51.8	83.5	135.3
Low Density	1,759.5	1,173.0	2,932.5	2,042.8	1,482.8	3,525.6	283.3	309.8	593.1
Medium Density	616.0	516.9	1,132.9	651.6	625.1	1,276.7	35.6	108.2	143.8
High Density	214.2	151.8	366.0	208.9	192.3	401.2	(5.3)	40.5	35.2
Total Residential	3,153.6	2,210.5	5,364.1	3,525.4	2,768.0	6,293.5	371.8	557.6	929.3
Nonresidential									
Commercial	414.6	1,195.5	1,610.1	337.9	1,322.7	1,660.6	(76.8)	127.2	50.5
Commercial/Residential	22.3	2.2	24.4	27.7	2.8	30.6	5.5	0.6	6.1
Industrial	328.0	453.4	781.4	316.1	529.8	845.9	(11.9)	76.4	64.5
Institutional	65.7	54.5	120.2	76.7	68.1	144.8	11.0	13.6	24.5
Elementary School	38.8	7.0	45.8	66.0	8.9	74.8	27.1	1.9	29.0
Intermediate School	12.8	6.2	19.0	19.4	7.7	27.1	6.6	1.5	8.1
High School	29.3	15.8	45.1	48.5	19.4	67.8	19.2	3.6	22.8
Park, Golf, Open Space	909.3	782.7	1,692.1	1,089.8	920.9	2,010.7	180.5	138.2	318.7
Proposed Park and Recreational Area	1.4	1.1	2.4	14.0	12.1	26.1	12.6	11.1	23.7
Lake	2.3	1.3	3.6	3.6	1.8	5.3	1.3	0.4	1.7
Reserve	82.3	70.1	152.4	94.5	96.9	191.4	12.3	26.8	39.1
Undefined	-	19.8	19.8	-	19.8	19.8	-	-	-
Undevelopable	166.5	183.8	350.4	184.7	224.5	409.3	18.2	40.7	58.9
Total Nonresidential	2,073.2	2,793.3	4,866.5	2,278.8	3,235.2	5,514.0	205.6	441.9	647.5
Total All Uses	5,226.9	5,003.8	10,230.6	5,804.3	6,003.2	11,807.5	577.4	999.5	1,576.8
% of total City land area:	13.5%	13.0%	26.5%	15.0%	15.5%	30.6%	1.5%	2.6%	4.1%

Source: Cotton/Beland/Associates, based on analysis of noise contours of Figures 3 and 4, excluding areas where terrain or exisitng barriers would be expected to substantially reduce noise levels.

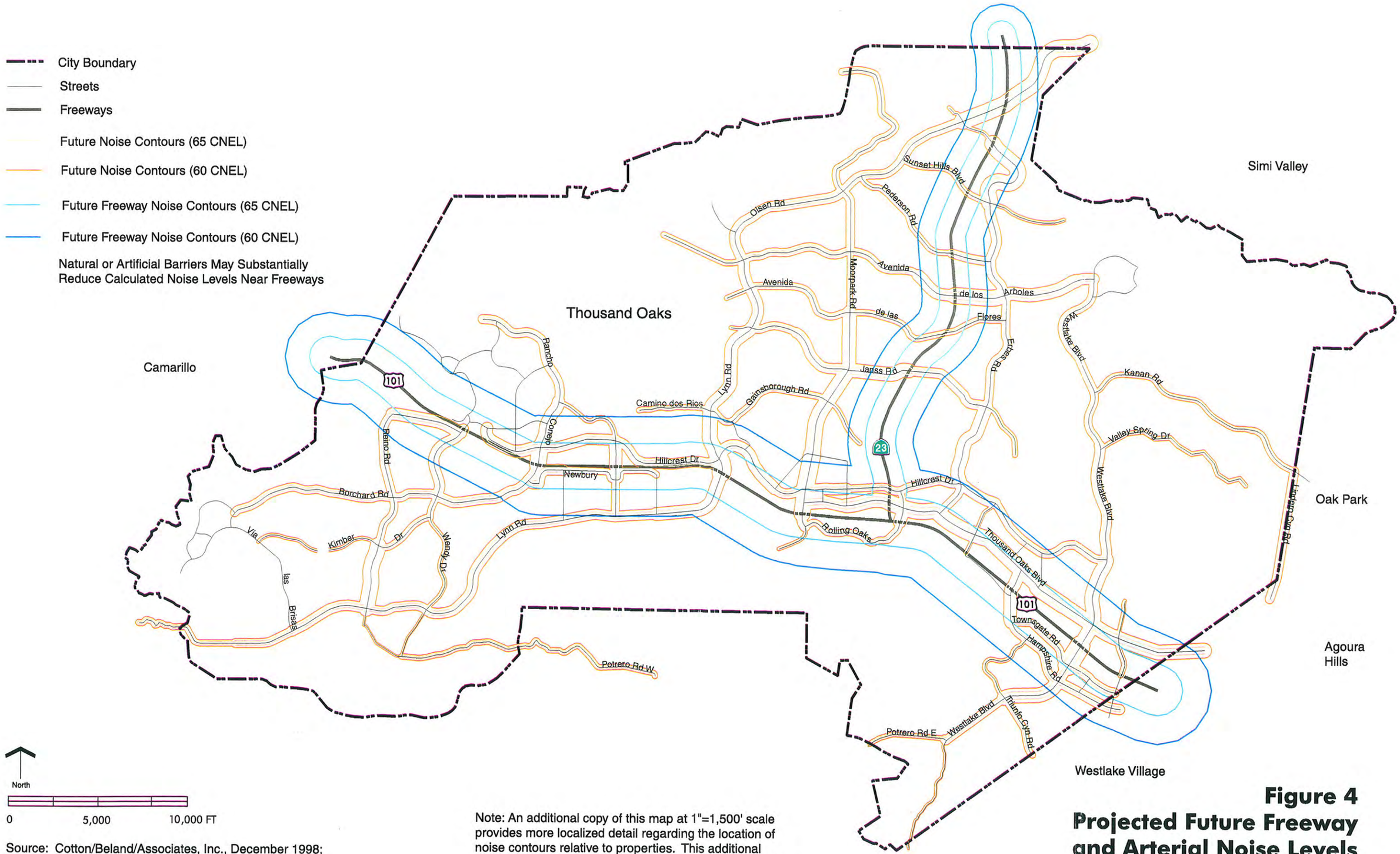
Totals may not add in last decimal place due to rounding throughout table.



Source: Cotton/Beland/Associates, Inc., December 1998; Gordon Bricken & Associates, January 1999

Note: An additional copy of this map at 1"=1,500' scale provides more localized detail regarding the location of noise contours relative to properties. This additional map is available for viewing at Thousand Oaks City Hall.

Figure 3
Existing Freeway and Arterial Street Traffic Noise Levels
Thousand Oaks Noise Element



Source: Cotton/Beland/Associates, Inc., December 1998; Gordon Bricken & Associates, January 1999

Note: An additional copy of this map at 1"=1,500' scale provides more localized detail regarding the location of noise contours relative to properties. This additional map is available for viewing at Thousand Oaks City Hall.

Figure 4
Projected Future Freeway and Arterial Noise Levels
Thousand Oaks Noise Element

2. Goals and Objectives

The City of Thousand Oaks seeks to maintain a standard of high environmental quality for all its residents. Thousand Oaks is predominately a residential community. A quiet environment is important to the quality of life in a residential area. The goals of the Noise Element are directed primarily at maintaining and improving the environment of residential areas and other noise-sensitive land uses by minimizing the adverse impacts of noise.

The Noise Element is only one element of the City's General Plan. In some specific situations, the goals, objectives, policies or programs of the noise element may conflict with other parts of the General Plan. In such cases, the City may determine that other objectives take higher priority, or that some balance is needed between the competing objectives.

Goal N-1. Achieve and maintain an environment in which noise-sensitive uses are not disturbed by noise that exceeds exposure guidelines established in this Noise Element.

This goal reflects the need to maintain basic environmental standards for quiet in residential areas and other noise-sensitive areas of the City. Where noise levels already exceed these standards, efforts to reduce noise levels should be directed at the source, and by measures to protect sensitive uses through sound insulation or noise barriers. Where noise conflicts cannot be eliminated in this way, in concept the conflict can be resolved by encouraging conversion of the noise-sensitive uses to uses which are less noise-sensitive. However, no substantial area in Thousand Oaks was identified where such land use conversion is justified based on the existing noise environment. Such conversion could have other land use policy implications, and is normally considered only in severe noise problem cases where no alternatives exist.

Policy N1-1. Land Use Compatibility for Noise. In establishing the pattern of land uses and setting standards for development within land use categories, the City will consider the need to minimize the potential for conflicts between noise-sensitive land uses and activities and land uses that are normally expected to generate noise.

Policy N1-2. Reduction of Existing Noise Conflicts at the Source. Recognizing that reduction of noise at the source is normally the most efficient strategy for reducing noise conflicts, and results in the greatest benefit in reducing overall noise exposure, the City will emphasize reducing noise levels at the source as the primary or preferred strategy for reducing potential conflicts.

Policy N1-3. Reduction of Existing Noise Conflicts by Other Means. Where it is not the most feasible measure to reduce noise conflicts at the source, the City will work to provide other protection for noise-sensitive land uses in areas exposed to noise that exceeds or is expected to exceed the noise guidelines for noise-sensitive land uses adopted in this Noise Element.

Policy N1-4. Prevention of Future Noise Conflicts. The City will strive to avoid future noise conflicts between land uses and noise sources or activities that would exceed the noise guidelines for noise-sensitive land uses adopted in this Noise Element.

Policy N1-5. Regulation of Nuisance Noise Sources. The City will maintain and actively enforce a noise ordinance which addresses the problems that may result from time to time from people's activities, use of mechanical equipment, amplified sound, and other sources of potential noise conflicts between users of property in the City. In regulating such noise sources, the City may consider such factors as noise level, frequency distribution of sound, duration and number of noise events, tonal content, information content such as music or human speech, time of day, and any other appropriate factors found to relate to human annoyance or interference with human activities.

Policy N1-6. Monitoring of the Noise Environment. The City will regularly evaluate the noise environment to ensure that the objective of minimizing reducing noise conflicts is being achieved. As a general guideline, a comprehensive review of community noise levels may be conducted approximately every 10 years.

Goal N-2. Preserve quiet and diminish existing noise levels in areas of noise-sensitive uses to the extent reasonable and feasible while permitting development in accordance with the Land Use and Circulation Elements of the General Plan.

This goal reflects the fact that even in areas that currently meet noise standards, the quality of the environment is in general improved by reducing ambient noise levels from urban activities, and is degraded if ambient noise levels increase. Since people have varying sensitivity to noise, providing choices including the choice of living in areas where existing quiet will be preserved is a matter of policy.

Although preserving quiet is an important objective, locations within the City will experience unavoidable increases in ambient noise levels as a result of development or transportation system improvements in accordance with the Land Use and Circulation Element policies of the General Plan. The City does not intend to limit such development in order to achieve this goal.

Policy N-2.1. Consider Impact of Noise Increases in Quiet Areas. In evaluating projects for significant adverse environmental effects under the California Environmental Quality Act, the City will consider substantial increases in community noise level to be a potentially significant effect even if these increases do not result in a violation of the City's guidelines for normally acceptable noise levels for noise-sensitive land uses.

3. Solving Noise Problems

This section of the Noise Element discusses the nature of the most important noise problems facing the City, and identifies ways to address these problems.

Section 3.1 discusses the nature of noise problems and how various approaches can be used to address them. It examines the appropriateness and need for City action to address each noise issue. This analysis provides the basis for the City's comprehensive noise abatement program outlined in Chapter 4.

Appendix B provides a list of noise control strategies identified by the California Office of Noise Control in its advisory Noise Element Guidelines. The discussion below and in Chapter 4 describing the City's noise abatement programs includes those strategies most applicable or important in Thousand Oaks.

3.1. Noise Control Strategies

A noise conflict situation involves a noise source, a path through which the noise travels, and a noise-sensitive receiver. Depending on the nature of the situation, the problem may be addressed at any of these three points.

Table 6 on page 33 is an outline of noise abatement strategies for motor vehicle noise that illustrates how noise conflicts can be reduced by acting at each of these points in the system.

Table 7 on page 34 is a summary of various noise control strategies for dealing with a variety of noise sources. This table summarizes the effectiveness of each strategy, its limitations and costs, and other considerations that may affect its implementation.

3.1.1. Noise Control at the Noise Source

Because a noise source may affect many different receivers, it is generally most efficient to deal with noise problems at the source. The objective of noise control at the source is to reduce the total amount of sound energy which reaches the environment from the noise source, or to change other aspects of the noise source which affect human response.

Noise sources produce sound energy and transmit it to the environment in a number of ways. These include direct excitation of vibrations in air (fans, loudspeakers, internal combustion engine exhaust, vibrating engine parts, air compressors, pumps), friction of metal parts (motors, fans, drilling), and pressure waves from striking of solid objects (sawing, hammering, banging, drilling, tires on roadway). The amount of sound energy generally increases with speed, force, and mass of air movement.

Sound energy can be reduced by modifying the system that creates the noise to produce a lower noise level, to reduce the amount of time the source generates noise, and/or to change the time of day to a less-sensitive time period. Sound energy emitted to the environment may be reduced by placing sound absorbing material around the source or along the path by which sound reaches the general environment from the source. For a noise source made up of many different sources, such as urban traffic, the noise level may be reduced by reducing the number of individual noise events, or by reducing the noise level of each individual event.

3.1.2. Reducing Motor Vehicle Noise at the Noise Source

Table 6 on page 33 is an outline illustrating how motor vehicle noise can be controlled at the noise source, in the noise path, or at the noise receiver.

Traffic noise levels from a given roadway increase with the number of vehicles, the average noise level of each vehicle, average speed, the percentage of trucks in the fleet mix, and the percentage of vehicles traveling at night. Other factors such as the number of vehicles violating muffler laws, squealing tires, occasional speeding, and vehicles with loud music systems, may increase annoyance without substantially affecting the total noise level. The smoothness of the pavement surface, and whether a sound-deadening treatment such as rubberized asphalt has been applied, can also affect noise level.

3.1.2.1. Noise Levels of Individual Vehicles

Local regulation of noise from automobiles is preempted by state law in California. California regulates the maximum noise level produced by mufflers, requires maintenance of mufflers and exhaust systems, and regulates the maximum noise produced by auto sound systems. Local agencies enforce these regulations, which are found in the California Vehicle Code. While enforcement of regulations can be effective in eliminating the most annoying individual vehicles, this enforcement has little impact on overall community noise exposure, because almost all vehicles comply with the state regulations.

The State of California regulates the maximum noise level produced by the muffler system of newly manufactured vehicles (see Appendix A). However, the maximum permitted noise level is substantially greater than the average noise level of typical vehicles, and the regulation has little effect on vehicle noise levels. When first adopted, the regulations prohibited aftermarket exhaust systems which exceeded original equipment noise levels; however, a few years after introduction this requirement was removed. Aftermarket exhaust systems are now permitted to be sold if they do not exceed the maximum permitted noise level.

While heavier cars require larger engines than small cars, and their larger tires and greater weight would be expected to result in more tire noise, their large size also permits greater sound insulation around the engine compartment. Large cars, including sport utility vehicles, are in general not noisier than smaller cars, although certain tread patterns can result in higher noise levels. At freeway speeds, tire noise is the dominant noise source from cars.

City efforts to reduce the typical noise of individual vehicles are limited to enforcement of vehicle code noise levels and advocacy of lower noise levels for newly manufactured vehicles and aftermarket exhaust systems.

3.1.2.2. Vehicle Speed.

Figure 5 on page 31 illustrates the effect of vehicle speed on noise level. In the discussion that follows, a standardized example of an arterial roadway is used to show the effect of various noise reduction strategies. This standardized example is a four-lane arterial roadway with 10,000 vehicles per day. The fleet mix is 94% autos, 4% light trucks and 2% heavy trucks (semi-trailer diesel trucks). The time of day distribution is 70% day, 15% evening and 15% night, based on a survey of arterial roadway data conducted in Los Angeles County by CBA staff.

Reducing vehicle speed on this sample arterial street with 10,000 vehicles per day from 45 mph to 35 mph would reduce the average noise level from a typical mix of traffic at 75 feet from the centerline of the roadway from 67.3 dB CNEL to 65.0 dB CNEL, a reduction of 2.3 decibels. A reduction of 2.3 decibels is equivalent to reducing the number of vehicles by approximately 42%, to 5,800 vehicles.

State law limits the ability of Cities to enforce speed limits which are lower than limits determined in a survey of current traffic speeds unless specific safety considerations are involved. Reducing speeds for noise abatement must therefore be accomplished by means other than setting the legal speed limit, or through legislation permitting use of the speed limit for this purpose.

