SANTA BARBARA COUNTY COMPREHENSIVE PLAN

NOISE ELEMENT

ADOPTED 1979

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Planning and Development
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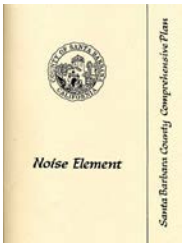
The electronic version of the Santa Barbara County Comprehensive Plan can be found at: http://longrange.sbcountyplanning.org



Former Noise Element Cover – Replaced March 2009

General Plan Advisory Committees (1986)

Santa Ynez Valley
Lompoc Area
Orcutt-Santa Maria Area

Santa Barbara County Resource Management Department (1986)

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Table of Contents

INTRODUCTION [i]

Since the time of the industrial revolution, the use of mechanical devices has increased dramatically. The technology that has brought motor vehicles, jet aircraft, and literally thousands of labor-saving implements into common usage has, at the same time, increased both the magnitude and frequency of occurrence of man-made sound in the environment. Recently, it was estimated that as a nationwide average, ambient sound levels in cities are rising one decibel each year.[1*]

[*] References will be found at the end of each chapter.

The need for increased attention to noise in the planning process is a consequence of this potential for continued elevation of ambient noise levels, the spread of noise producing activities into formerly quiet areas, and heightened awareness of the impact of noise on human health and amenity. Noise affects both physiological and psychological well-being. In addition to causing hearing loss, noise interferes with activities such as communication, sleep, and thought. Noise can be a source of great annoyance for many persons and may be a contributing factor in stress-related health disorders.

The purpose of the Noise Element is to develop a statement of public policy to deal with problems of excessive noise. The Noise Element identifies major sources of noise, estimates the extent of their impact on the County, and identifies potential methods of noise abatement. Noise exposure information developed in the Noise Element will become a basis for determining compliance with the State's Noise Insulation Standards. After adoption of Noise Element policies, specific implementation proposals, such as zoning ordinance revisions, will be presented.

LEGISLATIVE REQUIREMENT

The Noise Element is one of nine elements required by California law to be part of cities' and counties' general plans. Section 65302 (g) of the Government Code states that the General Plan shall include:

> "A noise element which shall recognize guidelines adopted by the Office of Noise Control pursuant to Section 39850.1 of the Health and Safety Code, and which quantifies the community noise environment in terms of noise exposure contours for both near and long-term levels of growth and traffic activity. Such noise exposure information shall become a guideline for use in development of the land use element to achieve noise compatible land use and also to provide baselines levels and noise source identification for local noise ordinance enforcement."

The sources of environmental noise considered in this analysis shall include, but are not limited to, the following:

(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.

The noise exposure information shall be presented in terms of noise contours expressed in community noise equivalent level (CNEL) or day-night average level (L_{DN}). CNEL means the average 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 before 7 a.m. and after 10 p.m. L_{DN} means the average equivalent A-weighted sound level during a 24-hour day, obtained after addition of 10 decibels to sound levels in the night before 7 a.m. and after 10 p.m.

The contours shall be shown in minimum increments of 5 dB and shall continue down to 60 dB. For areas deemed noise sensitive, including, but not limited to, areas containing schools, hospitals, rest homes, long-term medical or mental care facilities, or any other land use areas deemed noise sensitive by the local jurisdiction, the noise exposure shall be determined by monitoring.

A part of the noise element shall also include the preparation of a community noise exposure inventory, current and projected, which identifies the number of persons exposed to various levels of noise throughout the community.

The noise element shall also recommend mitigating measures and possible solutions to existing and foreseeable noise problems.

The state, local, or private agency responsible for the construction, maintenance, or operation of those transportation, industrial or other commercial facilities specified in paragraph 2 of this subdivision shall provide to the local agency producing the general plan, specific data relating to current and projected levels of activity and a detailed

methodology for the development of noise contours as specified in the foregoing statements.

> It shall be the responsibility of the local agency preparing the general plan to specify the manner in which the noise element will be integrated into the city or county's zoning plan and tied to the land use and circulation elements and to the local noise ordinance. The noise element, once adopted, shall also become the guidelines for determining compliance with the State's Noise Insulation Standards, as contained in Section 1092 of Title 25 of the California Administrative Code."[2]

RELATIONSHIP TO OTHER COMPREHENSIVE PLAN ELEMENTS

To some degree all Elements of the Comprehensive Plan are related and interdependent; the Noise Element is most closely related to the Land Use, Circulation, and Housing Elements.

Land Use

A primary objective of the Noise Element is to provide noise exposure information for use in the Land Use Element. The Noise Element will identify noise-sensitive land uses and suggest standards for their development in high noise impact areas. In some instances existing land use designations will need revision as a result of adoption and implementation of the Noise Element.

Circulation

Transportation systems are dominant sources of noise in Santa Barbara County. Their location, capacity, and design determine the extent of noise impacts on surrounding land uses. The Noise Element affects the Circulation Element by suggesting that noise evaluation be included in the analysis of location and design alternatives for new roadways.

Housing

The Housing Element is concerned with the provision of adequate housing of acceptable quality, and noise exposure is an important factor affecting the quality of housing. The Noise Element recommends design standards for new housing in high noise impact areas. This will affect the cost and, in some instances, the location of new or rehabilitated housing.

References

1. U.S. Senate Subcommittee on Air and Water Pollution, Noise Pollution. 92nd Congress, 2nd Session (Washington, D.C.: USGPO) 1972

2. Office of Noise Control, California Department of Health, Guidelines for the Preparation and Content of Noise Elements of the General Plan (Berkeley, California)

NOISE: PROPERTIES AND MEASUREMENT

Noise is defined as unwanted or objectionable sound. Sound is a form of energy detectable by the human hearing system, and it is commonly produced when some object is set into vibration. The vibration is transmitted to any surrounding media, such as air, causing pressure variations or "sound waves" among the air particles. These waves spread outward from the source, and along their path the waves can reflect off surfaces, they can bend around obstacles, and they can be absorbed by insulative materials. If sound waves reach one's ears, the membranes at the end of the ear canal begin vibrating. The vibration is transmitted by small bones in the middle ear to the cochlea, where the inner ear's sensory organ is located. Nerve impulses originating in the cochlea are interpreted by the brain as "sound."

Measurement of sound involves determining three variables: (1) magnitude; (2) frequency; and (3) duration.

MAGNITUDE

The magnitude of variations in air pressure associated with a sound wave results in the quality commonly referred to as "loudness." Human ears respond to a very wide range of sound pressures, producing numbers of awkward size when sound pressures are related on an arithmetic (1,2.3,…) scale. It has therefore become customary to express sound magnitude in decibels (dB) which are logarithmic (1,10,100,…) ratios comparing measured sound pressures to a reference pressure. The reference pressure commonly used in noise measurement is 20 microPascals, which is considered to be the quietest sound normal ears can hear. This sound level is assigned the value zero dB, and each increment in sound level of 20 dB represents a relative change in sound pressure of ten times.

*All "dB" notations used in this report are sound pressure levels referenced to 20 microPascals.

Because decibels are logarithmic ratios, they cannot be manipulated in the same way as arithmetic numbers. Addition of decibels produces such results as 70 dB + 70 dB = 73 dB. Thus, if a single automobile produces a sound level of 70 dB, two such automobiles would produce a total sound level of 73 dB. Twice as much acoustic energy is being generated, and this is represented in decibels as a 3 dB change. As a second example of decibel addition, if one automobile produces a sound level of 70 dB and the other 60 dB, the combined sound level will be 70.4 dB. When the difference between two sound levels is greater than about 10 decibels, the lesser sound is negligible in terms of affecting the total level.

A 3 dB increase in sound level represents a doubling of sound energy, but it will not be experienced as a doubling in loudness. Loudness refers to how people judge the volume of sound. As a rule of thumb, a 1 dB change in sound level requires close attention to notice a change in loudness; a 3 dB change is clearly noticeable; and a 10

dB change will be nearly twice (or one-half) as loud. A noise of 70 dB sounds about twice as loud as 60 dB and four times as loud as 50 dB. The 50 dB noise will be twice as loud as 40 dB, and so on. Figure 1 illustrates the relationship among sound level, relative sound pressure, and relative loudness.

Sound level diminishes as distance from the source increases. For a point source of sound in free space, the rate at which the sound attenuates is inversely proportional to the square of distance from the source. This means the sound level will drop 6 dB each time the distance from the source is doubled. A stream of vehicles on a busy highway represents a “line” source of sound and the rate of attenuation is different from a point source. The sound level from a busy highway will drop only about 3 dB for each doubling of distance. Sound attenuation from a train resembles a line source near the railroad tracks and at further distances (beyond about 3/10 the length of the train) can be considered a point source.[1]

Air and ground absorption of sound waves will further attenuate sound levels. The rate at which these factors attenuate sound depends on frequency content of the sound, air temperature, relative humidity, terrain, and type of ground cover.

FREQUENCY

A second characteristic of sound which must be included in its measurement is frequency. Typical community sounds consist of a wide range of frequencies, from the low roar of a diesel engine to the high-pitched whine of jet aircraft. Frequency refers to the number of times per second the object producing the sound vibrates, or oscillates. The unit of measurement of frequency is Hertz one vibration per second being equal to one Hertz (Hz).

The human ear responds to sounds whose frequencies are in the range from 20 Hz to 20,000 Hz. Frequencies above or below this range are inaudible to humans and are referred to as ultrasound and infrasound, respectively. Within the audible range, subjective response to noise varies. People generally find higher pitched sounds to be more annoying than lower pitched sounds. Sensitivity of the ear also varies. While “loudness” depends primarily on sound pressure, it is also affected by frequency; and, while “pitch” is closely related to frequency, it also depends on sound pressure. Thus, a 2,000 Hz tone at 5 dB sound pressure level sounds just as loud as a 20 Hz tone at 70 dB sound pressure level; 20 Hz at 70 dB sound pressure level is quiet to the ear; 2,000 Hz at 70 dB sound pressure level is quite loud.

Because of these variations, a great deal of effort has gone into the development of systems which relate physical measurements of noise to subjective human response. Most of these depend on calculations based on sound pressure levels in various frequency bands “weighted” to correspond with human response. These procedures are cumbersome for most community noise assessment needs. Presently, the most widely used measure of “loudness” for community noise evaluation is the A-weighted sound

level. The primary advantage of this descriptor is simplicity, and it has fair correlation with subjective assessments of loudness and annoyance.[2] Sound levels in this report are A-weighted and referred to as "dB(A)."

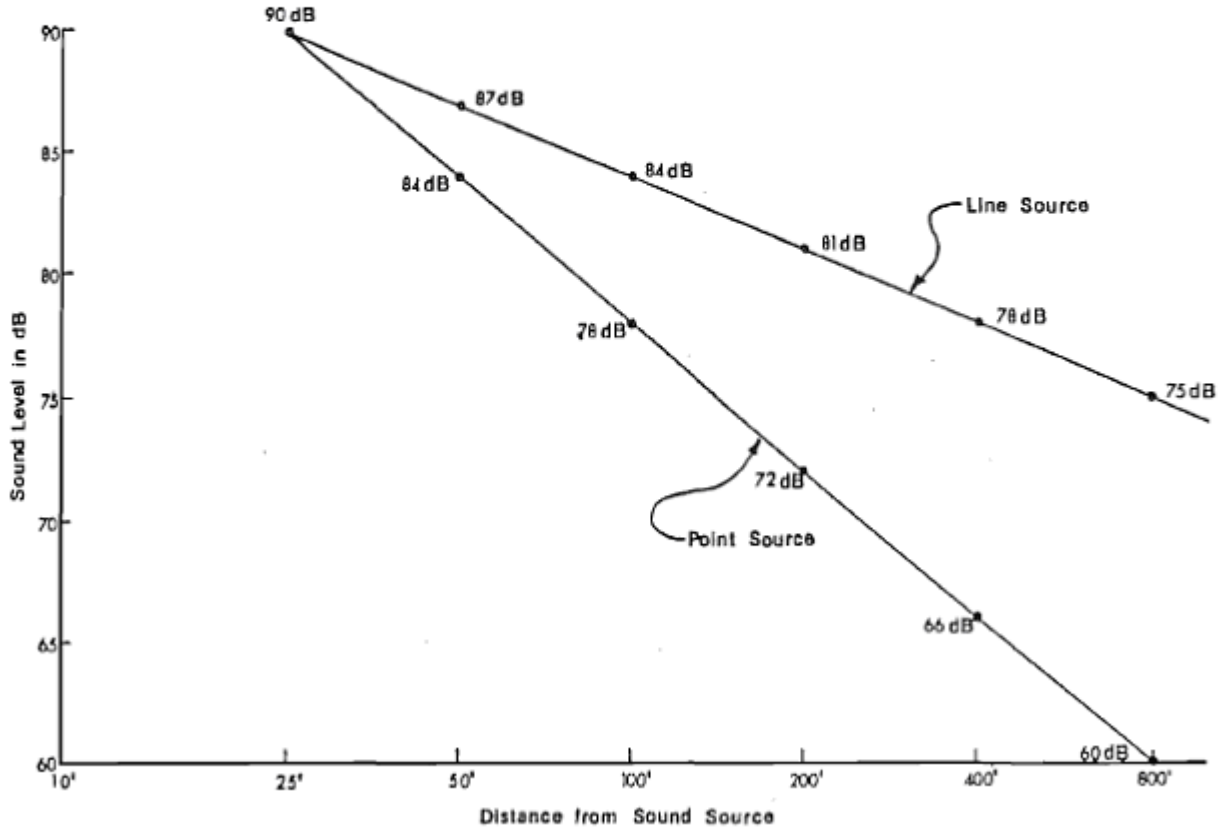
FIGURE 1: SOUND LEVEL OF COMMON SOUNDS

Sound	Sound Pressure Level (dB)*	Relative Sound Pressure	Relative Loudness (Approximate)
Jet Take-Off, 200 feet	120	1,000	64
Riveting Machine	110		32
Power Mower, 5 feet	100	100	16
Motorcycle, 50 feet	90		8
Inside Sports Car (50 mph)	80	10	4
Vacuum Cleaner	70		2
Ordinary Conversation, 3 feet	60	1	1
Private Business Office	50		1/2
Inside Average Residence	40	.1	1/4
Soft Whisper, 5 feet	30		1/8
Inside Recording Studio	20	.01	1/16
Rustle of leaves	10		1/32
Threshold of Hearing	0	.001	1/64

* Reference 20 microPascals

Adapted from several sources

Figure 2
Attenuation of Sound Level
Illustrated for 90 dB Sound Sources



DURATION

The third characteristic of noise that must be accounted for to describe noise response is duration. Noise-induced hearing loss, for example, is directly related to magnitude, frequency content, and duration of noise exposure. Annoyance due to noise is also associated with how often noise is present and long noise persists.

Environmental noise at any location is usually fluctuating from quiet one moment to loud the next. To adequately describe a noise environment, it is necessary to quantify the variation in noise level over time. One way to do this is to use a statistical approach and specify noise levels that are observed to be exceeded a given percentage of time. Commonly used exceedance levels are:

L_{90} - That level exceeded 90 percent of the time, sometimes referred to as the Residual Noise Level.

L_{50} - That level exceeded 50 percent of the time, the median sound level.

L_{10} - That level exceeded 10 percent of the time, representing higher level, shorter duration noise.

Another approach to quantifying time-varying noise levels is to calculate the Energy Equivalent Sound Level (L_{eq}) for the time period of interest. L_{eq} represents a sound level which, if continuous, would contain the same total acoustical energy as the actual time-varying noise which occurs during the observation period.

Application of L_{eq} to problems of community noise measurement presumes that there is a trade-off between noise level and length of exposure. Two noises can represent the same amount of acoustical energy, even though one is of relatively lower level but longer duration: both noises have the same L_{eq} value and are therefore considered identical in this methodology. L_{eq} is the basis for the Community Noise Equivalent Level and Day-Night Average Level.