3.1.2.3. Number of Vehicles

Table 10 on page 61, following the Glossary, provides a convenient method of determining the impact on total noise exposure of changes in the number of vehicles or other approximately identical noise sources. Figure 5 shows that 10,000 vehicles at 45 mph result in a noise level of 67.2 dB CNEL at 75 feet from the centerline of the roadway. Reduction of the noise level by 3 decibels to 64.2 dB CNEL would require a reduction in traffic volume of 50%. To reduce the noise level by 10 decibels would require a reduction in traffic to 1,000 vehicles, a reduction of 90%.

Because of the large change in traffic volume required to produce a substantial reduction in noise level, reducing traffic volume is generally not a practical solution to arterial traffic noise problems. An exception is if there is an alternate route that has substantially less noise-sensitive use, or is protected by barriers or distance from noise-sensitive land uses.

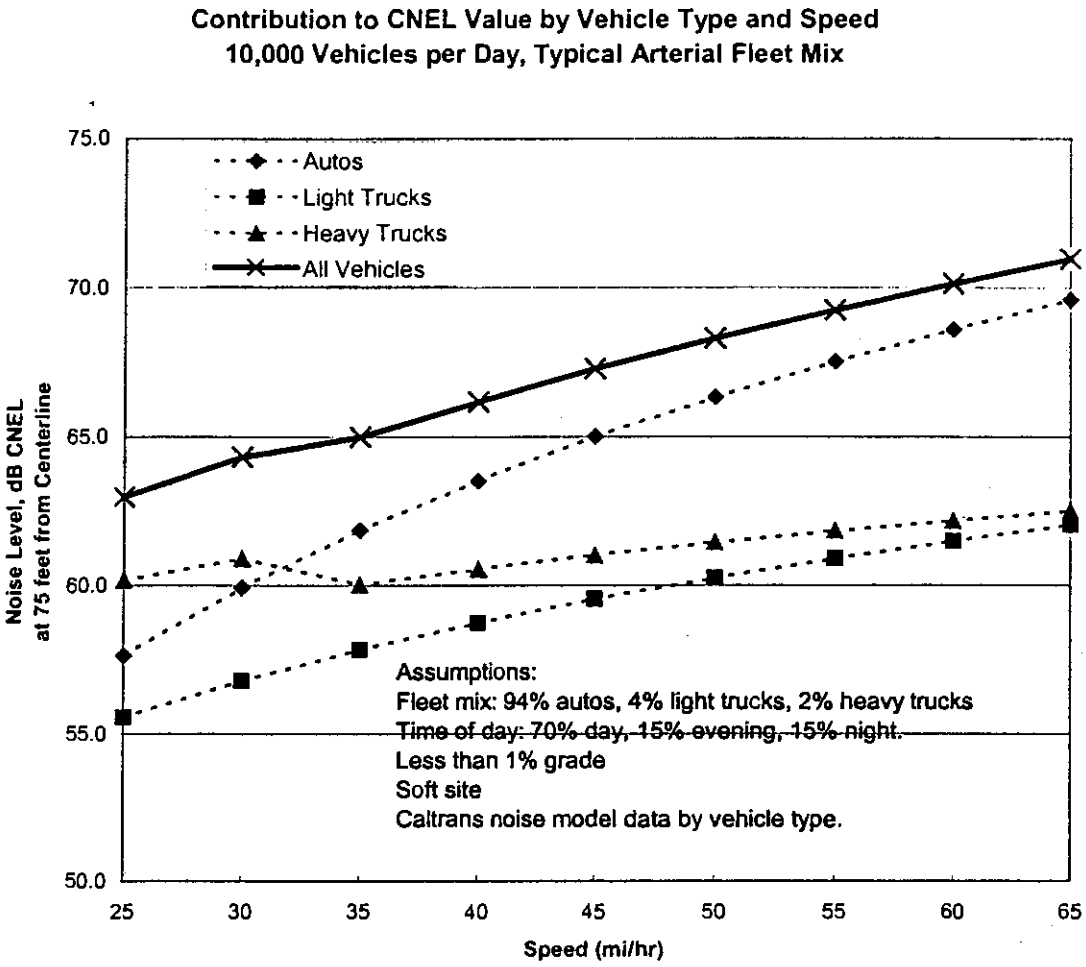


Figure 5. Noise as a Function of Vehicle Speed

This figure illustrates the effect of vehicle speed and the contribution of autos, medium trucks and heavy trucks to daily average noise levels for an arterial street with a typical mix of vehicles and typical distribution by time of day.

3.1.2.4 Development Density

A number of residents at public meetings on the Noise Element commented that reduction of the permitted density of as yet undeveloped areas should be considered as a means of reducing noise. Unless the reduction in density is substantial, noise reduction resulting from this strategy is relatively small. Reductions in density do not proportionately reduce vehicle travel or noise, since lower density in general results in a higher number of vehicle trips per dwelling unit, longer average trips and total vehicle miles traveled, and higher vehicle speeds, all of which counteract the effect of reduction in density.

An exception exists where the density reduction results in the elimination of certain areas from potential development. Roadways directly serving these areas may have substantially less traffic and resulting noise level than if the area were developed. Because most of Thousand Oaks is nearly built to its potential development density under the General Plan, very little community noise benefit is to be gained from reducing the potential development density of as yet undeveloped areas.

3.1.2.5. Fleet Mix.

Heavy diesel trucks have high noise levels compared to cars, particularly at low speed. Because engine and exhaust noise is a higher percentage of truck noise than car noise, truck noise levels do not rise with speed as much as automobile noise levels. Figure 5 on page 31 shows the difference in contribution of autos and trucks to total vehicle noise exposure at different speeds. While the contribution of autos increases from 61.9 dB CNEL at 35 mph to 67.5 dB CNEL at 55 mph, a change of 5.6 dB, the contribution of heavy trucks increases from 60.0 to 61.8 dB CNEL, a change of 1.8 dB.

Because trucks contribute more of the total noise exposure at low speeds, changing the number of trucks as a percentage of the fleet has a greater impact at low speeds. The effect of reducing the percentage of trucks is also greater if the roadway has a high percentage of truck traffic.

For an arterial street that currently has a high percentage of truck traffic and a relatively low average speed of 35 mph, changing the percentage of trucks from 5% to 2% would reduce the noise level at 75 feet from the centerline of the roadway from 66.6 dB CNEL to 65.0 dB CNEL, a reduction of 1.6 dB CNEL. Reducing the percentage of trucks further from 2% to 0% would further reduce the noise level from to 65.0 to 63.4 dB CNEL, a reduction of 1.6 dB. Reducing the percentage from 5% to 2% on a roadway with a typical speed of 55 mph would reduce the noise level from 70.2 dB CNEL to 69.3 dB CNEL, a change of only 0.9 dB. Thus, restricting truck use with the City's ability to establish truck routes with noise abatement in mind on local arterials and collector streets can be effective in reducing noise levels, but has greater impact at low speeds and for roadways that already have a high percentage of truck traffic.

3.1.2.6. Time of Day.

Reducing the percentage of vehicles that travel in the evening or at night could reduce the average noise level. Elimination of all traffic between 10:00 p.m. and 7:00 a.m and distributing this traffic proportionately over the remaining hours of the day would reduce the noise level of the sample arterial roadway from 65.0 dB CNEL at 75 feet from the roadway to 61.3 dB CNEL, a reduction of 3.7 dB CNEL. As a practical solution, this strategy has limited effectiveness because of the inability of local government to control people's driving choices, and the fact of long commutes in a large metropolitan region.

Table 6. Outline of Potential Noise Abatement Strategies

I. Noise Source

- A. Levels of individual vehicles
  - 1. Quieter vehicles
    - a. Quieter tires.
    - b. Lighter vehicles (providing adequate sound insulation is provided).
    - c. Improved muffler systems.
    - d. Control sound system volume.
  - 2. Reduce number of vehicles violating exhaust system or noise standards
  - 3. Reduce speed
  - 4. Rubberized asphalt
- B. Number of vehicles
  - 1. Reduce number of vehicles on roadway
    - a. Reroute to other locations
    - b. Minimize total vehicle miles traveled
- C. Fleet mix
  - 1. Reduce percentage of trucks
- D. Time of day
  - 1. Reduce nighttime travel by all vehicles
  - 2. Reduce nighttime travel by trucks

II. Noise Path Changes

- A. Increase distance between source and receiver
- B. Barriers between source and receiver

III. Noise Receiver Changes

- A. Receiver location changes
  - 1. Encourage compatible development in noise impact areas
  - 2. Relocate existing incompatible uses
  - 3. Prohibit incompatible uses in noise impact areas
- B. Receiver sensitivity changes
  - 1. Insulation of structures
    - a. Insulation requirements
    - b. Insulation retrofit programs for existing uses
  - 2. Sound masking
  - 3. Public relations

IV. Feedback and control mechanisms

- A. Development fees based on noise impact
- B. Regulation of noise sources
- C. Provide information to buyers and builders

Table 7. Noise Abatement Strategies: Costs, Effectiveness, Other Considerations

Noise Abatement Strategy	Noise Reduction	Costs	Limitations, Comments, Other Considerations
Motor Vehicle Noise			
Reduced noise levels of individual vehicles (engine insulation, mufflers, quiet tires)	2-3 dB average over time as older vehicles are retired from the fleet	To a few hundred dollars per vehicle over life cycle	Likely to require federal action, City has little influence. Increased fuel consumption for heavier vehicles.
Eliminate noise and muffler law violators	Less than 1 dB average, can reduce peaks from worst offenders substantially	$5-10,000 per year	Requires training, equipment, allocation of police and attorney time, signs and public relations program. Limited ability to be there when worst offenders are causing noise problems
Reduce arterial roadway speed	2 dB for reduction of auto speed from 45 mph to 35 mph	Signage, enforcement	Enforcement problems from legal requirements for setting speed limits. May require state legislation.
Reduce truck percentage in fleet mix	2 dB for reduction of heavy trucks from 4% to 2% of fleet	Cost of establishing truck routes	Likely to relocate trucks to other locations with similar noise sensitivity.
Reduce nighttime travel	1 – 1.5 dB for cutting nighttime volume in half (10 PM – 7 AM)		Likely to relocate nighttime traffic to another location. Includes early morning commute hours.
Reduce number of vehicles on roadways	1 dB for 20% reduction in traffic, 3 dB for 50% reduction in traffic, 5 dB for 68% reduction in traffic	Varies – signage, neighborhood traffic control (barriers, traffic calming), upgrade alternate routes	Requires either demand reduction or availability of adjacent routes for relocation of traffic. Requires substantial reduction in traffic (30-40%) for meaningful reduction in noise level. Ridesharing, HOV lanes.
Reduce density or intensity of future development	Proportional to reduction in traffic.	Increased infrastructure per unit of use, lower city revenues per unit of area for some revenue sources	Reduction in density results in less than proportional reduction in noise since additional travel per unit is required with lower density, and higher average speeds are likely with low-density development. May force development out to greater distances, increasing through traffic with reductions in locally generated traffic.
Reduce nighttime travel	3.7 dB with elimination of all night travel for a typical fleet mix.	Unknown	Difficult to force this kind of driver choice.
Aircraft Noise			
Ensure helicopters follow freeway routes, particularly during special VFR	To 1 dB CNEL for heavily impacted areas	May require substantial effort to address if a problem occurs	FAA routes are recommended, difficult to influence FAA
Limit heliports to locations where immediate access to acceptable routes is possible	To 3-5 dB CNEL for a residence that might be affected by a large number of helicopter operations	Nominal regulatory and enforcement cost, applicant covers CEQA costs	Zoning for heliports, CEQA process. Not currently a significant noise problem, though may be a nuisance near hospital emergency heliports.
Minimize noise from approaches and departures from LAX, Burbank, Van Nuys, Oxnard and Camarillo airports	No measurable impact on CNEL since not likely to affect CNEL, may reduce peaks from overflights 3-5 dB	May be difficult and expensive to influence FAA if a problem occurs.	Likely to move impact to another area which may complain. Not currently a significant noise problem. Future navigational systems may improve control.
Mechanical Equipment Noise (pumps, fans, compressors, etc.)			
Quantify noise limits in Noise Ordinance. Limit noise level by time of day, adjacent zoning district	Localized benefit, little change in CNEL. Limit to acceptable levels, minimize interference with adjacent activities	Nominal regulatory and enforcement cost, reduces cost relative to "disturbance of the peace" standards by providing clear violation.	Review of Noise Ordinance part of Noise Element Update program.
Require shielding around noise sources	Noise limits define benefit. Shielding may not change noise level	Nominal regulatory and enforcement cost	

Noise Abatement Strategy	Noise Reduction	Costs	Limitations, Comments, Other Considerations
Nuisance Noise (animals, people, deliveries, miscellaneous noise sources)			
Limit hours of commercial deliveries near residential areas.	Reduce nuisance noise during most sensitive hours.	Nominal regulatory and enforcement cost	
"Disturbance of the Peace" provisions in Noise Ordinance	Existing City noise ordinance includes provisions	Nominal regulatory and enforcement cost	Difficult cases may require specific noise limits in ordinance.
Construction Noise			
Prohibit night construction except for emergencies	5-7 dB average daily CNEL during construction period compared to 24-hour operation	Current City program. Negligible regulatory and enforcement costs	Substantially reduces complaints. May reduce contractor flexibility for specific operations (such as large concrete pours) Increases duration of construction, reduces intensity but increases duration of air quality and other impacts. Increases traffic congestion because operations are during peak travel hours.
Limit number of pieces of heavy excavation equipment	1-3 dB average daily CNEL and peak noise level, no change in annual	Negligible regulatory and enforcement costs	Increases construction and carrying costs for projects, increases duration of construction, without reducing total noise exposure over the year.
Truck haul routes away from residential areas (existing program)	1-5 dB average daily CNEL on roadways during construction period	Negligible regulatory and enforcement costs	Moves noise to another location – requires availability of alternate routes. May increase air pollution and travel time if requires substantial detour, normally not significant
Require special quiet equipment (such as compressors) within 500 feet of noise-sensitive areas	10 dB or more from quiet compressors. Little impact on CNEL because temporary	Moderately higher equipment lease costs, some impact on utility construction costs	Equipment generally available, used for OSHA compliance by many contractors.
Animals			
Noise ordinance or animal control ordinance to limit problems from barking dogs, other animals (existing program)	No substantial change in CNEL. Reduces a significant potential nuisance	Existing program. Contract for animal control	
Amplified Sound			
Limit sound levels produced by amplified sound used outdoors, near noise-sensitive uses, require permits	No substantial change in CNEL. Reduces a significant potential nuisance.	Nominal additional city cost to manage permit process	May require use of pagers rather than outdoor paging for some uses

3.1.3. Noise Control in the Noise Path

Along the noise path, noise impact may be reduced by placing barriers between the source and the receiver. Noise may also be reduced by increasing the length of the noise path by moving either the source or receiver to a greater distance.

3.1.3.1. Barriers.

To be effective, barriers must obstruct the line of sight between the source and receiver. Noise reduction by barriers is a function of the ratio of the length of the noise path with the barrier to the noise path without the barrier. This ratio is greatest when the barrier is close to either the source or receiver, and least when it is located at an equal distance between them.

Barriers are particularly effective at reducing noise from automobiles, which is created at high speeds primarily by tires. Because this noise is created close to the roadway, barriers are very effective in reducing this noise. An 8-foot to 12-foot barrier wall on a freeway can reduce noise by 10 decibels or more compared to the case without the barrier. However, even a small break in a barrier can substantially reduce its sound attenuation value. Substantially higher barriers are required to reduce truck noise, much of which comes from the exhaust outlet at a height of 10 to 12 feet. To be most effective, barriers need to be high and continuous.

In some cases, barriers on one side of a roadway may slightly increase noise on the opposite side of the roadway by reflecting noise back to the other side of the roadway. Because of the greater distance and the fact that a substantial amount of such noise is absorbed in the noise path, this contribution to noise levels is in general quite small compared to the benefit of barrier walls. However, in cases in which it may be a problem, sound-absorbing barrier walls, or compensating barriers on the opposite side of the roadway, may be considered.

Barriers are only practical and effective where access is not required to adjacent uses. For this reason, subdivision design which avoids residential driveway access on arterial roadways is recommended.

3.1.3.2. Distance

Increasing the distance between the source and receiver is particularly effective at close distances (less than 50 feet from the source, for example), where a small increase in distance can substantially reduce noise levels. For a point source of noise, increasing the path distance typically reduces the noise level by 6 decibels or more for each doubling of distance, depending on the characteristics of the path over which sound travels. For a line source of noise such as a roadway, increasing the path typically results in a 3 to 4.5-decibel reduction for each doubling of distance. At longer distances, the additional distance needed for each decibel of noise reduction increases substantially, and a substantial unusable area can result from using separation by distance as a noise attenuation strategy.

3.1.4. Noise Control at the Receiver

At the receiver, sound insulating material may be placed around the receiver, or masking noise may be used to reduce the intrusiveness of the noise source. The receiver may be relocated to a location farther from the source.

3.1.4.1. Sound Insulation.

Typical residential construction with no special attention to sound insulation typically results in 20 to 25 decibels of noise reduction between in outside and inside of the unit with windows closed. Sound insulation can increase this sound reduction by up to 10 decibels. Achieving more than 35 decibels of sound insulation in a residential unit is likely to involve unusually high costs.

Sound insulation at the receiver is particularly effective for unusually noise-sensitive uses (such as recording studios, or residences of people who are unusually sensitive to noise). It is also an appropriate strategy in cases in which a high noise level results from a wide variety of different noise sources, making it difficult to reduce noise at the source.

California law requires all new multiple-family residences to provide sound insulation from exterior noise sources to maintain an interior noise level of 45 dB CNEL or lower in all habitable rooms. The City finds that in order to preserve housing values and protect the health and welfare of residents, this standard should also apply to new single-family residences.

As a strategy for reducing noise impact in residential areas exposed to high noise levels, sound insulation is more effective for multi-family residences than for single-family detached housing. Occupants of single-family homes generally place substantial value on outdoor living. Outdoor living areas cannot be protected by sound insulation.

3.1.4.2. Sound Insulation Retrofit of Existing Residences

Sound insulation retrofit of existing residences is an expensive method of achieving acceptable noise levels for interior living areas. However, in cases in which the noise source cannot be effectively controlled, such as on existing residential streets with high traffic volumes, it may be the only method available.

Sound insulation retrofit for aircraft noise has been studied extensively in pilot programs for Los Angeles International Airport and other locations. The effectiveness of retrofit is highly dependent on the quality of construction, since small holes and gaps can allow substantial leakage of sound energy around openings.

Sound insulation retrofit for motor vehicle noise sources can be less expensive than for airport noise, since normally only one or two building faces are affected, with the other faces protected by the structure itself, and insulation of the ceiling and roof is less important.

In a pilot study conducted for Los Angeles International Airport in 1982, Wyle Laboratories identified strategies and costs of meeting the 45 dB CNEL interior sound level for a variety of types of residential structures exposed to aircraft noise.[2] The discussion of sound insulation below is based on that study.

In insulating houses against exterior noise, modifications must be made considering the three paths by which sound enters the structure:

1. Air filtration paths (gaps and cracks),
2. Small wall elements (windows and doors), and
3. Main wall elements (walls, roofs and floors).

Air Filtration Paths

Air filtration paths are the small gaps and cracks that normally exist around doors and windows. Even if the noise reduction effectiveness of the walls is high, that effectiveness will be lost if there are are air filtration gaps or windows and doors with poor acoustic performance.

The improvement in noise reduction that can be obtained merely by treating the leakage paths without modifying the windows, doors or other building elements has been shown to be on the order of 2 dB, but could be as high as 5 dB depending on the condition of weatherstripping and seals. Thus the first step in increasing the noise reduction of residences is to seal all infiltration cracks using weatherstripping, non-hardening caulking, and door threshold seals. If the sealing of cracks and leaks does not achieve the desidred interior levels, then modifications of the building elements are required.

Small Wall Elements

Since small wall elements such as windows and doors usually have noise reduction values less than that of the surrounding wall, they must usually be modified in the second stage of soundproofing. This modification should upgrade these elements to a sound reduction value close to that of the surrounding wall. This is achieved by replacement with improved elements, and can result in noise reduction increases of up to 10 dB. One basic small element modification is the installation of secondary glazing for doors and windows (conventional storm windows and doors are the most cost-effective form of openable secondary glazing). This modification can provide a substantial increase in door and window noise reduction values, but must remain in place if the benefits are to be realized year-round. In this stage of soundproofing, acoustic baffles in air vents, chimneys, and kitchen ducts are generally necessary.

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[2] Wyle Laboratories, *Residential Sound Insulation Retrofit Cost-Effectiveness Analysis*, Wyle Research Report WR-82-16, May, 1982.

Main Wall Elements

The final stage of sound insulation is the modification of the major wall elements. This stage of sound insulation is substantially more expensive than the previous two steps, and requires careful custom evaluation and design of the wall, floor and roof.

Ventilation Requirements

Air conditioning is required to achieve the sound reduction benefits of the modifications discussed, since all value of eliminating air filtration gaps and double-glazing of windows and doors are lost if doors or windows are left open for ventilation. The climate of Thousand Oaks requires air conditioning for year-round comfort with windows closed. Thus the cost of air conditioning must be considered as part of the sound insulation cost for any residence that is not currently provided with air conditioning. Window air conditioners are generally not satisfactory for this purpose since they provide an additional path for sound to enter the unit.

Costs of Sound Insulation Retrofit

The Wyle Laboratories study provided cost estimates, in 1981 dollars, for sound insulation retrofit of the structures common in the study area. Because these costs are estimates for aircraft noise, which is less directional in its impact on residences than motor vehicle noise, costs for insulation from vehicle noise could be less. 1981 cost estimates were multiplied by 2.5 to provide a 1999 dollar estimate of costs for Thousand Oaks. These estimates should be considered a general and comparative guide only. The actual costs of such retrofit vary greatly with the nature of the individual structure being retrofitted.

Table 8. Sound Insulation Retrofit Cost Estimates

Dwelling Unit Type	Cost per Square Foot to Increase Noise Reduction to:					
	20 dB	22.5 dB	25 dB	27.5 dB	30 dB	32.5 dB
Single-family, One-Story	0.20	1.35	2.25	5.25	9.00	12.00
Multi-family, Lower Floor, Interior Unit	0.03	0.20	0.35	0.80	1.40	2.00
Multi-family, Lower Floor, End Unit	0.10	0.40	0.55	1.70	3.25	4.25
Multi-Family, Top Floor, Interior Unit	0.03	0.25	0.50	1.60	2.75	3.75
Multi-Family, Top Floor, End Unit	0.12	0.60	1.00	3.00	5.00	7.00

Source: Cotton/Beland/Associates, based on information from Wyle Laboratories, *Residential Sound Insulation Retrofit Cost-Effectiveness Analysis*, WR 82-16, 1982. Standard noise reduction for typical residential units is approximately 15 to 20 dB. Costs are adjusted from 1981 estimates by multiplying by approximately 2.5. Costs do not include costs of architectural drawings, permits, minor repairs to existing structures, and contractors contingency, which may add approximately 30% to the above costs.

3.1.3.3. Sound Insulation for New Construction

The cost of sound insulation for new construction is substantially less than that for retrofit to existing structures, since the cost can be incorporated in the original plans and specifications for the structure, and removal of existing materials and custom fitting to existing conditions is not required. Because of the thermal insulation requirements of the current California building code, newly constructed residential buildings typically include double-pane windows and good weather sealing around window and door openings.

3.1.3.4. Sound Masking

Sound masking is the camouflaging of background noise events by addition of "white noise," music, or another sound source. Such masking can be effective in quiet environments where small noise events can cause distractions. It is less effective when the masking sound level needs to be high (55 dB or greater) to mask noise events, and when the interrupting noise events are substantially louder than the background noise level.

Sound masking may be effective for individuals that are exceptionally sensitive to noise interruptions at night. Sound masking can mask low-level noise events, such as from distant traffic, preventing sleep interruptions.

4. Quiet City Program

This chapter outlines the City's proposed program to achieve the goals and objectives of the Noise Element.

Some of the programs outlined below involve substantial cost, require substantial staff time, or require additional studies or regulations. All such programs compete for public funds and the resources of the City, and are subject to the City's regular annual budgeting procedures in which the City sets priorities among competing objectives. The Noise Element does not make these programs mandatory, but provides a list and description of programs that the City may consider to reduce noise.

4.1. Land Use Planning Standards

Objective. Establish and maintain standards for acceptable noise levels for various noise-sensitive land uses in the City so that the potential for noise conflicts can be identified and avoided in major land use and transportation planning decisions.

Program. Utilize the land use compatibility standards of Figure 1 on page 12 of the Noise Element to determine suitable locations for land uses based on community noise levels when amending the General Plan land use map and Zoning Map or evaluating new development projects, siting public facilities, and roadway improvement.

The standards in Figure 1 on page 12 of the Noise Element provide land use compatibility standards based on 24-hour average noise levels, and are the overall standards for acceptability of the noise environment for noise-sensitive land uses.

Specific additional standards (for example, for peak or hourly noise levels) based on the unique characteristics of specific noise sources or sensitivities of various land uses may be adopted by the Community Development Department to supplement these standards as appropriate. However, such standards shall not be less restrictive than the standards of Figure 1 on page 12.

Projects that would result in exceedance of these standards may require special investigations and mitigation.

Responsibility. Community Development Department.

Cost and Funding. Low, within normal budget allocation and responsibilities of Department. No new staff required.

Effectiveness in Reducing Noise Problems. Standards are absolutely required as a foundation for programs to address existing problems and prevent future ones.

4.2. Interior Noise and Sound Insulation Standards.

Objective. Prevent noise problems for noise-sensitive land uses by requiring noise barriers or sound insulation where necessary to achieve acceptable interior noise levels.

Program. This is a continuation of an existing program of enforcement and implementation of the California interior noise standards. Further, require that new projects be evaluated based on roadway and other noise impact anticipated at General Plan buildout rather than based on existing noise levels.

The City has extended the applicability of the noise standards to include single-family detached residential units. Applying this standard to single-family residences has substantial benefits and should be continued. State noise standards currently apply only to multi-family residential units. Because single-family residential units are part of the City's housing stock that must last for a long period of time through many cycles of ownership, it is appropriate that single-family detached residential units meet the same noise standards as multi-family units.

Responsibility. Community Development Department.

Cost and Funding. Enforcement of existing standards is a current activity, within normal budget allocation and responsibilities of Department. No new staff required.

Extension of the standards to new single-family residential development will require action by the City to adopt the standards for single-family residential units. Also, additional effort in public education, development of standard conditions, plan review, and site inspection will be required on a continuing basis, a minor incremental addition to existing costs of building inspection. Training for building inspectors may be appropriate to alert them to issues in providing sound insulation for single-family residential units and extending the geographic area where the City evaluates sound insulation performance of structures.

Because current California energy standards in general require double-pane windows and good weatherstripping around openings, no additional sound insulation requirements are expected for single-family residences except in areas exposed to very high noise levels ("normally unacceptable" for residential development).

4.3. Arterial Street Noise Abatement Program.

Objective. Minimize the noise impact of traffic on arterial streets in noise-sensitive areas.

Program. This program includes a number of components which can work together to minimize the noise impact of traffic on arterial streets where such roadways pass through noise-sensitive areas such as near schools and residences.

4.3.1. Rubberized Asphalt Treatment Program.

Program. The Citywide steet pavement resurfacing program currently uses asphalt rubber hot mix as a maintenance strategy that is also effective in reducing traffic noise.

Effects. Rubberized asphalt has been found to reduce noise levels from arterial roadways by 1 to 3 decibels compared to untreated roadways by minimizing tire noise. The treatment gradually loses its effectiveness over time, but continues to provide some noise reduction over the life of the treatment, up to 20 years. Given the limitations on other methods of reducing arterial roadway noise, this measure has potential to achieve measurable reductions in roadway noise at reasonable cost. This measure is most effective in areas with relatively high speeds where light duty vehicle tire noise is the most important component of vehicle noise.

Costs and Other Considerations. Rubberized asphalt treatment loses some of its sound deadening effect with time, and achieves full effect when the road is newly surfaced. The City has found that the rubberized asphalt is as good as or better than other surface treatments in terms of roadway life and maintenance.

The cost of this program is funded through the same sources as other transportation programs. This program may include funds from the project traffic noise mitigation program if such a program is established.

Responsibility. Public Works Department.

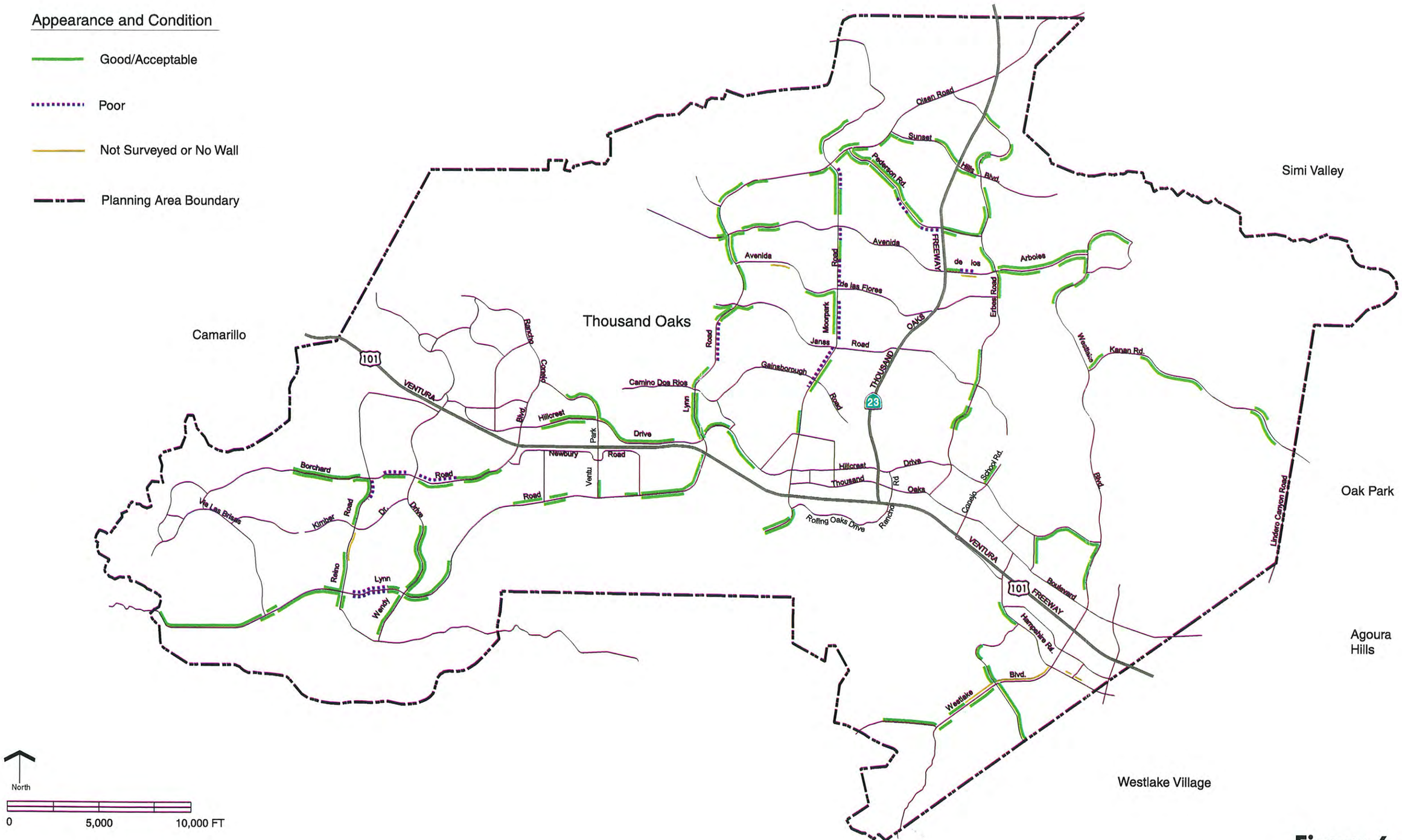
4.3.2. Arterial Roadway Noise Barrier Wall Program.

Objective. This program is intended to minimize noise impact of arterial streets on adjacent uses and on ambient noise levels throughout the City by requiring that noise barrier walls be constructed in new development projects, roadway extension or roadway widening projects where such walls would be effective in preventing or reducing noise problems.

Program. This program includes construction of noise barrier walls along arterial streets where such walls can be effective in minimizing existing noise problems and can be implemented without significant adverse impacts on site access and aesthetic character of roadways.

In addition, many existing noise barrier walls or decorative project boundary walls are in need of maintenance or could be made more effective as noise barriers with physical modifications. Improvement of such walls to improve their performance in reducing noise levels in noise-sensitive areas may also be funded by this program as appropriate. Where walls are located on private property, easements or agreements may be required with property owners.

Figure 6 on page 45 shows the status of existing arterial roadway barrier walls in the City. Figure 7 on page 47 shows the noise abatement effectiveness (in general terms) of existing arterial street noise barriers.