TIME-WEIGHTED NOISE MEASURES; CNEL, LDN

Noise in a residential, or other noise-sensitive setting, is often more bothersome at night than during daytime. At night, background noise levels outdoors are generally lower than during the day. Also, the activity in most households decreases at night, lowering internally generated noise levels. Individual noise events are therefore more intrusive at night, since they stand out against the background more sharply than during the daytime.

Community Noise Equivalent Level (CNEL) and Day-Night Average Level (L_{DN}) are noise indices that attempt to take into account differences in intrusiveness between

daytime and nighttime noises. CNEL and L_{DN} values result from the averaging of hourly Energy-Equivalent Sound Levels for a 24-hour period, with a weighting factor applied to evening and nighttime L_{eq} values.

For CNEL and L_{DN} calculations, the day is divided into time periods with the following weightings:

Community Noise Equivalent Level

Daytime: 7 a.m. - 7 p.m. - weighting factor of 1
Evening: 7 p.m. - 10 p.m.- weighting factor of 5 dB
Nighttime: 10 p.m. - 7 a.m. - weighting factor of 10 dB

Day-Night Average Level

Daytime: 7 a.m. - 10 p.m. - weighting factor of 1
Nighttime: 10 p.m. - 7 a.m. - weighting factor of 10 dB

CNEL and L_{DN} have been shown to have good correlation with group responses to long-term noise exposure.[3] In practice, CNEL and L_{DN} are virtually identical. Experience with highway, railroad, airport, and general community noise in this County has shown that the two measures consistently agree within 1.0 dB. In this report they are used interchangeably.

NOISE EXPOSURE CONTOURS

Noise exposure contours are the mapped expression of points of equal average noise level analogous to topographic contours which are the mapped expression of points of equal elevation. Noise contours can be drawn with respect to any noise measure; to satisfy State requirements for the Noise Element, L_{DN} and CNEL have been used in this report. Noise contours usually refer to a single source of noise such as a freeway, although they sometimes combine multiple sources.

Ambient Noise

Ambient noise is the composite of noise from all sources which impact a given location. It is the normally existing noise environment at a particular place.

References

1. U.S. Department of Transportation, Transportation Noise and its Control (Washington, D.C.: US GPO) 1972

2. U.S. Environmental Protection Agency, Public Health and Welfare Criteria for Noise (Washington, D.C.: US GPO) 1973

3. U.S. Environmental Protection Agency, Information on Levels of Environmental Noise Requisite to Protect the Public Health and Welfare with an Adequate Margin of Safety (Washington, D.C.: US GPO) 1974

EFFECTS OF NOISE

Noise may have a variety of consequences for physical, mental, or social well-being. For discussion, these effects are categorized as either auditory or non-auditory. Auditory effects of noise include hearing loss and interference with communication. Non-auditory effects include physiological reactions, interference with sleep, adverse affects on human performance, and annoyance.

AUDITORY EFFECTS

Hearing Loss

Permanent hearing loss is, so far as is presently known, the most severe effect of noise upon health. While noise-induced hearing loss was once associated primarily with certain industrial situations, increasing numbers of people in urban areas are presently exposed to ambient noise levels which over long periods of exposure will cause significant hearing impairment.[1] Even where daily exposure to general community noise does not in itself pose a distinct hazard to hearing, it may still contribute to hearing loss. Community noise may prevent the person who works in a high noise situation from receiving enough quiet while off the job to allow the ears to recuperate from temporary hearing loss experienced on the job.[2]

Hearing loss may be either temporary or permanent. Temporary loss, attributable to fatigue of the inner ear, can occur after brief exposure to high noise levels, or after longer exposure to more moderate levels. Often this temporary decrease in hearing acuity is accompanied by ringing or buzzing sensations in the ears. Continued exposure to levels sufficient to cause temporary hearing impairment can, over a period of time, result in damage to the inner ear that is permanent. Permanent hearing loss cannot be restored, either through medical treatment or hearing aids.

Hearing loss resulting from noise is referred to as a “noise-induced threshold shift.” It usually first affects those frequencies necessary to hear and understand speech communication. People who have a moderate threshold shift often are not aware of the condition except for the difficulty they experience in understanding others' speech, especially when some background sounds are also present.

Noise-induced permanent threshold shift is related to the intensity, duration, and frequency content of noise exposure. From extensive studies of industrial noise, it has been found that 8-hour exposure to continuous noise levels below approximately 80 dB does not cause significant permanent threshold shift.[3]

However, temporary threshold shift is experienced at these and even lower levels. Workers covered by the Occupational Safety and Health Act (OSHA) must be protected from noise exposures exceeding 90 dB(A) for 8 hours; there is some question whether this standard adequately protects workers against hearing impairment.[4] For non-

occupationally related exposure to intermittent and fluctuating noise for periods greater than eight hours, little primary research has been done to establish "safe" noise limits. On the basis of available evidence, the U.S. Environmental Protection Agency has concluded that a 24-hour Energy Equivalent Sound Level (L_{eg}) of 70 dB(A) is the maximum exposure consistent with long-term protection against significant hearing loss at a frequency of 4,000 Hz.[5] Since this frequency is within the most sensitive range of the ear, protection at 4,000 Hz insures that the entire frequency spectrum of human hearing would be protected from significant hearing loss.

Speech Communication

Interference with the ability to hear and understand speech communication is one of the more common experiences of noise intrusion. In a highly developed society, much value is placed on verbal exchange. Noise can reduce the amount and quality of this interaction.

The impact of noise on speech communication can be evaluated in terms of speech intelligibility requirements. Speech intelligibility is measured in terms of the percentage of key words in a group of sentences that can be correctly understood. As noise level increases, the percentage of words understood will decrease, unless the people communicating move closer together or raise their voices. One hundred percent intelligibility is not necessary for satisfactory communication in all situations. Most people can correctly infer the content of a sentence even though one or more words may not have been heard. Once intelligibility drops below about 90 percent, however, conversation becomes strained.[6]

For normal one-to-one conversation to proceed in the outdoor environment (with the distance between speaker and listener usually being around five feet), background noise levels should not exceed 50-60 dB(A). This assumes that 95 percent intelligibility is satisfactory. For interior spaces, a noise level not exceeding 40-45 dB (A) will permit 100 percent sentence intelligibility. This, however, assumes the speakers are young adults with normal hearing. Children have less precise speech than do adults. Also, their knowledge of language makes them less able to understand speech when some speech cues are lost. Children under about 13, the elderly, hard of hearing, and people with dialect differences will all require lower background levels than those indicated.[7]

NON-AUDITORY EFFECTS

Physiological Reactions

In addition to hearing loss, a number of other physiological responses to noise have been documented. Changes in cardiovascular blood pressure and blood volume, breathing rate, pulse rate, and endocrine gland secretions have all been observed to result from exposure to noise.[8] These non-auditory effects are usually termed “arousal” or “stress” reactions and are very difficult to distinguish physiologically from responses

that occur in emotional states of fear or anger. They usually take place without conscious knowledge of their occurrence.

It is not yet clear whether these physiological responses are associated with the onset or prolongation of any disease in humans. Noise has been cited as a contributing factor to the development of peptic ulcers, hypertension, colitis, migraine headaches and other disorders; but a causal link between noise exposure and non-auditory disease has not been established with certainty.[9,10]

A persistent myth with regard to the effect of noise on people is that people learn to adapt to their noise environment. Adaptation implies that with repeated exposure to a stimulus, people cease to exhibit a response. While it is true that after a time people can become relatively unconscious of noise, it is uncertain whether physiological adaptation occurs, meaning that people cease to show a stress response.