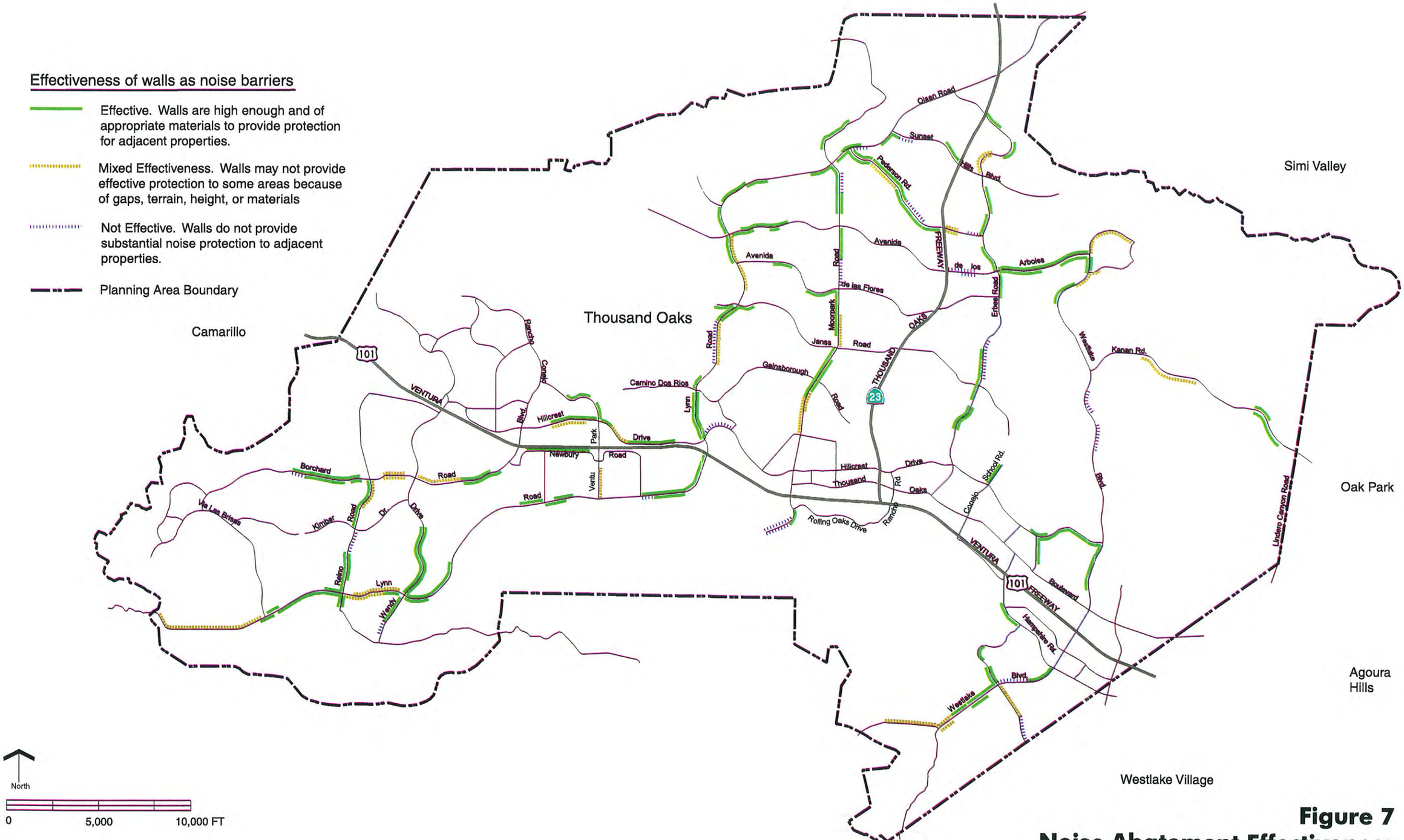


Source: Cotton/Beland/Associates, Inc., December 1998

Figure 6
Condition of Existing Arterial Roadway Walls
Thousand Oaks Noise Element

Effectiveness of walls as noise barriers

- Effective. Walls are high enough and of appropriate materials to provide protection for adjacent properties.
- Mixed Effectiveness. Walls may not provide effective protection to some areas because of gaps, terrain, height, or materials
- Not Effective. Walls do not provide substantial noise protection to adjacent properties.
- Planning Area Boundary



Source: Cotton/Beland/Associates, Inc., December 1998

Figure 7
Noise Abatement Effectiveness of Arterial Roadway Walls
Thousand Oaks Noise Element

Cost and Funding Sources. In general, noise barrier walls for arterial roadways are expected to be constructed at the time land is developed and are funded by developers. Walls are to be maintained by owners or homeowners associations, not by the City.

In some cases, noise barrier wall construction may be funded through noise mitigation fees levied on new development projects, or may be constructed as project-specific mitigation measures.

4.3.3. Arterial Roadway Sound Insulation and Noise Barrier Mitigation Program.

Objective. Mitigate cumulative impacts of new development on vehicle noise levels throughout the City through funding of construction or improvement of noise barrier walls and provision of sound insulation for existing residences and other noise-sensitive land uses.

Program. Under this optional program, new residential, commercial and industrial developments which result in increases in traffic volume on roadways in the City would be required to pay a noise mitigation fee to fund noise abatement projects in noise-sensitive areas of the City which are most affected by cumulative increases in traffic noise. Under this program, the City would establish priorities for areas in which noise abatement projects can have the greatest benefit, develop programs including barrier wall construction and sound insulation, and fund noise abatement programs as funding is available from development projects.

Because most areas of the City are near their development capacity, and substantial noise impacts resulting from growth are not expected except in unusual cases, the application of this program may be limited.

Responsibility. Community Development and Public Works Departments.

Cost and Funding Sources. This program if implemented would require the development of a program including specific projects, a cost estimate, a justification for assignment to development projects (to establish a "nexus" between costs and fees), and preparation and adoption of the program by the City Council by resolution or ordinance. Cost of establishing the program could range between $25,000 and $50,000 or more, and should be weighed against the potential benefits achieved and the potential for revenue from development projects. Ongoing management of the program would require staff review of individual projects and calculation of project fees.

Costs of construction of arterial roadway walls may range from $50.00 to $800.00 per linear foot or more, depending on the height of the wall, materials used in construction, structural requirements, aesthetics, graffiti protection, landscaping and irrigation systems required, etc. Costs would be expected to increase annually with typical construction costs.

4.3.4. Noisy Vehicle Code Enforcement Program.

Objective. Minimize nuisance noise from particularly noisy vehicles.

Program. This program includes the active enforcement of vehicle code provisions limiting engine noise from motor vehicles, limiting muffler modifications on motor vehicles, and limiting noise from sound systems in motor vehicles.

Responsibility. Police Department, City Attorney

Cost and funding sources. Additional cost of this program will include funding of training and equipment of Police Department staff involved in the enforcement program. While such programs are normally enforced on a complaint basis, periodic active enforcement of such laws can substantially reduce the number of violations since most violations are a result of a few non-complying vehicles and individuals. Equipment purchase and regular calibration (potentially shared with noise ordinance enforcement costs with the Community Development Department), staff training, and one or two focused periods involving a team of two officers for part of one shift for a week would be expected to cost approximately $5,000 to $10,000 per year. Cases which are taken to court for enforcement may involve additional costs. Funding would be from the City's general fund.

4.3.5. Arterial Roadway Speed Control

Objective. Minimize roadway noise by reducing vehicle speed.

Program: This program involves establishment and enforcement of lower speed limits on selected arterial roadways through noise-sensitive areas where speed can be effective in minimizing the amount of noise-sensitive land use exposed to "normally unacceptable" noise levels by City standards. If reducing speed limits is not feasible or enforcible, consider focusing public relations efforts such as a special "quiet streets" program with signage and public outreach, and seek special legislation to permit use of speed limits for noise abatement in special situations.

Figure 5 on page 31 illustrates the potential effect of reductions in speed limit and enforcement of speed laws for noise abatement.

Responsibility. Community Development Department, Public Works Department, Police Department

Cost and Funding. Some additional costs will be involved in order to identify suitable areas for application of this strategy, perform necessary studies to justify establishment of lower speed limits, install special signage, and enforce speed limits. If only two or three short stretches of roadway are involved, cost could be in the range of $10,000-20,000 to establish these areas, with some annual enforcement costs. A citywide program of extensive speed limit changes could be substantially more expensive.

Effectiveness in Reducing Noise Problems: A reduction in speed from 45 mph to 35 mph on an arterial roadway can be as effective as a 40% reduction in traffic volume or rubberized asphalt treatment. While the noise benefits are limited, this is one of a very few methods of reducing noise conflicts from existing traffic, and is worth investigation in noise impact areas.

State law limits the ability of local agencies to enforce speed limits lower than determined appropriate by speed surveys unless specific safety conditions dictate lower speed limits. Special legislation would be required to add noise to the considerations that can be used in setting speed limits. However, some benefit may be possible from a "slow and quiet" public relations program with special signage and other measures focused on specific problem roadways.

4.4. Noise Review of Project Time Extensions.

Objective. Ensure that previously approved projects which have not yet been constructed and request time extensions provide noise analysis and mitigation measures based on current conditions.

Program. This program involves the review for noise impact and noise sensitivity of projects that have remained undeveloped following approval for a considerable period of time (such as 5 years or more). In considering requests for time extensions for such projects, the City may require additional noise mitigation measures or noise studies, based on changes in the project, changes in land uses adjacent to the project, or changes in the noise environment of the project or surrounding areas.

Responsibility. Community Development.

Costs and Funding. Moderate additional costs for project reviews, should be funded by fees for project extensions and payment of noise study costs by project applicants.

4.5. Freeway Noise Barrier Wall Completion Program.

Objective. Ensure that aesthetically acceptable freeway noise barrier walls are ultimately constructed in all locations where such walls would be effective in minimizing noise problems. Priority should be given to locations where the benefits of constructing the walls are greatest, including the areas exposed to highest noise levels, and the areas where the walls are most effective in reducing noise impact for the largest number of people.

Program. This program has three primary components. The first involves coordination with the Ventura County Transportation Commission (VCTC) and Caltrans for prioritizing, funding, design, scheduling and construction of noise barrier walls. The second involves advocacy to increase state or other funding for Caltrans noise barriers. The third involves City participation to the extent feasible in constructing barriers in locations where barriers are effective but may not meet Caltrans criteria for barrier wall construction. This participation may be funded from project noise impact mitigation fees or other funds as available.

4.5.1. Caltrans Noise Barrier Construction Advocacy and Monitoring.

Objective. Ensure that noise barriers are constructed along freeways wherever they can be effective in protecting noise-sensitive land uses from freeway noise impacts.

Program. This program involves continuing coordination with the Ventura County Transportation Commission and Caltrans for prioritizing, funding, design, scheduling and construction of noise barrier walls.

Responsibility. City Manager, Community Development Department, Public Works Department.

Costs and Other Considerations. Recent legislation (SB 45) has transferred much of the responsibility to the Ventura County Transportation Commission for identifying, prioritizing and funding freeway sound walls countywide. Since the legislation is new, implementation details are still being developed. Funding for freeway noise barriers is anticipated to be from the State Transportation Improvement Program and would require that Caltrans design and construct the sound walls. Caltrans currently has an extensive backlog of sound wall work and delays are possible. Sound walls constructed by Caltrans are generally more expensive than those constructed by local agencies.

In the City of Thousand Oaks, the Route 23 Freeway is scheduled to be widened. New sound walls will be included in the widening project, which is scheduled for the year 2004. Other sound walls identified along the Route 101 Freeway or the Route 23 Freeway not associated with the widening will be a part of the priority process noted in the Program section above. The City should monitor the sound wall process and develop an advocacy program, if needed,for priority and funding of local noise barriers.

To the extent that the advocacy program will require special studies to justify expenditures, travel to Sacramento, special efforts by legislative advocates, or other actions, the program may require hiring of others and expenditures for City staff efforts outside of the normal budgets for Community Development and Public Works. The normal budgets of the Community Development and Public Works Departments provide for regular consultation with other agencies such as Caltrans on current projects as a normal departmental function, but do not provide for special studies or unusual efforts by City staff, consultants or legislative advocates. An additional effort could require additional funding of $10,000 to $50,000 per year depending on actions contemplated.

If the program requires an additional full-time staff member for the Public Works Department, costs could exceed $100,000 per year for the construction period, plus the cost of additional consultants for special studies.

4.5.2. Legislative Advocacy of Caltrans Noise Barrier Funding Increases.

Program. This program involves legislative advocacy to increase the funding for installation of noise barriers on freeways, so that the installation of these barriers can be accelerated.

Responsibility. City Council, City Manager, Community Development Department, Public Works Department

Costs and Other Considerations. The Caltrans schedule for implementing noise barrier walls along freeways is funded at a level that leaves a substantial backlog in construction of such walls throughout the state. The City should be able to gain cooperation of some other cities and counties to promote a faster implementation of the barrier wall program. However, legislative advocacy is an expensive and unpredictable means of reaching objectives. Cost may range from negligible for a low-effort program including a few contacts by City lobbyists or the League of California Cities, to substantial costs ($20,000 or more startup costs, plus annual advocacy until adopted) for a higher level of effort including drafting legislation and gaining support of other jurisdictions.

4.5.3. Freeway Noise Barrier Construction

Objective. Provide funding or coordinate funding from other sources to the extent necessary to complete noise barriers that are needed but cannot be funded by Caltrans.

Program. Identify locations where noise barriers are needed but cannot or will not be funded by Caltrans, identify other funding sources, and fund or assist in funding construction of these barriers to the extent revenues can be found for this purpose. Examples of the types of programs that might be considered are Community Development Block Grant funds, capital improvements funds from noise abatement development fees, local assessment districts paid for by those who benefit from the barrier wall, or other programs as available.

Responsibility. City Manager, Community Development Department, Public Works Department

Costs and Other Considerations. According to City staff estimates, noise barrier walls may cost from $200 to as much as $800 per linear foot. For lots with a 100-foot freeway frontage, the cost of the wall per residence would be approximately $20,000 to $80,000. Greatest benefits occur to those immediately adjacent to the noise barrier, so the number of people benefited substantially by a typical sound wall is small. Although the barrier may reduce freeway noise by 10 decibels or more for those nearest the wall, the benefits to residences which are separated from the freeway by other residences is likely to be 3 dB or less because of the protection provided by the first row of residences. Thus the benefit area is small in most cases, making expenditure of City funds for the entire cost of the program difficult to justify, and making walls difficult to fund through an assessment district. For the example of a 100-foot frontage, the cost per year of an assessment district to construct a barrier wall paid for by those adjacent to the wall would be approximately $2,000 per year for 10 to 20 years.

Community Development Block Grant funds may be available to fund barrier walls if a substantial benefit to low- and moderate-income persons can be found in each particular case.

City Boundary

Streets

Freeways

Terrain Barriers

Existing Freeway Walls or Structures Providing Noise Barrier

Proposed Sound Walls

Camarillo

Thousand Oaks

Simi Valley

Oak Park

Agoura Hills

Westlake Village

Sunset Hills Blvd

Olsen Rd

Pederson Rd

Avenida

Moorpark Rd

de los

Arboles

de las

Flores

Janss Rd

Lynn Rd

Gainsborough Rd

Camino dos Rios

Rancho

Conejo

Reino Rd

Hillcrest Dr

Newbury

Borchard Rd

Via

Kimber

Dr

Wendy Dr

Lynn Rd

Las Brisas

Rolling Oaks

Thousand Oaks Blvd

Townsgate Rd

Hampshire Rd

Portrero Rd W

Potrero Rd E

Westlake Blvd

Triunfo Cyn Rd

Eubanks Dr

Valley Spring Dr

Kanan Rd

Westlake Blvd

Eubanks Rd

101

23

North

0 5,000 10,000 FT

Source: Cotton/Beland/Associates, Inc., January 2000

Figure 8
Existing Freeway Noise Barriers
Thousand Oaks Noise Element

4.6. Noise Considerations in Environmental Impact Reports and Negative Declarations.

Objective. The purpose of this program is to identify and avoid potential noise problems at the project level when environmental impact of projects is considered in accordance with the California Environmental Quality Act (CEQA).

4.6.1. Thresholds of Significant Project and Cumulative Noise Impact

Under the California Environmental Quality Act, an Agency must determine whether or not a project has potentially significant adverse environmental effects in a variety of categories of effects. The following thresholds of potentially significant effects are adopted as the thresholds of significance to be used in Environmental Impact Reports and Negative Declarations prepared for projects for which the City or Redevelopment Agency is the Lead Agency under CEQA.

Table 9. Thresholds of Significance for Noise Impact

If the annual average noise level with the proposed project, cumulative projects and General Plan buildout in an area currently used for or designated in the General Plan for a noise-sensitive land use[1] is expected to be:	**A significant project or cumulative impact may result if the change in annual average noise levels from existing conditions due to all sources in an area currently used for or designated in the General Plan for a noise-sensitive land use[1] is:**	**The project alone may be considered to make a substantial contribution to significant cumulative impact if the change in annual average noise level due to the project is:**
Less than 55 dB CNEL	Not significant for any change in noise level	Not significant for any change in noise level
55-60 dB CNEL	Equal to or greater than 3.0 decibels	Equal to or greater than 1.0 decibels
60-70 dB CNEL	Equal to or greater than 1.5 decibels	Equal to or greater than 0.5 decibels
Greater than 70 dB CNEL	Equal to or greater than 1.0 decibels	Equal to or greater than 0.5 decibels

1. A noise-sensitive land use is a use for which the lower limit of the noise level considered "normally unacceptable" for development because of noise impact is 70 dB CNEL or lower. In identifying land use areas, areas which are undevelopable for noise-sensitive uses because of slope, devopment restriction, easement, etc., or which are used for non-noise-sensitive components of a multiple-use or mixed-use project, should not be considered noise-sensitive.

Exceptions.

1. Development of single-family or multi-family residential uses in an infill project in an existing residential area which is designated for development for residential uses in the General Plan, and for which a sound insulation study has been prepared by a qualified acoustical engineer or other sound insulation specialist, and for which sound insulation is included in the proposed project to meet state standards for interior noise levels for multi-family residential development, shall not be considered to have a significant adverse effect when considering the exposure of the project itself to noise levels exceeding the standards of this Noise Element. (Off-site impacts of such projects should still be considered in determining the potential significance of noise impacts.)

For projects which would result in a potentially significant impact, the City may require an acoustical study to identify mitigation measures to reduce impacts to a less-than-significant level.

4.6.2. Mitigation Measures.

The following mitigation measures should be considered in reducing project noise impacts:

All projects:

1. Contribution to a noise mitigation fund to mitigate cumulative impact of noise from additional traffic on arterial streets and freeways.

Projects involving new sources of noise on the project site:

1. Noise barriers to achieve acceptable exterior noise levels or reduce noise impacts on other properties.
2. Modifying hours of operation to minimize nighttime noise impacts.
3. Shielding noise-generating equipment, uses and activities to prevent impacts on adjacent properties.
4. Use of special low-noise versions of equipment.
5. Use of special mufflers.
6. Project design to locate noise sources away from adjacent sensitive land uses.

Projects involving development of noise-sensitive land uses:

1. Sound insulation to achieve acceptable interior noise levels.
2. Barriers on the project site to reduce exterior noise levels.
3. Design of the site and structures to provide maximum self-shielding and separation by distance of noise-sensitive uses from noise sources.

4.7. Nuisance Noise Control - Noise Ordinance

Objective. The purpose of this program is to protect residents and businesses from noise that is unnecessary or unusually severe for the land uses in the area affected by the noise.

Program. The program includes the adoption, enforcement, and regular re-evaluation of a noise ordinance which establishes permitted noise levels for land use or zoning districts of the City. In establishing such permitted noise levels, the City may consider all aspects of noise which may affect human activities, and may consider all aspects of land uses which may make them susceptible to disturbance due to noise. The Noise Ordinance is the City's primary tool for dealing with day-to-day noise problems that may arise as a result of people's activities.

Specific types of noise impacts expected to be regulated in the Noise Ordinance include the following:

Construction Noise. Regulation of time of day for high-noise construction activity (currently part of the City's standard development conditions), requirements for barriers, equipment mufflers, use of quiet types of certain equipment (such as compressors) when available, etc.

Amplified sound. Licenses for use of amplified sound throughout City, within specified distances from noise-sensitive land uses, or at certain locations. Limitations on sound level and hours of operation.

Mechanical equipment. Limitation on noise levels for compressors, fans, repair and maintenance equipment, etc. near noise-sensitive land uses.

Nuisance noise. Restrictions on nuisance noise including animals, people's voices, or all other types of nuisance noise including operation of electronic and mechanical equipment including but not limited to gasoline powered leaf blowers and lawn mowers.

Deliveries. Restrictions on location and shielding of delivery areas, hours of delivery, and days of delivery including holidays, particularly near residential areas.

Responsibility. Code Compliance, Community Development, City Attorney.

Costs and funding sources. The enforcement of the noise ordinance an existing function of the Community Development Department. Enforcement is not expected to involve substantial expense or staff time beyond the current duties of the department. The use of quantitative noise standards proposed to be added to the Noise Ordinance may require that the Department obtain or contract for use of noise measurement equipment and provide training for staff in its use in dealing with particular noise problems.

4.8. Noise in City Purchasing and Contracting

Objective. Protect residents, city employees, and businesses from unnecessary noise by ensuring that City operations are as quiet as reasonably feasible, considering costs and benefits of purchase of quiet equipment, quiet operation strategies, etc.

Program. This program involves the inclusion of noise as a factor for review in purchase of equipment, contracting for services, or issuance of licenses or franchises to operate in the City, where such purchase, contracting or licensing may result in substantial adverse noise impact on City employees, residents or businesses.

The program may involve simple review of such actions by a trained staff member or acoustical consultant as appropriate, or may involved detailed acoustical review of the entire system of operation (such as in a contract for rubbish collection services in which the noise levels of equipment, operating times, routes, etc. may all involve noise impacts). The program may involve setting of noise standards for certain types of equipment or operations (such as repair or service equipment used by licensees or franchisees) which are used in all contracting or licensing.

Responsibility. Community Development Department, Finance Department, Public Works Department, City Attorney

Cost and funding sources. This program may increase the cost of contracting including (1) cost of preparing specifications for equipment or evaluating bids, (2) cost of services using quiet equipment or procedures, and/or (3) cost of enforcement. No unusual or substantial increase in costs is expected as part of this program.

4.9. Noise in Public Construction Projects.

Objective. The purpose of this program is to minimize the impact of noise resulting from construction, maintenance and repair functions conducted by City Public Works Department staff and contractors.

Program. This program includes the evaluation of noise impact in all City construction projects. It is an extension of Program 4.8, Noise in City Purchasing and Contracting, to include contracts for construction and maintenance of public facilities and utilities.

The City currently limits construction to the hours between 7:00 A.M. and 7:00 P.M., Monday through Saturday. No construction is permitted on Sunday. In addition, no congregation of trucks or construction-related vehicles or construction workers is allowed before 7:00 A.M. at the project site or in the nearby residential areas.

Responsibility. Public Works Department, Community Development Department.

Cost and funding sources. Modest cost increases for public works construction, particularly in noise-sensitive areas, would be expected. Contractors would be expected to utilize quiet equipment and restrict hours of operation, which may result in slightly higher bids for public works construction. The City may request bids with and without "quiet equipment" standards, and provide a bonus for compliance with quiet equipment standards.

5. Glossary

A-weighted Sound Level (dB(A)). The A-weighted sound level is the sound pressure level in decibels as measured on a sound level meter using the A-weighting filter network. The A-weighting filter deemphasizes the very low and very high frequency components of the sound in a manner similar to the response of the human ear and provides good correlation with subjective reactions to noise.

Ambient Noise Level. The combined noise from all sources near and far is the ambient noise level. The ambient noise level is the existing level of environmental noise at a location. The sound level exceeded 90% of the time (L_{90}) is often used to represent the ambient sound level.

Community Noise Equivalent Level (CNEL). The CNEL is the average equivalent A-weighted sound level during a 24-hour day, obtained after addition of five decibels to sound levels occurring during the evening from 7:00 P.M. to 10:00 P.M., and addition of ten decibels to sound levels occurring during the night from 10:00 P.M. to 7:00 A.M. The five and ten-decibel penalties are applied to account for increased noise sensitivity during the evening and nighttime hours. The State of California has established guidelines for land use, and standards for sound insulation of residences and other noise-sensitive uses, based on the CNEL level.

Day-Night Average Level (L_{dn}). The L_{dn} is the average equivalent A-weighted sound level during a 24-hour day, obtained after addition of ten decibels to sound levels occurring during the night from 10:00 P.M. to 7:00 A.M. The ten-decibel penalties are applied to account for increased noise sensitivity during the evening and nighttime hours. For most typical urban noise sources, the CNEL is approximately 0.2 to 0.4 decibel higher than the L_{dn}. These levels would be substantially different only in an unusual situation in which high noise levels occurred between 7:00 P.M. and 10:00 P.M. and not at other times.

Decibel (dB). The decibel is the unit for measuring sound pressure level. Numerically it is equal to 10 times the logarithm to the base 10 of the measured sound pressure level square to a reference pressure of 20 micropascals squared. Using this scale, an increase of 10 times in sound energy results in an increase in sound level of 10 decibels.

Equivalent Sound Level (L_{eq}). L_{eq} is the sound level corresponding to a steady state sound level containing the same total energy as the time-varying sound level over a given sample period. The equivalent sound level is sometimes termed the energy-averaged sound level.

Habitable Room. A habitable room is defined as any room meeting the requirements of the Uniform Building Code or other applicable regulations which is intended to be used for sleeping, living, cooking or dining purposes, excluding such enclosed spaces as closets, pantries, bath or toilet rooms, service rooms, connecting corridors, laundries, unfinished attics, foyers, storage spaces, cellars, utility rooms, and similar spaces.

Intrusive Noise. That noise which exceeds the existing ambient noise level at a given location is termed an intrusive noise. The relative intrusiveness of a noise depends on its amplitude, duration, frequency, time of occurrence, and tonal or informational content as well as prevailing ambient noise level. An intrusive noise may be generated by a truck, aircraft, construction equipment, radio, or other noise source.

L percentile. L percentiles, or statistical noise levels, represent the sound level exceeded for the identified percentage of the sample time. For example, an L_{10} value of 55 dB(A) means that 55 dB(A) is exceeded 10% of the time. Other statistical noise levels commonly used are L_1, L_5, L_{50}, the level exceeded 50% of the time (sometimes used as the average noise level), and L_{90}, the level exceeded 90% of the time, often used to represent the ambient noise level. Statistical noise levels are sometimes used in noise regulation to ensure that unusually high noise levels are not permitted in a noise-sensitive area while permitting normal variation in noise level.

Noise. Noise is any unwanted sound, or sound which is undesirable because it interferes with speech and hearing, or is intense enough to damage hearing, or is otherwise annoying.

Noise Contours. Lines of equal noise value, or isopleths, drawn around a noise source indicating equal levels of noise exposure from that source are termed noise contours. Noise contours are similar to lines on a topographic map indicating areas of equal elevation.

Noise-sensitive Land Use. Noise-sensitive land uses are uses associated with indoor or outdoor human activities that may be subject to stress or significant interference from noise. Noise-sensitive land uses include residences (single and multi-family dwellings, mobile home parks, dormitories, and similar uses), transient lodging (hotels, motels), hospitals, nursing homes, schools, libraries, churches, and places of public assembly.

Outdoor Living Area. Outdoor living area is a term used to define spaces that are associated with residential land uses and are typically used for passive recreation activities. Such spaces include patio areas, barbecue areas, jacuzzi areas, etc. Outdoor areas usually not included in this definition include front yards, driveways, greenbelts, maintenance areas, and storage areas.

Sound Level Meter. An instrument, including a microphone, an amplifier, an output level indicator such as a meter or electronic display, and frequency weighting networks, for the measurement and determination of noise and sound levels is called a sound level meter.

Table 10. Adding Noise Levels in Decibels

Adding noise from two noise sources in Decibels		Change in Noise Level in Decibels Resulting from Change in Intensity of a Noise Source	
If the difference between the two noise levels is this much	Then add this much to the higher noise level to get the sum in decibels	If the intensity of the noise source (number of vehicles, overflights, etc.) is changed by this percentage	Then add this amount to the previous noise level
0	3.01	-90%	-10.00
0.5	2.77	-75%	-6.02
1	2.54	-50%	-3.01
2	2.12	-25%	-1.25
3	1.76	-20%	-0.97
4	1.46	-15%	-0.71
5	1.19	-10%	-0.46
6	0.97	-5%	-0.22
7	0.79	0%	0.00
8	0.64	5%	0.21
9	0.51	10%	0.41
10	0.41	15%	0.61
11	0.33	20%	0.79
12	0.27	25%	0.97
13	0.21	33%	1.24
14	0.17	50%	1.76
15	0.14	75%	2.43
16	0.11	100%	3.01
20	0.04	150%	3.98
25	0.01	200%	4.77
		250%	5.44
		500%	7.78
		1000%	10.41

Appendix A.

Noise Standards and Guidelines.

This appendix summarizes noise standards and guidelines of federal and state agencies which may apply to noise problems in Thousand Oaks. Some types of noise regulation are not appropriate to be regulated at the local level because a pattern of varying local standards would be difficult or expensive to implement and have the potential to result in inequities between communities. In addition, the development and enforcement of a noise standard imposes a cost on a local community. To the extent that standards are established and enforced by others, the cost to the local agency is minimized.

In particular, the state and federal governments have preempted the City's ability to establish standards for noise levels produced by newly manufactured motor vehicles and aircraft. The state has adopted its own standards and guidelines for roadway noise impact and placement of noise barriers along freeways.

The state and federal governments have also occupied the field of employee health and safety regulation.

The City's role in these areas is to use the established standards where appropriate to assist it in meeting its objectives for a quiet, safe community for its residents.

Until the 1940s, noise in cities was largely the result of large, stationary industrial processes, and noise problems were a problem between property owners. Urban rail systems resulted in concentrated noise impacts in major cities, but were not widespread.

In the late 1940s and the 1950s, the rapid expansion of residential development into new suburbs combined with the development of freeways and airports resulted in obvious noise conflicts between residential uses and major transportation facilities. These noise problems were widely recognized and studied in both Europe and the United States. Political and legal action, particularly involving airport noise, began to substantially affect airport planning in the 1960s as jets replaced propeller aircraft. The new economies and speed resulted in the rapid growth of air travel. Public reaction to these factors culminated in the passage by Congress of the Noise Control Act of 1972, one of a number of federal environmental laws (including the Clean Air Act, Clean Water Act, and National Environmental Policy Act) passed in the early 1970s. As required by Congress as a result of the Noise Control Act, the Environmental Protection Agency undertook a survey of research on noise in order to develop national standards.

In parallel with this federal effort, the State of California adopted noise standards for airports, noise standards for automobiles and motorcycles, noise guidelines for highway projects, and sound insulation standards for multi-family residences. The State Department of Health Services developed planning guidelines for compatible land uses for use in City Noise Elements. The state legislature adopted the California Environmental Quality Act, specifying that public agencies should consider noise impacts among other factors in approving projects which might have a physical impact on the environment.

The standards and guidelines adopted during that period have remained largely unchanged since their original adoption. The standards adopted in the State of California, by federal agencies, and in Europe and Japan have been similar, reflecting a common human response to noise throughout much of the world.

1. Federal Standards

The federal government has adopted a number of standards and recommended noise criteria to protect people in both the working and home environments. The standards and criteria most applicable to the City of Thousand Oaks are discussed below. The federal agencies involved include: Department of Labor - noise standards for the workplace; Federal Highway Administration - design noise levels for federal highway projects; Department of Housing and Urban Development - maximum noise level standards for federally-assisted housing projects, and; Environmental Protection Agency - guidelines to adequately protect the public welfare.

1.1. Department of Labor

The first federal efforts regulating noise were issued by the Department of Labor in 1969 and established noise as an occupational health hazard. As a result, two legislative acts have been adopted that regulate noise from industrial fixed-point sources resulting in hearing loss. The Walsh Healey Public Contracts Act, as amended, includes provisions for occupational noise regulations. Failure by a corporation to comply with the established standards may result in the corporation's removal from a list of bidders eligible for federal contracts.

The second legislative action, the Occupational Safety and Health Act (OSHA) of 1970, set noise exposure standards as shown in Table A-1 for all businesses engaged in interstate commerce.

Table A-1. OSHA Permissible Noise Exposure in the Workplace

Duration-Hours Per Day	Sound Level dB(A)
8	90
6	92
4	95
3	97
2	100
1	105

Source: Department of Labor Occupational Noise Exposure Standard, Code of Federal Regulations, Title 29, Chapter XVII Part 1910, Subpart G, 36 FR10466, May 29, 1971, as amended and corrected through June 19, 1983.

1.2. Federal Highway Administration (FHWA)

The FHWA has established noise standards for various types of land use. The FHWA noise standards by land use category for use in the planning and designing of highways are shown in Table A-2. These standards apply to federally funded highway projects, and are in terms of both Equivalent Noise Level (Leq) and L_{10}.