Until it is proven conclusively either that physiological adaptation to noise does occur, or that stress reactions are harmless, it cannot be assumed that if people seem not consciously bothered by noise, they are not affected by noise. For the present, noise must be regarded as a potential threat to physiological well-being.[11]

Stress reactions have not been observed at noise levels below that at which hearing loss can occur; the threshold of this stress effect seems to be 70-80 dB(A). Therefore, if people are protected from noise exposures capable of causing hearing loss, it is believed they will also be protected from the experience of any noise-induced non-auditory disease.[12]

Sleep Interference

From everyday experience as well as laboratory research, it is evident that noise interferes with sleep. In addition to awakening a person, or preventing the person from falling asleep, noise can shift the stage of sleep from a deep, restful stage to a lighter one. In laboratory tests this is observed as a change in brain-wave pattern of a sleeping subject. The significance of these shifts in stage of sleep to a person's long term well-being has not been established.

Disruption of sleep can occur at sound levels as low as 35 dB(A), but there is a great deal of variability in response among individuals. Some people awaken consistently when exposed to rather low level noise while others practically never awaken, even at levels up to 75 dB(A).[13] A number of factors influence the degree to which noise may interfere with sleep. Impulsive or fluctuating noise is more disruptive than steady-state noise. Familiarity with the noise may reduce its ability to awaken, but there is no clear evidence that the quality of sleep is unaffected. Noise which has some information value is more likely to wake a person. A familiar example is the parent who awakes instantly to the faint sound of a crying child, but sleeps through virtually everything else. The ability of noise to disrupt sleep is related to age. Elderly persons are much more easily

awakened by noise than younger age groups, and once awakened find it more difficult to return to sleep.[14]

Because of the number of variables involved, it has been difficult to establish a quantitative relationship between noise exposure and sleep interference. In light of present knowledge, however, researchers recommend that noise levels inside dwellings not exceed 35-40 dB(A) for satisfactory sleeping conditions.[15]

Physical and Mental Performance

Noise levels, such as are found in certain industrial situations, are known to adversely affect the ability to perform physical tasks, even when the task requires little mental concentration. For a familiar, steady-state noise this is generally true only when the noise exceeds 90 dB(A). Irregular or unfamiliar bursts of noise can affect work efficiency at lower noise levels. Usually, the total quantity of work performed will not decrease, but the number of errors made will increase.[16] Any task requiring the use of speech or other auditory signals will be subject to noise interference.

The ability to perform mental tasks such as reading, problem solving, or writing is also impaired by a noisy environment. As with sleep interference, there is a great deal of variability in individuals' responses. The degree of distraction, or interference with concentration, is related to the person's state of motivation, morale, stress, and fatigue, as well as characteristics of the noise such as intensity, pitch, impulsiveness, and information content.[17] Complex or demanding tasks are more likely to be disrupted by noise than are simple assignments.

While the impact of noise on mental efficiency has not been correlated to some measure of noise exposure, higher noise levels make it less likely that performance will adapt. Even when identical performance is achieved in or out of noise, there may yet be a cost to the individual. This cost can be increased fatigue at the end of the day, or reduced ability to react to additional demands of a job.[18]

Annoyance

Annoyance is considered here to mean feelings of displeasure or resentment associated with the experience of noise, either because the noise is judged unpleasant or because the noise disrupts some ongoing activity. Annoyance is partly a psychological response to noise and partly a sociological response. Attitudes or values prevalent in a particular community can influence an individual an evaluation of noise.

Community-wide annoyance by noise has been extensively studied through social surveys. These attempts to gauge the intrusiveness of noise by questioning large numbers of people about the manner in which noise may affect their lives and about whether and to what degree they consider noise from various sources to be disturbing. Such studies have been performed in numerous counties and in many cities and regions within the United States. One was conducted in the Goleta Valley in 1973.[19]

These studies are usually geared to investigate the impact of noise on residential populations.

When the responses to attitudinal surveys are correlated with measurements of the noise environment to which participants are exposed, predictions of community-wide response to noise are possible. Time-integrated measures of noise (such as Community Noise Equivalent Level) allow significantly better prediction of perceived annoyance than do maximum or peak-level measures. While most surveys have addressed themselves to aircraft noise exposure, those studies of noise sources other than aircraft show relationships between noise exposure and annoyance similar to aircraft studies.[20]

While it is impossible to predict what a particular individual's reaction to a given noise will be, there is good statistical correlation between characteristics of noise exposure and average annoyance reported by groups of individuals. The higher the average noise level, the greater the number of persons who report annoyance and the more frequently they report being bothered. As noise levels increase there is smaller variation in annoyance response, indicating a greater consensus among individuals.[21]

The variation in response can be explained statistically by factors other than the noise itself. For example, people who are afraid of airplane crashes are more likely to be annoyed by aircraft noise. People who are more highly educated or who are more economically well-off have higher than average annoyance scores. If people feel the noise source is necessary for social or economic reasons; if they personally benefit from it; if they feel those responsible for the noise source care about their welfare, or if they like them; they are less likely to report dissatisfaction with the noise.[22]

Subjective responses to noise can be related to the character of the noise. The higher the noise level and the longer it lasts, the more persons are bothered. Higher pitched sounds are more disturbing than lower pitches. Noises with pure tone components tend to be piercing and are therefore annoying at lower sound levels. If the noise is impulsive, intermittent, or rhythmic, it will be more bothersome than steady-state noise.

Where and when the noise occurs will influence perceived annoyance. Noise that is accepted in a downtown area may be found objectionable in a suburban or rural setting. When noise occurs in the evening or at night, it is found to be more disturbing than during the day. If noise interrupts some activity such as speech, watching television, or relaxation, it is highly objectionable. People are seldom upset with noise they themselves make or which they have chosen to experience.

A portion of any community, ranging from 2 to 10 percent of the population, will report a high degree of annoyance by noise at almost any level of intensity. At the other end of the spectrum, approximately 20 percent of the population seems almost never bothered by noise, whatever the intensity.[23] Thus, noise control measures would not be likely to affect the reactions of those who might be classed as ultrasensitive or insensitive to noise, but would be of benefit to the remaining two-thirds of the population lying between the two extremes.

The willingness to express a formal complaint to a public agency about noise is partially dependent on attitudes and factors other than the actual degree of annoyance. Those who complain tend to be older, more highly educated, and of higher economic status than non-complainants. Complainants represent only a small fraction of those who report annoyance.[24] This implies that it could be misleading to use the number of complaints made to a public agency about noise as an indicator of public dissatisfaction. Many people may be highly annoyed and yet never communicate this to a responsible agency.

The Environmental Protection Agency consolidated data from a number of surveys conducted in England and the United States to measure the association between noise exposure and community response. The results of this study are summarized here, showing community noise exposure in Day-Night Average Level versus percent of residential populations reporting that they are "highly annoyed" by noise in their neighborhood.

L_{DN}(dB) [25]	Percent Highly Annoyed
55	17%
60	25%
65	34%
70	43%
75	52%

In a recent survey conducted by the U. S. Bureau of the Census, the importance of noise as a factor influencing residents' dissatisfaction with their neighborhoods was evaluated.[26] Ten percent of survey respondents residing in suburban areas reported they wished to move because of neighborhood conditions. Interestingly, noise was cited by 33 percent of these respondents as a condition causing their dissatisfaction while crime was cited by only 28 percent.

ENVIRONMENTAL PROTECTION AGENCY HEALTH AND WELFARE CRITERIA

The Noise Control Act of 1972 established by statutory mandate a national policy "… to promote an environment for all Americans free from noise that jeopardizes their public health and welfare." The Environmental Protection Agency was directed by Congress to publish information about levels of environmental noise consistent with protection of public health and welfare with an adequate margin of safety. Figure 3 summarizes levels identified by the EPA.

It is EPA's judgment that maintenance of levels of environmental noise at or below those specified in Figure 3 is required to protect the public from adverse effects on

health and welfare. With respect to a residential setting, this gives consideration to the following factors:

1. Conservation of hearing requires a quiet residential environment to permit the human hearing mechanism to recuperate if it is exposed to higher levels of noise in an occupational or other setting.

2. Normal speech communication outdoors requires that background levels not exceed an energy average of 50-58 dB(A).

3. Normal sound attenuation of a residential structure, with windows partly open for ventilation, will reduce exterior noise to an indoor level which should in most cases protect against sleep interference.