Table A-2. FHA Design Noise Level/Land Use Relationships

Category	Leq[a]	L10[a]	Location	Description of Land
A	57	60	Exterior	Tracts of land in which serenity and quiet are of extraordinary significance and serve an important public need and where the preservation of those qualities is essential if the area is to continue to serve its intended purpose. Such areas could include amphitheaters, particular parks or portions of parks, open spaces or historic districts which are dedicated or recognized by appropriate local officials for activities requiring special qualities of serenity and quiet.
B	67	70	Exterior	Picnic areas, recreation areas, playgrounds, active sport areas, and parks not included in Category A and residences, motels, hotels, public meeting rooms, schools, churches, libraries, and hospitals.
C	72	75	Exterior	Developed lands, properties, or activities not included in the above categories.
D	Noise abatement criteria have not been established for these lands. They may be treated as developed lands if the probability of development is high. Provisions for noise abatement would be based on the need, expected benefits and cost of such measures			Undeveloped lands which do not contain improvements or activities devoted to frequent human habitation or use and for which such improvements or activities are unplanned and not programmed.
E	52	55[b]	Interior	Residences, motels, hotels, public meeting rooms, schools, churches, libraries, hospitals, and auditoriums.

a L_{eq}: Equivalent Noise Level. L_{10}: Level exceeded 10% of the time. One or the other, but not both, may be used.
b Interior noise abatement criteria in this category apply to (1) indoor activities where no extreme noise-sensitive land use or activity is identified, and (2) exterior activities that are either remote from the highway or shielded so that they will not be significantly affected by the noise, but the interior activities will.

Source: *Federal Aid Highway Program Manual*, Volume 7, Chapter 7, Section 3 Transmittal 348, August 9, 1982

Exterior noise levels apply to outdoor areas which have regular human use and in which a lowered noise level would be beneficial. The noise level values need not be applied to areas having limited human use or where lowered noise levels would produce little benefit. The indoor level relates to indoor activities where no exterior noise-sensitive land use or activity is identified.

1.3. Department of Housing and Urban Development (HUD)

It is HUD's general policy to provide minimum national noise standards applicable to HUD programs to protect citizens against excessive noise in their communities and places of residence. HUD has adopted environmental criteria and standards for determining project acceptability and necessary mitigation measures to insure that activities assisted by HUD achieve the goal of a suitable living environment. By "activities assisted," HUD is referring to its various housing and urban development financial assistance programs.

HUD's overall goal is for exterior residential noise levels not to exceed 55 dB Ldn and for interior noise levels not to exceed 45 dB Ldn. However, as Table A-3 indicates, for purposes of regulation and to meet other

program objectives, exterior sound levels of 65 dB Ldn and below are acceptable and allowable. Projects within 65 to 75 dB Ldn require special environmental clearance and additional noise insulation. Projects with a 75 dB and greater require a submittal of an Environmental Impact Statement (EIS).

Table A-3. HUD Housing Site Acceptability Standards

Acceptability	Noise Level (L_{dn})	Special Approvals and Requirements
Acceptable	65 dB and less	None
Normally Unacceptable		Special environment clearance and 5 dB additional attenuation for building with 65 to 70 dB Ldn and 10 dB additional attenuation for buildings within 70 to 75 dB Ldn.
Unacceptable	75 dB and greater	Submittal of Environmental Impact Statement.

Source: U.S. Department of Housing and Urban Development Environmental Criteria and Standards, 24 CFR Part 51.

1.4. Environmental Protection Agency (EPA)

In 1972, Congress enacted the Noise Control Act. This act authorized the EPA to publish descriptive data on the effects of noise and establish levels of sound requisite to protect the public welfare with an adequate margin of safety. These levels are separated into health (hearing loss levels) and welfare (annoyance levels) as shown in Table A-4. The EPA cautions that their identified levels are not standards because they do not take into account the cost or feasibility of the levels. For protection against hearing loss, 96% of the population would be protected if sound levels are less than or equal to an Leq (24) of 70 dB. The (24) signifies and Leq duration of 24 hours. The EPA activity and interference guidelines are designed to ensure reliable speech communication at about 5 feet in the outdoor environment. For outdoor and indoor environments, interference with activity and annoyance should not occur if levels do not exceed 55 dB(A) and 45 dB(A), respectively.

Table A-4. Summary of EPA Noise Levels Identified as Requisite to Protect the Public Health and Welfare with an Adequate Margin of Safety

Effect	Level Necessary to Protect the Public Health and Welfare with an Adequate Margin of Safety	Area
Hearing Loss	Leq (24) ≤ 70 dB	All areas.
Outdoor activity interference and annoyance	Ldn ≤ 55 dB	Outdoors in residential areas and farms and other outdoor areas where people spend widely varying amounts of time and other places in which quiet is a basis for use.
	Leq (24) ≤ 55 dB	Outdoor areas where people spend limited amounts of time, such as school yards, playgrounds, etc.
Indoor activity interference and annoyance	Leq ≤ 45 dB	Indoor residential areas.
	Leq (24) ≤45 dB	Other indoor areas with human activities such as schools, etc.

Source: U.S. Environmental Protection Agency, *Information on Levels of Environmental Noise Requisite to Project Public Health and Welfare with an adequate Margin of Safety* March 1974, p. 3.

The noise effects associated with an outdoor L_{dn} of 55 dB are summarized in Table A-5. At 55 dB Ldn, 95% sentence clarity (intelligibility) may be expected at 3.5 meters, and no community reaction. However, 1% of the population may complain about noise at this level and 17% may indicate annoyance.

Table A-5. Summary of Human Effects in Areas Exposed to 55 dB CNEL

Type of Effect	Magnitude of Effect
Speech – Indoors	100% sentence intelligibility (average) with a 5 dB margin of safety.
- Outdoors	100% sentence intelligibility (average) at 0.35 meters. 99% sentence intelligibility (average) at 1.0 meters. 95% sentence intelligibility (average) at 3.5 meters.
Average Community Reaction	None evident; 7 dB below level of significant complaints and threats of legal action and at least 16 dB below "vigorous action" (attitudes and other non-level related factors may affect this result).
Complaints	1%, dependent on attitude and other non-level related factors.
Annoyance	17%, dependent on attitude and other non-level related factors.
Attitudes Towards Area	Noise essentially the least important of various factors.

Source: U.S. Environmental Protection Agency, *Information on Levels of Environmental Noise Requisite to Protect Public Health and Welfare with an Adequate Margin of Safety*, March 1974, p. 23.

2. California Standards and Guidelines

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, freeway noise affecting classrooms, noise insulation, occupational noise control and airport noise. The state has also developed land use compatibility guidelines for community noise environments. The applicable standards and guidelines for the city are discussed.

2.1. Motor Vehicles

The California Motor Vehicle Code sets operational noise limits for motor vehicles (Section 23130), requires and adequate muffler in constant operation and properly maintained (Section 27150), prohibits the sale or installation of a motor vehicle exhaust system unless it meets regulations or standards (Section 27150.1), prohibits the modification of the exhaust system to amplify or increase the noise above that of the original system (Section 27151), prohibits the sale of new vehicles exceeding the noise limits (Section 27160), and sets noise limits for the operation of off-highway motor vehicles (Section 38280) as shown in Table A-6. Police and traffic officers generally enforce this code.

Table A-6. California Motor Vehicle Noise Limits for Vehicles

Sale of New Vehicles	**Date of Manufacture**	**dB(A) Value at 50 Feet**	
Motorcycles Motorcycles, other than motor-driven cycles	Before 1970 After '69, Before '73 After '72, Before '75 After '74, Before '86 After '85	92 88 86 83 80	
Vehicle with a gross vehicle weight of 6,000 lbs. or more	After '67, Before '73 After '72, Before '75 After '74, Before '78 After '77	88 86 83 80	
Any other motor vehicle	After '67, Before '73 After '72, Before '75 After '75	86 84 80	
Noise level limits for the operation of off-highway motor vehicles	Before '73 After '72, Before '75 After '74	92 88 86	
Operation of Vehicle	35 of Less[1]	45 of Less[2]	More than 45[2]
Any motor vehicle with a manufacturer's gross vehicle weight rating of 6,000 pounds or more and any combination of vehicles towed by such motor vehicle.	82 dB(A)	--	--
Any motor vehicle with a manufacturer's gross vehicle weight rating of more than 10,000 pounds and any combination of vehicles towed by such a motor vehicle.	--	86 dB(A)	90 dB(A)
Any motorcycle other than a motor driven cycle.	77 dB(A)	82 dB(A)	86 dB(A)
Any other motor vehicle and any combination of vehicles towed by such motor vehicle.	74 dB(A)	76 dB(A)	82 dB(A)

1. On streets with a grade not exceeding plus or minus 1%.
2. On any street.

Source: Excerpts from the California Motor Vehicle Code.

2.2. Freeway Noise Affecting Classrooms

The California law on freeway noise affecting classrooms is designed to mitigate noise impacts to existing classrooms, libraries, multi-purpose rooms, and spaces used for pupil personnel services of a public or private elementary or secondary school. State funded noise abatement programs are required when freeway traffic or the construction of the freeway exceeds 55 dB(A) L_{10} or 52 dB(A) Leq. The temporary or permanent noise abatement program may include installing acoustical materials, eliminating windows installing air conditioning, or constructing sound buffer structures. Further explanations of this law are found in California Streets and Highway Code, Division 1, State Highways, Chapter 1, Administration, Article 6; Section 216, as amended.

2.3. Noise Insulation Standards

The California Sound Transmission Control Standards are found in California Code of Regulations, Title 24, Building Standards, Chapter 2.5 as adopted March 1, 1986. The purpose of the standards is to establish minimum noise insulation performance standards to protect persons within new hotels, motels, apartment houses, and dwellings other than detached single-family dwellings.

The standards state that interior noise levels with windows closed attributable to exterior sources shall not exceed an annual noise level of 45 dB CNEL in any habitable room. In addition residential buildings or structures within a 60 dB CNEL from airport, vehicular, or industrial noise sources shall require an acoustical analysis showing that the proposed building has been designed to limit intruding noise to the allowable 45 dB CNEL interior noise level.

2.4. Airport Noise Standards

California Administrative Code, Title 21, Public Works, Chapter 25, Division of Aeronautics, Subchapter 6, noise standards require that land use be compatible within a criterion CNEL contour for airports. While helicopters are not specifically mentioned, it is the intent of this standard to also be applicable to heliports and helipads. One objective of this standard is to create an urban development pattern in which all the land included within the criterion CNEL contour is devoted to either airport or nonsensitive land uses as defined in the standards.

Currently the standards do not permit land use incompatibilities within an airport's 65 dB CNEL contour. No land in Thousand Oaks is within the 65 dB CNEL contour from any airport, and there are no plans to construct any airport or operate any airport in a manner such that Thousand Oaks would include such a noise impact area.

2.5. Occupational Noise Control Standards

California Occupational Noise Control Standards are found in California Administrative Code, Title 8, Industrial Relations, Chapter 4, as revised and effective September 28, 1984. A summary of the permissible noise exposure at a workplace is shown in Table A-7 below.

Table A-7. California Occupational Noise Control Standards

Sound Level dB(A)	Permitted Hours of Exposure Per Weekday
90	8
95	4
100	2
105	1
110	0.5

Source: California Code of Regulations, Title 8, Industrial Relations, Chapter 4, as revised and effective September 28, 1984.

Appendix B.

Noise Abatement Strategies from California Office of Noise Control Noise Element Guidelines.

Guidelines for the Preparation and Content of the Noise Element of the General Plan

OUTLINE

I. INTRODUCTION

The Noise Element of the General Plan provides a basis for comprehensive local programs to control and abate environmental noise and to protect citizens from excessive exposure. The fundamental goals of the Noise Element are:

- To provide sufficient information concerning the community noise environment so that noise may be effectively considered in the land use planning process. In so doing, the necessary groundwork will have been developed so that a community noise ordinance may be utilized to resolve noise complaints.
- To develop strategies for abating excessive noise exposure through cost-effective mitigating measures in combination with zoning, as appropriate, to avoid incompatible land uses.
- To protect those existing regions of the planning area whose noise environments are deemed acceptable and also those locations throughout the community deemed "noise sensitive."
- To utilize the definition of the community noise environment, in the form of CNEL or Ldn noise contours as provided in the Noise Element for local compliance with the State Noise Insulation Standards. These standards require specified levels of outdoor to indoor noise reduction for new multi-family residential constructions in areas where the outdoor noise exposure exceeds CNEL (or Ldn) 60 dB.

The 1976 edition of the Noise Element Guidelines, prepared by the State Department of Health Services (DOHS), was a result of SB 860 (Beilenson, 1975), which became effective January 1, 1976. SB 860, among other things, revised and clarified the requirements for the noise element of each city and county general plan and gave the DOHS authority to issue guidelines for compliance thereto. Compliance with the 1976 version of these guidelines was mandated only for those noise elements which were not submitted to the Office of Planning and Research by the effective date of SB 860 and to subsequent revisions of previously submitted noise elements.

A comparison between the 1976 Noise Element Guidelines and this revised edition will not reveal substantial changes. The basic methodology advanced by that previous edition remains topical. Where necessary, code references have been updated and the text revised to reflect statutory changes.

II. DEFINITIONS

Decibel, dB: A unit of measurement describing the amplitude of sound, equal to 20 times the logarithm to the base 10 of the ratio of the pressure of the sound measured to the reference pressure, which is 20 micropascals (20 micronewtons per square meter).

A-Weighted Level: The sound level in decibels as measured on a sound level meter using the A-weighting filter network. The A-weighting filter de-emphasizes the very low and very high frequency components of the sound in a manner similar to the response of the human ear and gives good correlation with subjective reactions to noise.

L10: The A-weighted sound level exceeded ten percent of the sample time. Similarly, L50, L90, etc.

Leq: Equivalent energy level. The sound level corresponding to a steady state sound level containing the same total energy as a time varying signal over a given sample period. Leq is typically computed over 1, 8, and 24-hour sample periods.

CNEL: Community Noise Equivalent Level. The aver-

age equivalent A-weighted sound level during a 24-hour day, obtained after addition of five decibels to sound levels in the evening from 7 p.m. to 10 p.m. and after addition of 10 decibels to sound levels in the night from 10 p.m. to 7 a.m.

Ldn: Day-Night Average Level. The average equivalent A-weighted sound level during a 24-hour day, obtained after addition of 10 decibels to sound levels in the night after 10 p.m. and before 7 a.m.

Note: CNEL and Ldn represent daily levels of noise exposure averaged on an annual or daily basis, while Leq represents the equivalent energy noise exposure for a shorter time period, typically one hour.

Noise Contours: Lines drawn about a noise source indicating equal levels of noise exposure. CNEL and Ldn are the metrics utilized herein to describe annoyance due to noise and to establish land use planning criteria for noise.

Ambient Noise: The composite of noise from all sources near and far. In this context, the ambient noise level constitutes the normal or existing level of environmental noise at a given location.

Intrusive Noise: That noise which intrudes over and above the existing ambient noise at a given location. The relative intrusiveness of a sound depends upon its amplitude, duration, frequency, and time of occurrence, and tonal or informational content as well as the prevailing noise level.

Noisiness Zones: Defined areas within a community wherein the ambient noise levels are generally similar (within a range of 5 dB, for example). Typically, all other things being equal, sites within any given noise zone will be of comparable proximity to major noise sources. Noise contours define different noisiness zones.

III. NOISE ELEMENT REQUIREMENTS

Government Code Section 65302(f):

A noise element shall identify and appraise noise problems in the community. The noise element shall recognize the guidelines established by the Office of Noise Control in the State Department of Health Services and shall analyze and quantify, to the extent practicable, as determined by the legislative body, current and projected noise levels for all of the following sources:

(1) Highways and freeways.

(2) Primary arterials and major local streets.

(3) Passenger and freight on-line railroad operations and ground rapid transit systems.

(4) Commercial, general aviation, heliport, helistop, and military airport operations, aircraft overflights, jet engine test stands, and all other ground facilities and maintenance functions related to airport operation.

(5) Local industrial plants, including, but not limited to, railroad classification yards.

(6) Other ground stationary sources identified by local agencies as contributing to the community noise environment.

Noise contours shall be shown for all of these sources and stated in terms of community noise equivalent level (CNEL) or day-night average level (Ldn). The noise contours shall be prepared on the basis of noise monitoring or following generally accepted noise modeling techniques for the various sources identified in paragraphs (1) to (6), inclusive.

The noise contours shall be used as a guide for establishing a pattern of land uses in the land use element that minimizes the exposure of community residents to excessive noise.

The noise element shall include implementation measures and possible solutions that address existing and foreseeable noise problems, if any. The adopted noise element shall serve as a guideline for compliance with the state's noise insulation standards.