The levels identified by the EPA were established without consideration of cost or feasibility of attainment, and they do not constitute an agency standard. The identified levels provide a basis for assessing the effectiveness of noise source emission regulations, land use policies, and building codes, as to the degree they protect the public health and welfare. Such regulatory action must consider technical feasibility and economic reasonableness, the scale of time over which results can be expected, and specific problems of enforcement. In the process of balancing these sometimes conflicting elements, the public health and welfare consequence of a specific decision can be evaluated against the environmental noise levels identified by the EPA.[27]

Figure 3: [27]

SUMMARY OF NOISE LEVELS IDENTIFIED AS REQUISITE TO PROTECT PUBLIC HEALTH AND WELFARE WITH AN ADEQUATE MARGIN OF SAFETY

Effect	Level	Area
Hearing Loss	$L_{eq(24)}$ - 70 dB	All areas
Outdoor activity interference and annoyance	L_{dn} - 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.
	$L_{eq(24)}$ - 55 dB	Outdoor areas where people spend limited amounts of time, such as school yards, playgrounds, etc.
Indoor activity interference and annoyance	L_{dn} - 45 dB	Indoor residential or hospital areas.
	$L_{eq(24)}$ - 45 dB	Other indoor areas with human activities such as schools, etc.

Explanation of Figure 3:

1. $L_{eq(8)}$ represents sound energy averaged over an 8-hour period, while $L_{eq(24)}$ averages energy over a 24-hour period.
2. The hearing loss level identified here represents annual averages of the daily sound level over a period of forty years.

References

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24. Ibid.

25. U.S EPA, Information …, Op. cit.

26. U.S. Department of Commerce, Bureau of the Census.
U.S. Department of Housing and Urban Development, 1975 Annual Housing Survey (Washington, D.C.: US GPO) 1975.

27. U.S EPA, Information …. Op. cit.

EXISTING STATE AND FEDERAL NOISE LEGISLATION

Development of County noise control policies needs to be undertaken with full knowledge of guidelines, standards, and policies already existing at state and federal levels of government. The role of the County in noise abatement is, in many instances, circumscribed by pre-emptory state or federal legislation. In other instances, the County must assume the role of enforcing standards that have been adopted at another governmental level. A summary of important noise control regulations is included in Appendix E. Some of these regulations directly relate to land use and transportation planning concerns, and these are reviewed here in more detail.

Department of Housing and Urban Development Noise Standards

As set forth in HUD Circular 1390.2, this policy is to:

1. Encourage land utilization patterns for housing and other municipal needs that will separate uncontrollable noise sources from residential and other noise-sensitive areas.

2. Withhold HUD financial support for construction of noise-sensitive development, particularly housing, on sites which are adversely impacted by noise.

Affected programs include low-income housing assistance, interest subsidies, and loan guarantees including FHA Mortgage Insurance.

The standards define four noise exposure categories which are applied to the site of proposed construction: Acceptable, Discretionary-Normally Acceptable; Discretionary-Normally Unacceptable, and Unacceptable. These are shown in Figure 6. Approval of construction on sites rated Unacceptable can come only from the Secretary of HUD. In the Discretionary categories, approval requires noise attenuation measures to be included in the project design and the concurrence of the HUD Regional Administrator.

It is difficult to relate the HUD criteria to existing data describing the County's noise environment. Except for airport noise, where L_{DN} standards are specified, “Acceptable” and “Unacceptable” locations for HUD assisted housing cannot readily be identified by reference to either the ambient noise survey data or noise contour data generated for the Noise Element. Such determinations will require on-site noise measurement.

Figure 6

DEPARTMENT OF HOUSING AND URBAN DEVELOPMENT
NOISE EXPOSURE STANDARDS FOR NEW CONSTRUCTION SITES

Exterior	Airport Noise
UNACCEPTABLE 75 dB(A)-L_{33}* (not to be exceeded more that 8 out of 24 hours)	75 dB(A)-L_{DN}
DISCRETIONARY-NORMALLY UNACCEPTABLE Greater than 65 dB(A)-L_{33} (exceeded more than 8 out of 24 hours)	65-75 dB(A)-L_{DN}
DISCRETIONARY-NORMALLY ACCEPTABLE Less than 65 dB(A)-L_{33} (not to be exceeded more than 8 out of 24 hours)	
ACCEPTABLE 45 dB(A)-L_2* (not to be exceeded more than 30 minutes out of 24 hours)	Less than 65 dB(A)-L_{DN}

Interior

ACCEPTABLE
45 dB(A)-L_{33}
(not to be exceeded more than 8 out of 24 hours)

55 dB(A)-L_4
(not to be exceeded more than 1 out of 24 hours)

45 dB(A)-L_6 (night)
(not to be exceeded more than 30 minutes out of 8 hours)

* L_{33}, L_2, etc. are exceedance levels. See page 9 for explanation.

Federal Highway Administration Design Standards

Federal Highway Program Manual, Volume 7, Chapter 7 establishes “design noise levels” for the planning and design of highway projects funded by the federal aid system. The regulations require that a noise analysis be conducted for highway projects, projecting anticipated highway noise levels and identifying noise sensitive land uses in the vicinity of the project. Action is to be taken to meet the standards given in Figure 7 to the extent that reasonable opportunities exist to do so. Federal funds may be used to construct noise barriers, to acquire land as a buffer zone, or to implement other noise abatement measures. Highway agencies are encouraged by FHWA to achieve noise levels below the “design noise levels” where this can be accomplished with benefits outweighing costs.

There is no unique relationship between the FHWA design levels and L_{DN} or CNEL measurements so that comparisons can be made with other standards. However, the FHWA criteria are based on “design hour” traffic volumes, which are roughly equivalent to peak hour traffic. Employing the rule-of-thumb that peak hour traffic volume is about 10% of average daily traffic, the following approximations to L_{DN} can be made for comparison purposes:

Activity Category	Design Noise Level in L_{DN}
A	55 (Exterior)
B	65 (Exterior)
C	70 (Exterior)
E	50 (Interior)

Figure 7

Federal Highway Administration
Design Noise Level/Activity Relationships

Activity Category	Design Noise Levels – dBA[1]		Description of Activity Category
	L_{eq} hourly	L_{10} hourly	
A[2]	57 (Exterior)	60 (Exterior)	Tracts of land 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[2]	67 (Exterior)	70 (Exterior)	Picnic areas, recreation areas, playgrounds, active sports areas, and parks which are not included in Category A and residences, motels, hotels, public meeting rooms, schools, churches, libraries, and hospitals.
C	72 (Exterior)	75 (Exterior)	Developed lands, properties or activities not included in Categories A and B above.
D	--	--	For requirements on undeveloped lands, see Paragraph 11.a, and c.
E	52 (Interior)	55 (Interior)	Residences, motels, hotels, public meeting rooms, schools, churches, libraries, hospitals, and auditoriums.

25

1 Either L_{eq} or L_{10} design noise levels may be used.

2 Parks in Categories A and B include all such lands (public or private) which are actually used as parks as well as those public lands officially set aside or designated by a governmental agency as parks on the date of public knowledge of the proposed highway project.

California Airport Noise Standards

California Administrative Code, Title 4 defines airport noise standards for all airports operating under permit from the California Department of Transportation, Division of Aeronautics. These regulations require each county to determine whether any of the airports within its boundaries has a “noise problem.” An airport is defined by this legislation to have a “noise problem” if the 70 dB Community Noise Equivalent Level contour around the airport includes residential uses, schools, or land uses other than specified compatible uses. The compatible land uses are:

a) Agricultural
b) Airport property
c) Industrial property
d) Commercial property
e) Property subject to an avigation easement for noise
f) Zoned open space
g) High rise apartments in which adequate noise insulation has been provided. Adequate means the noise reduction of the structure is sufficient to assure that the interior CNEL in any habitable room does not exceed 45 dB.
h) Existing acoustically treated homes, provided that the difference between the exterior CNEL and the noise impact criterion level (70 dB) does not exceed the difference between the noise attenuation provided by the acoustically treated home and the value 20 decibels.

After December 31, 1985, the noise impact criterion becomes 65 dB CNEL.