IV. PROCESS OF NOISE ELEMENT DEVELOPMENT

The sequential steps for development of a noise element as an integral part of a community's total noise control program are illustrated in the flow diagram of figures 1A and 1B. The concept presented herein utilizes the noise element as the central focus of the community's program and provides the groundwork for all subsequent enforcement efforts. The process may be described in terms of four phases:

A. Noise Environment Definition

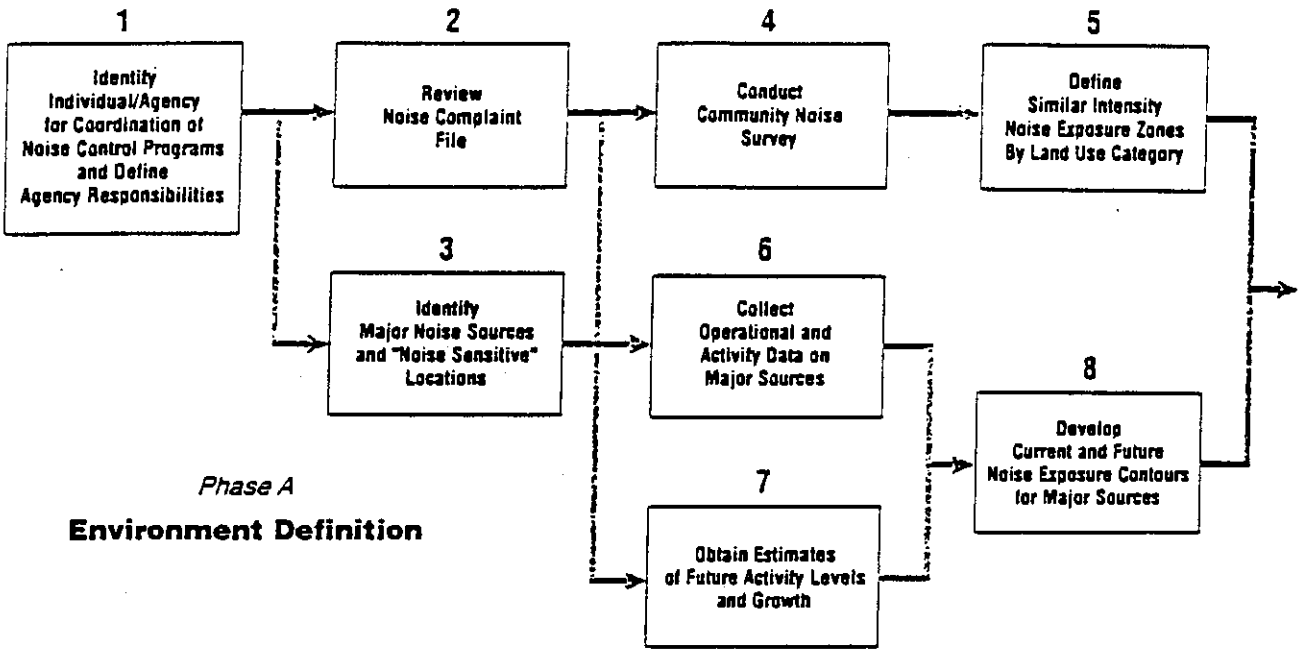
B. Noise Compatible Land Use Planning

C. Noise Mitigation Measures

D. Enforcement

These phases encompass a total of eighteen defined tasks, the first thirteen of which relate directly to the statutory requirements contained in §65302(f), while the remainder relate to critical supportive programs (noise ordinances, etc.). Citations from §65302(f) are contained within quotation marks.

Figure 1A



A. Noise Environment Definition

The purpose of this phase is to adequately identify and appraise the existing and future noise environment of the community in terms of Community Noise Equivalent Level (CNEL) or Day-Night Average Level (Ldn) noise contours for each major noise source and to divide the city or county into noise zones for subsequent noise ordinance application.

Step 1:

Identify a specific individual or lead agency within the local government to be responsible for coordination of local noise control activities. This individual or agency should be responsible for coordinating all intergovernmental activities and subsequent enforcement efforts.

Step 2:

Review noise complaint files as compiled by all local agencies (police, animal control, health, airport, traffic department, etc.) in order to assess the following:

(1) Location and types of major offending noise sources.

(2) Identification of noise sensitive areas and land uses.

(3) Community attitudes towards specific sources of noise pollution.

(4) Degree of severity of noise problems in the community.

(5) Relative significance of noise as a pollutant.

Step 3:

Specifically identify major sources of community noise based upon the review of complaint files and interagency discussion and the following statutory subjects:

(1) Highways and freeways.

(2) Primary arterials and major local streets.

(3) Passenger and freight on-line railroad operations and ground rapid transit systems.

(4) Commercial, general aviation, heliport, helistop, and military airport operations, aircraft overflights, jet engine test stands, and all other ground facilities and maintenance functions related to airport operation.

(5) Local industrial plants, including, but not limited to, railroad classification yards.

(6) Other ground stationary noise sources identified by local agencies as contributing to the community noise environment. (Government Code §65302(f))

In addition, the land uses and areas within the community that are noise sensitive should be identified at the same time.

Step 4:

Given the identification of major noise sources and an indication of the community's attitude toward noise pollution (when available), it is advisable to conduct a

community noise survey. The purposes of the survey are threefold:

First and foremost, to define by measurement the current noise levels at those sites deemed noise sources and to establish noise level contours around them. The noise contours must be expressed in terms of CNEL or Ldn.

Second, the collected data will form the basis for an analysis of noise exposure from major sources.

Finally, the survey should define the existing ambient noise level throughout the community. Intrusive noises, over and above this general predetermined ambient level, may then be controlled through implementation of a noise ordinance.

Step 5:

Given the definition of existing ambient noise levels throughout the community, one may proceed with a classification of the community into broad regions of generally consistent land use and similar noise environments. Because these regions will be varying distances from identified major noise sources, the relative levels of environmental noise will be different from one another. Therefore, subsequent enforcement efforts and mitigating measures may be oriented towards maintaining quiet areas and improving noisy ones.

Step 6:

Directing attention once again to the major noise sources previously identified, it is essential to gather operations and activity data in order to proceed with the analytical noise exposure prediction. This data is somewhat source specific, but generally should consist of the following information and be supplied by the owner/operator of the source:

(1) Average daily level of activity (traffic volume, flights per day, hours of operation, etc.).

(2) Distribution of activity over day and night time periods, days of the week, and seasonal variations.

(3) Average noise level emitted by the source at various levels of activity.

(4) Precise source location and proximity to noise impacted land uses.

(5) Composition of noise sources (percentage of trucks on highway, aircraft fleet mix, industrial machinery type, etc.).

Step 7:

In addition to collecting data on the variables affecting noise source emission for the existing case, future values for these parameters need to be assessed. This is best accomplished by correlating the noise element with other general plan elements (i.e. land use, circulation, housing, etc.) and regional transportation plans and by coordination with other responsible agencies (Airport Land Use Commission, Caltrans etc.).

Step 8:

Analytical noise exposure modeling techniques may be utilized to develop source-specific noise contours around major noise sources in the community.

"The noise contours shall be prepared on the basis of noise monitoring or following generally accepted noise modeling techniques..."

(§65302(f))

Simplified noise prediction methodologies are available through the State Department of Health Services for highway and freeway noise, railroad noise, simple fixed stationary and industrial sites, and general aviation aircraft (with less than twenty percent commercial jet aircraft activity — two engine jet only). Noise contours for larger airport facilities and major industrial sites are sufficiently complex that they must be developed via sophisticated computer techniques available through recognized acoustical consulting firms. (Airport contours, generally, have already been developed in accordance with requirements promulgated by the Division of Aeronautics: Noise Standards — Sections 5000, et seq. of Title 21, California Code of Regulations.)

Although considerable effort may go into developing noise contours which, in some instances, utilize rather sophisticated digital programming techniques, the present state-of-the-art is such that their accuracy is usually no better than +/- 3 dB. In fact, the accuracy of the noise exposure prediction decreases with increasing distance from the noise source. In the near vicinity of the source, prediction accuracy may be within the range of +/- 1 dB, while at greater distances this may deteriorate to +/- 5 dB or greater. At greater distances, meteorological and topographic effects, typically not totally accounted for in most models, may have significant influence. Thus, while dealing with the concept of noise contours, it is best not to think of them as absolute lines of demarcation on a map (such as topographical contours), but rather as bands of similar noise exposure.

In addition to assessment of the present day noise environment, it is recommended that the noise exposure data be projected through the time horizon of the general plan. The noise element should be updated and corrected every five years, or sooner as is necessary, and, at that time, the forecasted noise exposure be projected an additional five years.

Phase B. Noise Compatible Land Use Planning

A noise planning policy needs to be rather flexible and dynamic to reflect not only technological advances in noise control but also economic constraints governing application of noise control technology and anticipated regional growth and demands of the community. In the final analysis, each community must decide the level of noise exposure its residents are willing to tolerate within a limited range of values below the known levels of health impairment.

Step 9:

Given the definition of the existing and forecasted noise environment provided by the Phase A efforts, the locality preparing the noise element must now approach the problem of defining how much noise is too much. Guidelines for noise compatible land use are presented in Figure 2. The adjustment factors given in Table 1 may be used in order to arrive at noise acceptability standards which reflect the noise control goals of the community, the particular community's sensitivity to noise (as determined in Step 2), and their assessment of the relative importance of noise pollution.

Step 10:

As a prerequisite to establishing an effective noise control program, it is essential to know, in quantitative terms, the extent of noise problems in the community. This is best accomplished by determining, for each major noise source around which noise contours have

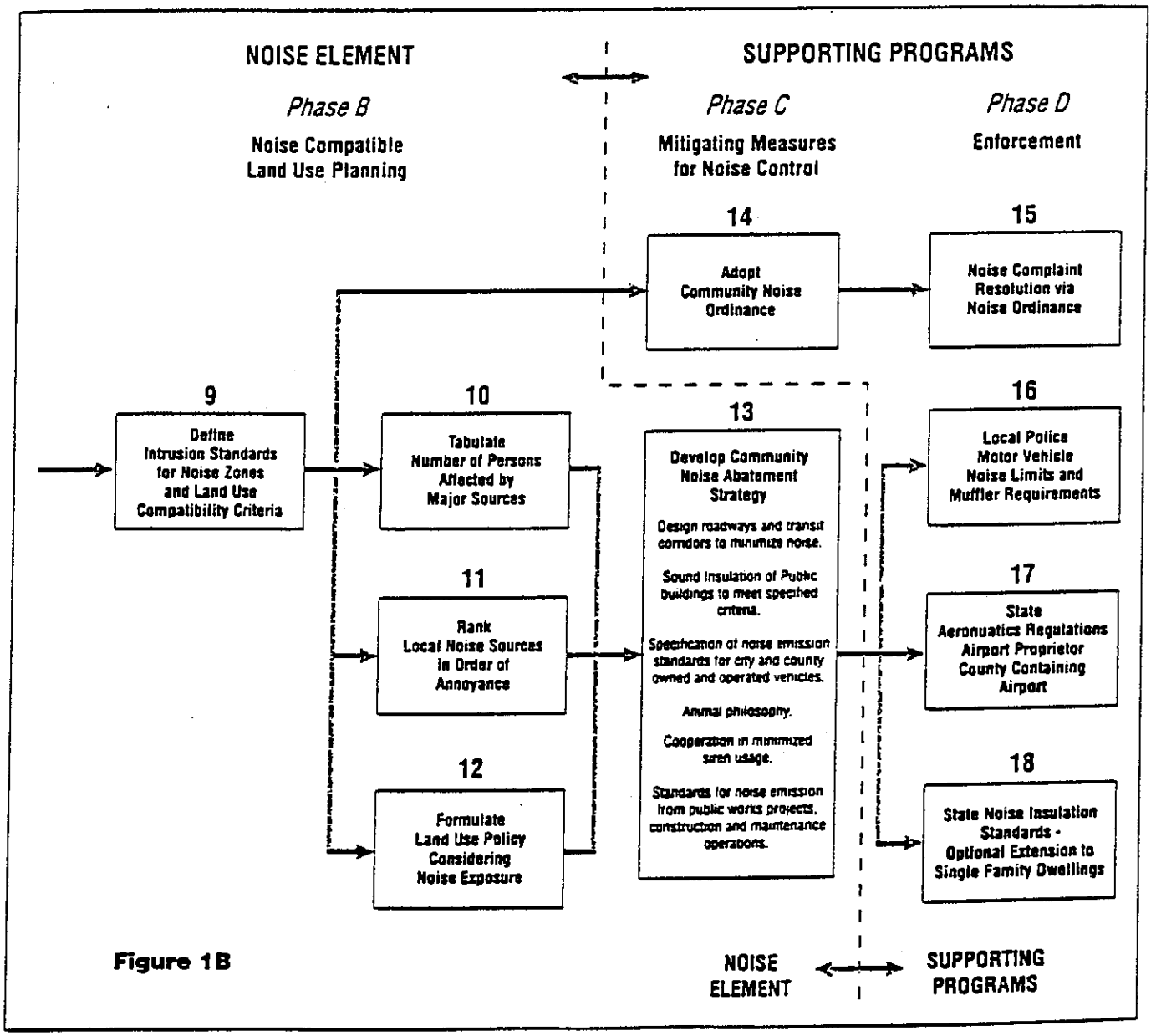


Figure 1B

Table 1

Type of Correction	*Description*	*Amount of Correction to be Added to Measured CNEL in dB*
Seasonal Correction	Summer (or year-round operation)	0
	Winter only (or windows always closed)	- 5
Correction for Outdoor Residual Noise Level	Quiet suburban or rural community (remote from large cities and from industrial activity and trucking).	+ 10
	Quiet suburban or rural community (not located near industrial activity).	+ 5
	Urban residential community (not immediately adjacent to heavily traveled roads and industrial areas).	0
	Noisy urban residential community (near relatively busy roads or industrial areas.	- 5
	Very noisy urban residential community.	- 10
Correction for Previous Exposure and Community Attitudes	No prior experience with the intruding noise.	+ 5
	Community has had some previous exposure to intruding but little effort is being made to control the noise. This correction may also be applied in a situation where the community has not been exposed to the noise previously, but the people are aware that bona fide efforts are being made to control the noise.	0
	Community has had considerable previous exposure to the intruding noise and the noise maker's relations with the community are good.	- 5
	Community aware that operation causing noise is very necessary and it will not continue indefinitely. This correction can be applied for an operation of limited duration and under emergency circumstances.	- 10
Pure Tone or Impulse	No pure tone or impulsive character.	0
	Pure Tone or impulsive character present.	+ 5

nition of these limitations should prompt more effective land use planning strategies.

Step 12:

A major objective of the noise element is to utilize this information to ensure noise compatible land use planning:

"The noise contours shall be used as a guide for establishing a pattern of land uses in the land use element that minimizes the exposure of community residents to excessive noise." (§65302(f))

The intent of such planning is to:

(1) Maintain those areas deemed acceptable in terms of noise exposure.

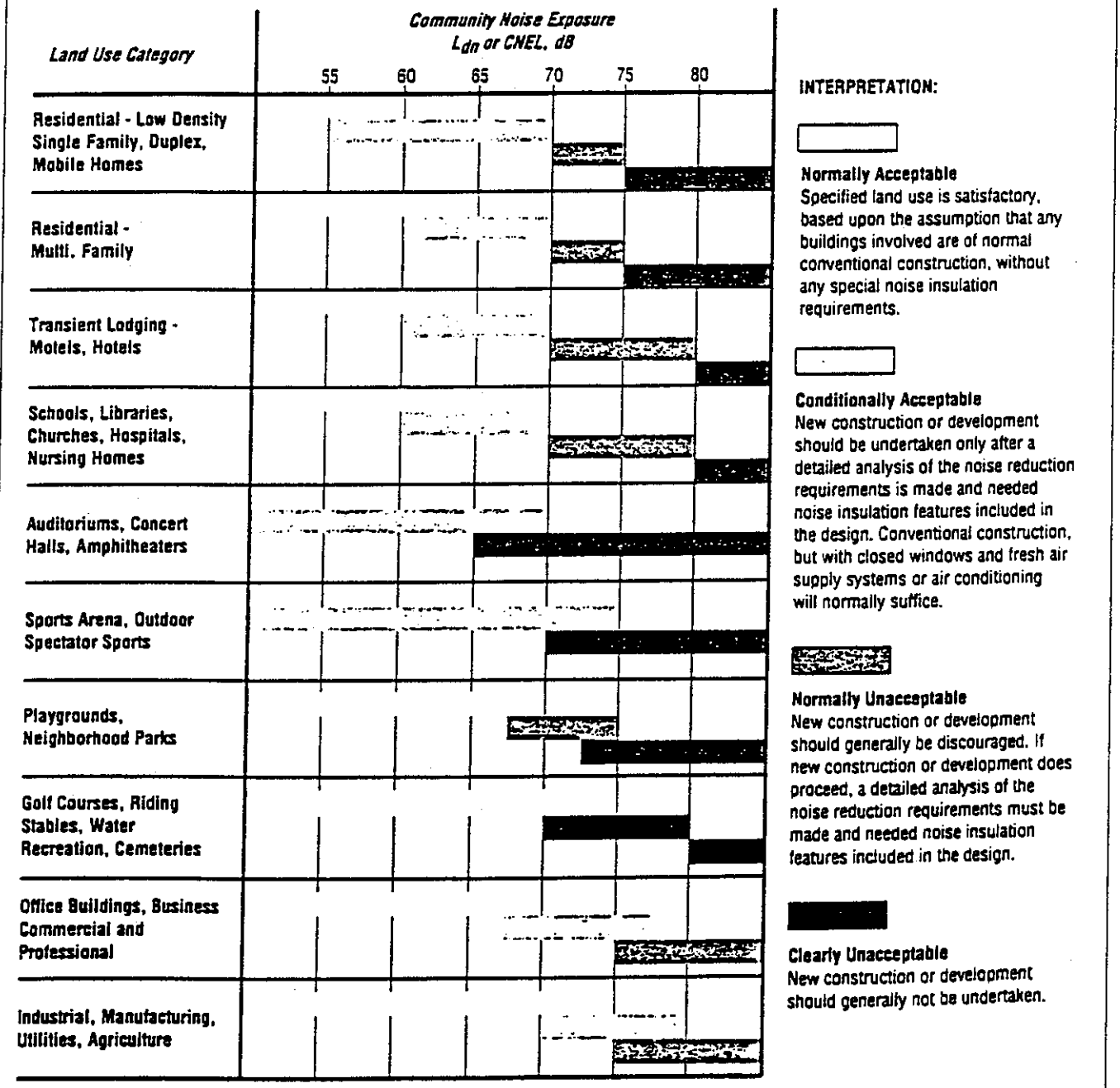
(2) Use zoning or other land use controls in areas with excessive noise exposure to limit uses to those which are noise compatible and to restrict other less compatible uses.

been developed, the number of community residents exposed and to what extent. It is also useful to identify those noise sensitive land uses whose noise exposure exceeds the recommended standards given in Figure 2. The exposure inventory can be accomplished by using recent census data, adjusted for regional growth, and tabulating the population census blocks within given noise contours.