If an airport is determined by the County to have a “noise problem," the airport proprietor must install a continuous noise monitoring system at the airport and must implement a plan to reduce the airport's noise impact so that only compatible land uses will be within the noise impact criterion contour. Methods to be used to control the noise impact include:

a) Encouraging use of the airport by aircraft classes with lower noise level characteristics and discouraging use by higher noise level aircraft classes;

b) Encouraging approach and departure flight paths and procedures to minimize the noise in residential areas,

c) Planning runway utilization schedules to take into account adjacent residential areas, noise characteristics of aircraft and noise-sensitive time periods,

d) Reduction of the flight frequency, particularly in the most noise sensitive time periods and by the noisier aircraft;

e) Employing shielding for advantage, using natural terrain, buildings, etc., and

f) Development of a compatible land use within the noise impact boundary.

It was determined in 1972 that none of the airports within Santa Barbara County has a "noise problem" under criteria established in the Airport Noise Standards.[1] This finding was based on the fact that the 70 dB and 65 dB CNEL contours for the Lompoc, Santa Ynez, and Santa Maria airports were contained entirely within airport property. However, at the Santa Barbara Airport, the 70 dB CNEL contour in 1972 included about 20 dwelling units in an industrial zoning district east of the airport. The 65 dB CNEL contour included another 130 dwelling units. The Rancho Goleta Mobile Home Park, approved by the County in 1969, was constructed after 1972 and about 45 homes in this development lie within the 70 dB CNEL contour. Within the 65 dB CNEL contour there are now an estimated 280 houses, including those inside the 70 dB contour. If this situation exists in 1986, the Airport will be in clear violation of the California Airport Noise Standards.

California Noise Insulation Standards

Noise Insulation Standards are now part of the California Administrative Code, Title 25. These apply to all new multi-family dwelling units including apartment houses, condominium units, hotels, and motels. Detached single-family dwellings are excluded. The standard considers two areas of noise control: insulation of one unit from another; and isolation of interior living spaces from exterior noise. The insulation requirement is implemented through the Uniform Building Code, Chapter 35, which specifies minimum design requirements for party walls and floor/ceiling assemblies in terms of Sound Transmission Class (STC) and Impact Insulation Class (IIC) ratings.

The noise isolation requirement specifies that the interior Community Noise Equivalent Level attributable to exterior sources, shall not exceed 45 dB in any habitable room. It also states that residential structures to be located within an annual CNEL contour of 60 dB require an acoustical analysis showing that the proposed building has been designed to limit intruding noise to the allowable interior noise level. Evidence of compliance with the standard is to consist of an acoustical analysis report prepared by a person experienced in the field of acoustical engineering and submitted with the application for a building permit.

The noise contours produced for the Noise Element provide a basis for identifying residential projects which will be affected by isolation requirements of the Noise Insulation Standards. Administrative procedures need to be set up within the County so that affected projects will receive the acoustical analysis stipulated by these standards.

California Office of Noise Control, Noise Compatibility Guidelines

The California Office of Noise Control has published guidelines for evaluating land use compatibility with various noise environments.[2] (See Figure 8.) These recommendations consider noise sensitivity factors such as:

1. Speech communication needs;
2. Subjective judgments of noise acceptability and relative noisiness;
3. Need for freedom from noise intrusions; and
4. Sleep sensitivity criteria.

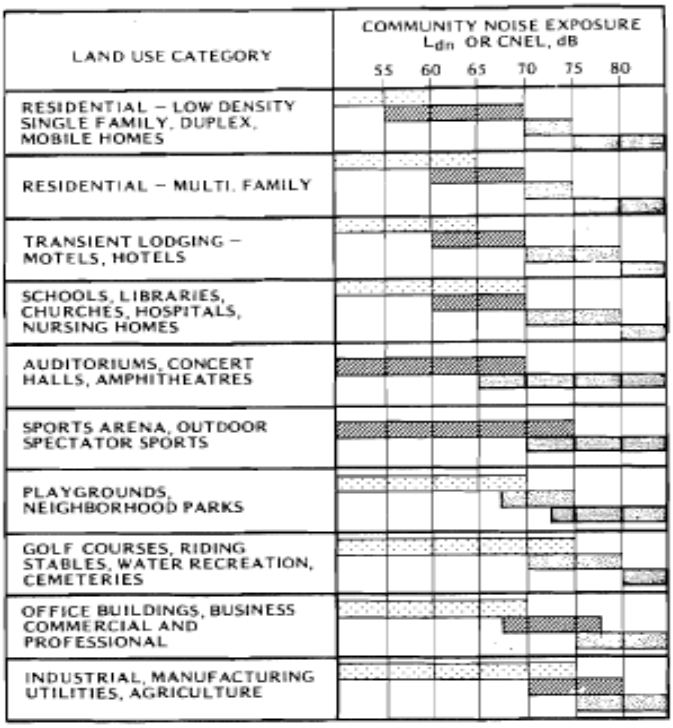
Different considerations are involved in determining noise sensitivities for differing land uses and activities. For example, noise level limits for satisfactory speech communication in a home are different from those for satisfactory telephone usage in an office. The guidelines attempt to account for these considerations as well as anticipated noise-sensitive activities that occur both outdoors and indoors. Also recognized is the amount of outdoor-to-indoor noise reduction provided by typical structures.

In conjunction with the land use compatibility recommendations, the Office of Noise Control has developed numerical correction factors to be applied to noise sources. These values account for some of the influences which may cause noise to be more acceptable, or less acceptable, than normally expected. Significant among these influences are: existing outdoor ambient levels (which indicates relative intrusiveness of the noise source), general community attitude towards the noise source, prior history with the noise source, and tonal characteristics of the noise. When it is possible to evaluate some or all of these factors, the measured or estimated level of a noise source may be adjusted by means of the correction values listed in Figure 9 in order to more accurately assess the acceptability of a new noise source.

In development of these land use acceptability recommendations, the Office of Noise Control made an effort to maintain consistency with the U.S. Environmental Protection Agency's “Levels Identified as Requisite to Protect Public Health and Welfare with an Adequate Margin of Safety” (see page 18). In both the EPA findings and Office of Noise Control recommendations, an interior Day-Night Average Sound Level of 45 dB, attributable to exterior noise sources, is considered to be the maximum level consistent with normal residential activity. Considering the typical range of 12 to 18 dB (A) noise reduction provided by residential dwellings (with windows partly open), the 60 dB value identified in Figure 8 as "normally acceptable" for residential land use would provide an interior environment of about 45 dB.

Figure 8

CALIFORNIA OFFICE OF NOISE CONTROL
LAND USE COMPATABILITY FOR COMMUNITY NOISE ENVIRONMENTS



INTERPRETATION

NORMALLY ACCEPTABLE

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

CONDITIONALLY ACCEPTABLE

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

CLEARLY UNACCEPTABLE

New construction or development should generally not be undertaken.

CONSIDERATIONS IN DETERMINATION OF NOISE–COMPATIBLE LAND USE

A. NORMALIZED NOISE EXPOSURE INFORMATION DESIRED

Where sufficient data exists, evaluate land use suitability with respect to a "normalized" value of CNEL or L_{dn}. Normalized values are obtained by adding or subtracting the constants described in Table 1 to the measured or calculated value of CNEL or L_{dn}.

B. NOISE SOURCE CHARACTERISTICS

The land use-noise compatibility recommendations should be viewed in relation to the specific source of the noise. For example, aircraft and railroad noise is normally made up of higher single noise events than auto traffic but occurs less frequently. Therefore, different sources yielding the same composite noise exposure do not necessarily create the same noise environment. The State Aeronautics Act uses 65 dB CNEL as the criterion which airports must eventually meet to protect existing residential communities from unacceptable exposure to aircraft noise. In order to facilitate the purposes of the Act, one of which is to encourage land uses compatible with the 65 dB CNEL criterion wherever possible, and in order to facilitate the ability of airports to comply with the Act, residential uses located in Community Noise Exposure Areas greater than 65 dB should be discouraged and considered located within normally unacceptable areas.

C. SUITABLE INTERIOR ENVIRONMENTS

One objective of locating residential units relative to a known noise source is to maintain a suitable interior noise environment at no greater than 45 dB CNEL or L_{dn}. This requirement, coupled with the measured or calculated noise reduction performance of the type of structure under consideration, should govern the minimum acceptable distance to a noise source.

D. ACCEPTABLE OUTDOOR ENVIRONMENTS

Another consideration, which in some communities is an overriding factor, is the desire for an acceptable outdoor noise environment. When this is the case, more restrictive standards for land use compatibility, typically below the maximum considered "normally acceptable" for that land use category, may be appropriate.

Figure 9

CALIFORNIA OFFICE OF NOISE CONTROL
Corrections to be Added to the
Measured Community Noise Equivalent Level (CNEL)
to Obtain Normalized CNEL

Type of Correction	Description	Amount of Correction to be Added to Measure 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 noise 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

References

1. Board of Supervisors of the County of Santa Barbara, Board Minutes, August 14, 1972.

2. Office of Noise Control, California Department of Health, Guidelines for the Preparation and Content of Noise Elements of the General Plan (Berkeley, California) 1976.

NOISE IN SANTA BARBARA COUNTY

A primary objective of the Noise Element is to provide information about the County's noise environment so that noise may be systematically included in the evaluation of land use alternatives and so that a quantitative noise ordinance may be adopted. For purposes of this study, the County's noise environment was described using the following methods.

1. Day-Night Average Sound Level or Community Noise Equivalent Level contours were mapped around major transportation noise sources.

2. A survey was initiated in urbanized areas of the County to measure ambient sound levels.

3. An inventory of numbers of persons exposed to various levels of noise was prepared.

TRANSPORTATION NOISE SOURCES

In Santa Barbara County, as in most areas, transportation facilities are by far the most significant sources of noise. This is true in terms of the magnitude of noise produced and the number of people affected. In order to determine the extent of noise impact from airports, railroads, and major roadways; Day-Night Average Sound Level (L_{DN}) contours were estimated, using analytical modeling techniques, for each of these transportation facilities. Contours are provided for L_{DN} values of 70 dB and greater, 65 to 69 dB, and 60 to 64 dB. They have been mapped at a scale of 1" = 1000' on five maps covering unincorporated portions of the County: Santa Maria-Orcutt, Lompoc and vicinity, Santa Ynez Valley, Goleta Valley, Carpinteria-Montecito.

Noise contours illustrate the dispersion of noise from its source, depicting points of equal average noise level. L_{DN} values represent weighted-average levels that account for the magnitude, frequency of occurrence, and time of occurrence of noise events. Noise occurring at night is given added emphasis to account for its greater intrusiveness compared with daytime noise.

Although a great deal of effort goes into the estimation of noise contours from analytical noise exposure models, the present state-of-the-art is such that their accuracy is somewhat limited. In the near vicinity of the noise source, prediction accuracy may be quite good. However, even under ideal conditions (level terrain, no shielding from structures or other physical barriers) predictions at greater distances may be in error by 5 dB. Noise contours should therefore be interpreted as bands of similar noise exposure, approximately 5 dB in width, rather than as absolute lines of demarcation.

The contours provide a good first estimate of noise exposure around major transportation facilities, and when more precise noise information is needed for a specific location, on-site monitoring should be used to supplement the noise contours.

AIRPORT NOISE CONTOURS

Santa Barbara County has four public airports serving commercial air transport and general aviation needs: Lompoc and Santa Ynez airports are owned by the County and operated under contract with fixed-base operators; Santa Barbara Municipal Airport is operated by the City of Santa Barbara; and Santa Maria Public Airport is operated by the Santa Maria Public Airport District. In addition, Vandenberg Air Force Base has an airfield for exclusive military use.

Noise exposure contours around airports are predictable from the number and type of aircraft using the airport, magnitude and duration of each flyover, flight paths, and time of day when the flights occur. Community Noise Equivalent Level (CNEL) contours were estimated for all public airports in the County in 1972 by Bolt, Beranek & Newman, an acoustical consulting firm. This was done to establish noise impact boundaries in compliance with Airport Noise Standards contained in Title 4 of the California Administrative Code. The Airport Noise Standards state that, after giving consideration to economic and technical feasibility, airports of the class existing in this County shall not permit noise exposures of 70 CNEL to extend into residential or school areas. After December 31, 1985, the CNEL criterion becomes 65 dB.

Community Noise Equivalent Level values average noise from all aircraft over a 24-hour period, after applying a weighting factor to aircraft operations occurring in the evening or at night. They should not be confused with peak sound level values from individual aircraft. Peak sound levels from a departing Boeing 727 jet were measured at 97 dB(A) at a location near Storke Road, west of the Santa Barbara Airport. At this same location, the Community Noise Equivalent Level, representing the weighted-average of noise experienced over an entire day, is approximately 64 dB(A). Similarly, at a location under the downwind leg of the approach pattern to Santa Maria Public Airport, peak sound levels from light twin-engine aircraft were measured at 68 dB(A) while the CNEL at that location is about 55 dB.

While the CNEL contours indicate areas around the airports which are most severely noise-impacted, noise problems are not confined to these locations. Airport managers at each of the civilian airports report that complaints about aircraft noise, while not frequent, are received about aircraft overflying residential areas while on the crosswind, downwind, and base legs of the airports[1] traffic patterns. Aircraft noise in these areas is less than 60 dB CNEL. Noise complaints are received from the following residential areas located outside the airports' 60 dB CNEL contours:

Santa Maria Airport	-	Foxenwoods subs division area
Lompoc Airport	-	Mesa Oaks subdivision area
Santa Ynez Airport	-	Meadowlark Ranch subdivision area

Santa Barbara Airport of Highway	-	Isla Vista, Hope Ranch, and areas north 101

Lompoc Airport

Aircraft operations consist predominantly of light single or twin-engine aircraft. The CNEL contours projected in 1972 were based on 45,300 annual aircraft operations; in 1977 there were an estimated 35,000 operations at the Lompoc Airport. (Each takeoff or landing is counted as an operation.) The smaller number of aircraft operations occurring in 1977, as compared with the number used to derive the CNEL contours, indicates that the contours overestimate actual noise exposure by about 1.1 dB.[2,3] This difference is insignificant for purposes of the Noise Element. Referring to the Lompoc noise contour maps, it can be seen that the 70 dB, 65 dB, and virtually all of the 60 dB contours lie within the airport boundary.

Santa Ynez Airport

Like the Lompoc Airport, activity at Santa Ynez Airport consists of light general aviation aircraft. The 1972 CNEL estimates are based on 48,700 annual operations; in 1977 there were an estimated 50,000 operations at this airport. The 1972 contours included 183 annual business jet operations at the Santa Ynez Airport. Since this activity no longer exists and since use of the airport by jets is in fact discouraged, the CNEL contours were revised assuming no jet operations. (See Santa Ynez Valley noise contour map).

Santa Barbara Municipal Airport

The Santa Barbara Airport has four airlines providing scheduled air passenger service. Total operations in 1977 amounted to 228,384. Of these, 5,923 were air carrier movements using jet aircraft.[4] CNEL contours projected in 1972 were based on 201,115 annual operations, including 6,570 jet air-carrier movements. To assess the credibility of the CNEL contours in relation to currently existing levels of aircraft activity, noise measurements were collected at five locations near the airport. The results of this are tabulated below and lead to the conclusion that the 1972 CNEL contours provide a reasonable description of noise exposure from present air traffic at the Santa Barbara Airport.

Comparison of Projected CNEL Contours
with Field Measurements

Station #*	CNEL from Projected Contours	CNEL from Field Measurements
11	60-64	58
16	60-64	61
17	65-69	64
39	60-64	58
30	60-64	64

*See Appendix for locations.

Santa Maria Public Airport

Annual operations at the Santa Maria airport are estimated to be 86,000.[5] This includes scheduled air carrier service using turboprop equipment. CNEL contours were projected for 1975 and used 85,775 annual operations as a basis for projection. This included four flights per day involving Douglas DC-9 aircraft. These jet flights have since been terminated; however, it is likely that they will be re-introduced. The CNEL contours projected for 1975 have therefore been accepted for use in the Noise Element without adjustment.