Step 11:

Once the noise exposure inventory is completed, the relative significance of specific noise sources in the community (in terms of population affected) will become apparent. The local agencies involved may wish to use this information to orient their noise control and abatement efforts to achieve the most good. Clearly, control of certain major offending sources will be beyond the jurisdiction of local agencies; however, recog-

FIGURE 2



Phase C. Noise Mitigation Measures

Step 13:

Based upon the relative importance of noise sources in order of community impact and local attitudes towards these sources, "[t]he noise element shall include implementation measures and possible solutions that address existing and foreseeable noise problems, if any" (§65302(f)).

Selection of these noise mitigating measures should be coordinated through all local agencies in order to be most effective. Minimization of noise emissions from all local government-controlled or sanctioned activities should be a priority item. This includes low noise specifications for new city or county owned and operated vehicles (and noise reduction retrofitting where economically possible) and noise emission limits on public works projects. Local governments should insure that public buildings (especially schools) are sufficiently insulated to allow their intended function to be uninterrupted by exterior noise. Local agencies can work with State and Federal bodies to minimize transportation noise, primarily through transit way design, location or configuration modifications.

Additional measures might include such policies as limitation of siren useage by police, fire, and ambulance units within populated areas. Animal control units may be encouraged to minimize barking dog complaints through use of an improved public relations campaign termed "Animal Philosophy." This involves working with pet owners to determine why the dog barks and attempting solutions rather than just issuing citations. Local zoning and subdivision ordinances may require the use of noise reducing building materials or the installation of sound insulating walls along major roads in new construction and subdivisions.

In general, local noise reduction programs need to address the problems specific to each community, with the ultimate goals being the reduction of complaint frequency and the provision of a healthful noise environment for all residents of the community.

The following steps are beyond the scope of the noise element requirements, but pertain to coordination with other state noise control programs and achievement of the goals set forth in the noise element through development of an active local noise control effort.

Step 14:

While the noise element identifies problem areas and seeks to develop medium and long-range solutions to them, a community noise ordinance is the only viable instrument for short-term or immediate solutions to intrusive noise. A model noise ordinance which may be tailored to the specific needs of a given community by simply incorporating those sections deemed most applicable has been developed by the Department of Health Services. The model ordinance also suggests a cure for non-stationary or transient types of noise events, for which noise contours are generally meaningless.

Phase D. Enforcement

To adequately carry out the programs identified in the noise element and to comply with State requirements for certain other noise control programs, specific enforcement programs are recommended at the local level.

Step 15:

Adopt and apply a community noise ordinance for resolution of noise complaints.

Step 16:

Recent studies have shown that the most objectionable feature of traffic noise is the sound produced by vehicles equipped with illegal or faulty exhaust systems. In addition, such hot rod vehicles are often operated in a manner that causes tire squeal and excessively loud exhaust noise. There are a number of statewide vehicle noise regulations that can be enforced by local authorities as well as the California Highway Patrol. Specifically, §23130, 23130.5, 27150, 27151, and 38275 of the California Vehicle Code, as well as excessive speed laws may be applied to curtail this problem. Both the Highway Patrol and the State Department of Health Services (through local health departments) are available to aid local authorities in code enforcement and training pursuant to proper vehicle sound level measurements.

Step 17:

Commercial and public airports operating under a permit from the Caltrans Aeronautics Program are required to comply with both the State Aeronautics standards governing aircraft noise and also all applicable legislation governing the formation and activities of a local Airport Land Use Commission (ALUC). The function of the ALUC is, among other things, to develop a plan for noise compatible land use in the immediate proximity of the airport. The local general plan must be reviewed for compatibility with this Airport Land Use Plan and amended if necessary (Public Utilities Code §21676). Therefore, the developers of the noise element will need to coordinate their activities with the local

ALUC to ensure that compatible standards are utilized throughout the community and that the noise element develops as part of a coherent master plan, of which the ALUP forms an integral component.

Step 18:

"The adopted noise element shall serve as a guideline for compliance with the State's noise insulation standards." (§65302(f))

Recognizing the need to provide acceptable habitation environments, State law requires noise insulation of new multi-family dwellings constructed within the 60 dB (CNEL or Ldn) noise exposure contours. It is a function of the noise element to provide noise contour information around all major sources in support of the sound transmission control standards (Appendix, Chapter 2-35, Part 2, Title 24, California Code of Regulations).

V. RELATIONSHIP OF THE NOISE ELEMENT TO OTHER GENERAL PLAN ELEMENTS

The noise element is related to the land use, housing, circulation, and open-space elements. Recognition of the interrelationship of noise and these four mandated elements is necessary in order to prepare an integrated general plan. The relationship between noise and these four elements is briefly discussed below.

Land Use — A key objective of the noise element is to provide noise exposure information for use in the land use element. When integrated with the noise element, the land use element will show acceptable land uses in relation to existing and projected noise contours. Section 65302(f) of the Government Code states that: "The noise contours shall be used as a guide for establishing a pattern of land uses in the land use element that minimizes the exposure of community residents to excessive noise."

Housing — The housing element considers the provision of adequate sites for new housing and standards for housing stock. Since residential land use is among the most noise sensitive, the noise exposure information provided in the noise element must be considered when planning the location of new housing. Also, State law requires special noise insulation of new multi-family dwellings constructed within the 60 dB (CNEL or Ldn) noise exposure contour. This requirement may influence the location and cost of this housing type. In some cases, the noise environment may be a constraint on housing opportunities.

Circulation — The circulation system must be correlated with the land use element and is one of the major sources of noise. Noise exposure will thus be a decisive factor in the location and design of new transportation facilities and the possible mitigation of noise from existing facilities in relation to existing and planned land use. The local planning agency may wish to review the circulation and land use elements simultaneously to assess their compatibility with the noise element.

Open-Space — Excessive noise can adversely affect the enjoyment of recreational pursuits in designated open-space. Thus, noise exposure levels should be considered when planning for this kind of open-space use. Conversely, open-space can be used to buffer sensitive land uses from noise sources through the use of setback and landscaping. Open-space designation can also effectively exclude other land uses from excessively noisy areas.

VI. SELECTION OF THE NOISE METRIC

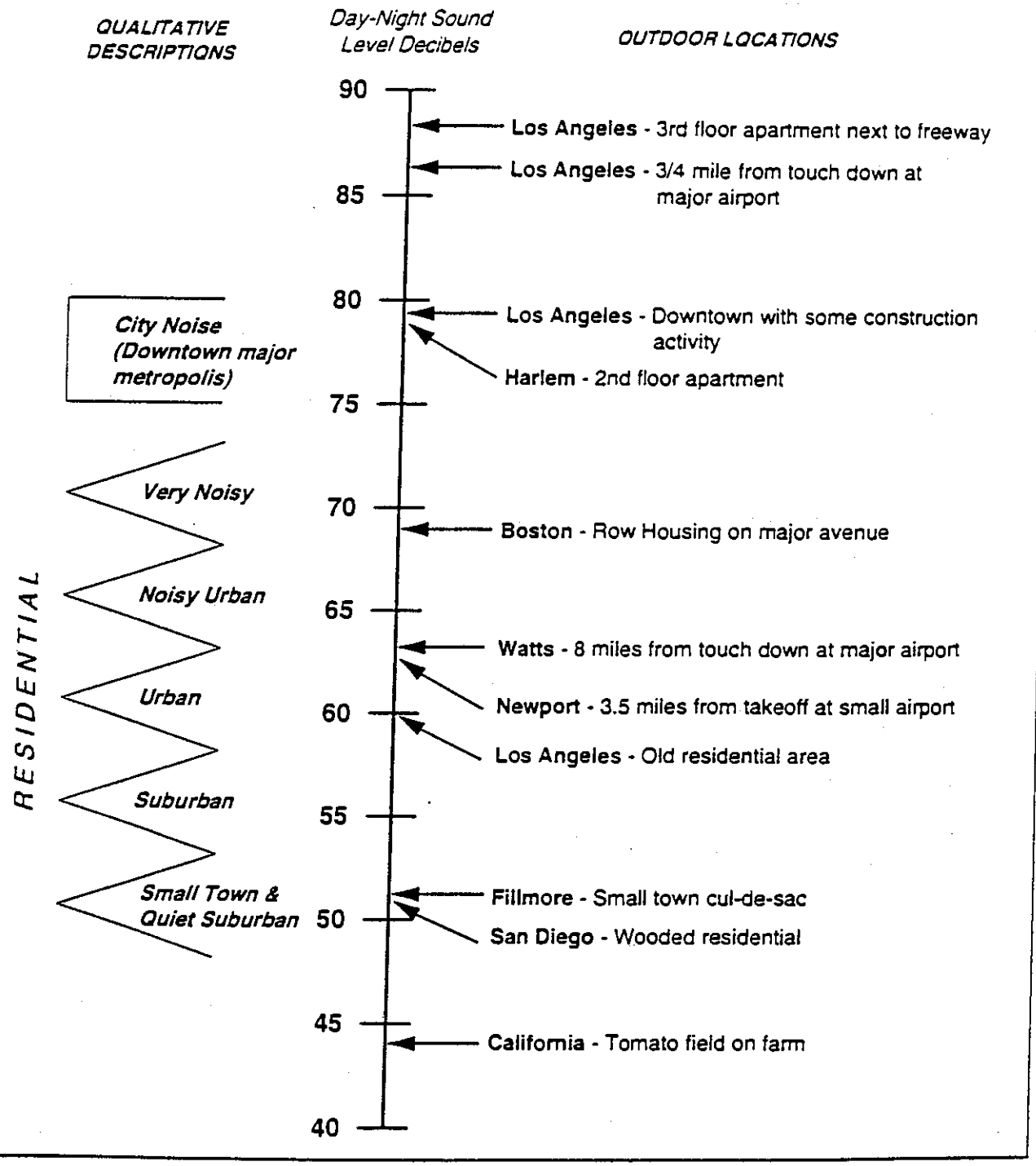
The community noise metrics to be used in Noise Elements are either CNEL or Ldn (as specified in §65302(f)). A significant factor in the selection of these scales was compatibility with existing quantifications of noise exposure currently in use in California. CNEL is the noise metric currently specified in the State Aeronautics Code for evaluation of noise impact at specific airports which have been declared to have a noise problem. Local compliance with the state airport noise standards necessitates that community noise be specified in CNEL. The Ldn represents a logical simplification of CNEL. It divides the day into two weighted time periods (Day — 7a.m. to 10 p.m. and Night — 10 p.m. to 7a.m.) rather than the three used in the CNEL measure (Day — 7a.m. to 7p.m., Evening — 7p.m.to 10 p.m., and Night — 10 p.m. to 7a.m.) with no significant loss in accuracy.

VII. CRITERIA FOR NOISE COMPATIBLE LAND USE

Figure 2 summarizes the suggested use of the CNEL/Ldn metrics for evaluating land use noise compatibility. Such criteria require a rather broad interpretation, as illustrated by the ranges of acceptability for a given land use within a defined range of noise exposures.

Denotation of a land use as "normally acceptable"

Figure 3



on Figure 2 implies that the highest noise level in that band is the maximum desirable for existing or conventional construction which does not incorporate any special acoustic treatment. In general, evaluation of land use which falls into the "normally acceptable" or "normally unacceptable" noise environments should include consideration of the type of noise source, the sensitivity of the noise receptor, the noise reduction likely to be provided by structures, and the degree to which the noise source may interfere with speech, sleep, or other activities characteristic of the land use.

Figure 2 also provides an interpretation as to the

suitability of various types of construction with respect to the range of outdoor noise exposure.

The objective of the noise compatibility guidelines in Figure 2 is to provide the community with a means of judging the noise environment which it deems to be generally acceptable. Many efforts have been made to account for the variability in perceptions of environmental noise which exist between communities and within a given community.

Beyond the basic CNEL or Ldn quantification of noise exposure, one can apply correction factors to the measured or calculated values of these metrics in order to account for some of the factors which may cause the noise to be more or less acceptable than the mean response. Significant among these factors are seasonal variations in noise source levels, existing outdoor ambient levels (i.e., relative intrusiveness of the source), general societal attitudes towards the noise source, prior history of the source, and tonal characteristics of the source. When it is possible to evaluate some or all of these factors, the measured or computed noise exposure values may be adjusted by means of the correction factors listed in Table 1 in order to more accurately assess local sentiments towards acceptable noise exposure.

In developing these acceptability recommendations, efforts were made to maintain consistency with the goals defined in the Federal EPA "Levels Document" and the State Sound Transmission Control Standards for multifamily housing. In both of these documents, an interior noise exposure of 45 dB CNEL (or Ldn) is recommended to permit normal residential activity. If one considers the typical range of noise reduction provided by residential dwellings (12 to 18 dB with windows partially open), the 60 dB outdoor value identified as "clearly acceptable" for residential land use would provide the recommended interior environment.

Figure 3 has been included in order to better explain the qualitative nature of community noise environments expressed in terms of Ldn. It is apparent that noise environments cover a broad range and that, in general, if may be observed that the quality of the environment improves as one moves further away from major transportation noise sources.

VIII. BIBLIOGRAPHY

Airport Land Use Planning Handbook: A Reference and Guide for Local Agencies, prepared for the California Department of Transportation, Division of Aeronautics (California Department of Transportation, Sacramento, CA), 1994.

Lynch, Kevin and Hack, Gary: *Site Planning*. Massachusetts Institute of Technology, Cambridge, MA, 1984.

Peterson, Arnold P.G. and Gross, Ervin E. Jr.: *Handbook of Noise Measurement*. General Radio Co., Concord, MA, 1974.

Simplified Procedures for Estimating the Noise Impact Boundary for Small and Medium Size Airports in the State of California. Wyle Research Report No. WCR 72-3, prepared for the California Department of Aeronautics by Wyle Laboratories, May 1973.

Swing, J.W. and Pies, D.B.: *Assessment of Noise Environments Around Railroad Operations*. Wyle Research Report No. WCR 73-5, Wyle Laboratories, El Segundo, CA, July 1973.

Swing, J.W.: *Estimation of Community Noise Exposure in Terms of Day-Night Average Level Noise Contours*. California Office of Noise Control, Department of Health, Berkeley, CA, May 1975.

U.S. Department of Housing and Urban Development: *Aircraft Noise Impact — Planning Guidelines for Local Agencies*. Prepared by Wilsey and Ham, (GPO Stock No. 2300-00214), Pasadena, CA, November 1972.

U.S. Department of Transportation, Federal Highway Administration, National Highway Institute: *Fundamentals and Abatement of Highway Traffic Noise*. (Report No. FHWA-HHI-HEV-73-7976-1), June 1973.

U.S. Environmental Protection Agency: *Information on Levels of Environmental Noise Requisite to Protect Public Health and Welfare with an Adequate Margin of Safety*. (550/9-74-004), March 1974.

Veneklasen, Paul S.: *Development of a Model Noise Ordinance*. Performed under contract to the California Office of Noise Control, Department of Health, Berkeley, CA, March 1975.