Vandenberg Air Force Base

Information on aircraft operations at Vandenberg Air Force Base is not readily available. Composite Noise Rating (CNR) contours have, however, been provided by the Air Force and are considered by them to be current.[6] For purposes of the Noise Element, the CNR values have been converted to their approximate equivalents in L_{DN}.[7]

Future Airport Noise

Whether airport noise will increase or decrease in the future depends primarily on two factors: 1. Changes in the number of aircraft operations; 2. Changes in aircraft noise emission characteristics.

Changes in the number of aircraft operations will be heavily influenced by variables such as demographic changes, changes in the local economy, personal income levels, availability of aviation fuel, and the cost of air transport relative to other transportation modes. Past studies have made projections of future commercial air travel and general aviation activity. However, these have been based on population projections for Santa Barbara County which are no longer considered appropriate.[8] No accepted forecasts of air traffic currently exist.

Future reductions in individual aircraft noise emissions will result from existing federal legislation. Federal Aviation Regulations, Part 36, require aircraft manufacturers seeking certification of new aircraft types or modifications to existing types to meet maximum noise emission standards. This has resulted in recent aircraft types such as the Lockheed L-1011, Douglas DC-10, and Boeing 747 having noise characteristics which are significantly improved over older generation jets. These regulations also apply to general aviation aircraft. Because the replacement cost of airplanes is high and because they generally have a long useful life, the full benefit of FAR Part 36 standards will not be realized for many years. As older aircraft are gradually phased out and replaced with newer models meeting FAR Part 36, some improvement in noise exposure around airports may be experienced. This, however, will be partially offset by increased airport activity, since noise exposure is a function of both noise level and number of noise events.

In the absence of forecasts of aviation activity for Santa Barbara County, Figure 4 has been prepared to illustrate a range of future airport noise exposure possibilities. Increases in aircraft operations, relative to current levels of operation, are compared with decibel reductions in "average" aircraft noise levels. Resultant changes in Community Noise Equivalent Level exposure near an airport can be determined. For example, if at some point in the future aircraft are, on average, 4 dB quieter than those operating today, and if at the same time total aircraft operations have increased 30%, noise exposure in CNEL will have been reduced by about 2.9 dB.

Figure 4: Change in Airport Noise Exposure Expressed in CNEL*

Increase in Aircraft Operations (%) \ Reduction in Average Aircraft Noise Level (dB)	0	2	4	6	8	10
0	0	-2.0	-4.0	-6.0	-8.0	-10.0
10	+.4	-1.6	-3.6	-5.6	-7.6	-9.6
20	+.8	-1.2	-3.2	-5.2	-7.2	-9.2
30	+1.1	-.9	-2.9	-4.9	-6.9	-8.9
50	+1.8	-.2	-2.2	-4.2	-6.2	-8.2
100	+3.0	+1.0	-1.0	-3.0	-5.0	-7.0
150	+4.0	+2.0	0	-2.0	-4.0	-6.0

* Table assumes:

1. Operations of all aircraft types increase proportionately.
2. No change in distribution of operations between daytime and nighttime.
3. No change in aircraft operational procedures.

RAILROAD NOISE CONTOURS

Two railroad companies, the Southern Pacific Railroad and the Santa Maria Valley Railroad, operate in Santa Barbara County. The Southern Pacific generally follows the coast through the County with two branches off the main line. One branch, at Surf, serves the City of Lompoc and the diatomaceous earth mining operation south of the city. A second branch serves Vandenberg Air Force Base. Two passenger trains and an average of twelve freight trains traverse the Southern Pacific main line daily.

The Santa Maria Valley Railroad connects with the Southern Pacific at Guadalupe and serves the City of Santa Maria. A short spur connects with Santa Maria Public Airport to the south. Twelve train movements per day occur on the main Santa Maria Valley line. These are all freight trains moving at slow speed (10-19 mph).[10]

Rail operations noise contours were estimated from data obtained from the two railroad companies using a methodology developed by Wyle Laboratories.[11] This methodology considers the noise level in dB(A) of each passing train, the length of time the noise is present, the total number of trains, and the time of day each train passes. Trains operating during evening or nighttime hours are weighted by a factor of 5 or 10 respectively, in accordance with their relative annoyance. The summation of these noise "events" is averaged over 24 hours and allows the generation of noise contours in the Community Noise Equivalent Level noise scale. To facilitate mapping, the CNEL contours ignore attenuation by topographic features, structures, or other barriers as train noise propagates from the railroad tracks. Where significant barriers exist, their effect on CNEL values may be approximated using procedures described in Appendix A.

Along the Southern Pacific main line, maximum sound levels from passing trains at one hundred feet from the tracks reach 96 dB(A) to 100 dB(A). At the same location, CNEL values, representing the weighted average of all train noise for a 24-hour period, are between 70 and 75 dB(A). CNEL values will be reduced to 60 dB(A) or less, beyond about 800 feet from the tracks. Along the Santa Maria Valley Railroad, CNEL values of 65 dB(A) or more exist within about 150 feet of the tracks. Beyond about 300 feet from the tracks, CNEL values are 60 dB(A) or less. (See Appendix B.)

Significant changes in Community Noise Equivalent Level exposure around railroads are not expected within the next ten to fifteen years. Substantial increases in the movement of goods and passengers are necessary to justify additional train movements. Increased demand for rail transport is generally handled by hitching additional cars to already scheduled trains, rather than running a new train. This has a negligible effect on total noise exposure. Even a 30 percent increase in the movement of goods would increase established CNEL values by only about 1 to 1.5 dB.

Although the federal government has adopted noise emission limits for locomotives and rail cars used in interstate commerce, the standards will have little or no effect on reducing noise exposure adjacent to railroads in this County. Maximum noise levels

from locomotives on the Southern Pacific Railroad have been measured at 96 to 100 dB(A), 100 feet from the tracks; noise from rail cars is typically between 83 and 90 dB(A) at the same distance. The adopted federal standard will limit noise from locomotives manufactured after December 31, 1979 to 90 dB(A) measured at a distance of 100 feet. Effective December 31, 1979, rail cars moving at speeds greater than 45 mph may not exceed 93 dB(A) when measured at 100 feet. The reduction in locomotive noise will therefore be quite significant, but the average noise level of a train pass-by will not decline greatly, if at all, because the noise limit on rail cars is actually greater than typical levels now experienced. Therefore no decline in CNEL exposure is anticipated.

MAJOR ROADWAYS NOISE CONTOURS

Day-Night Average Sound Levels (L_{DN}) from traffic on major roadways can be estimated from information about total traffic volume, truck traffic volume, traffic speed, distribution of traffic between daytime and nighttime hours, and physical characteristics of the roadway. The L_{DN} contours produced for the Noise Element are based on procedures developed by Wyle Laboratories.[12] For the Santa Maria-Orcutt area, the noise contours prepared for the City of Santa Maria's Noise Element were used. Contours were mapped where estimates indicated that L_{DN} levels of 60 dB or greater would be experienced beyond 50 feet from the roadway.* The influence of topographic features and other physical barriers was not considered in the estimation of noise contours. Where these features exist, their effect may be approximated using procedures described in Appendix A.

Fifty feet from U.S. Highway 101, noise levels from individual trucks reach 85-90 dB(A). Maximum levels from automobiles at this distance are about 75-80 dB(A). L_{DN} values represent a weighted average of noise levels experienced over an entire day and depend on total traffic volume, percent truck traffic, and other parameters cited above. L_{DN} at fifty feet from Highway 101 varies from a low of 70 dB(A) (between Buellton and Los Alamos) to a high of about 78 dB(A) (between Mission Street and Las Positas in Santa Barbara). L_{DN} drops to 60 dB(A) or less beyond about 200 feet from the highway segment between Buellton and Los Alamos; along the stretch of highway between Mission Street and Las Positas, L_{DN} is 60 dB(A) or less beyond about 800 feet. Combining the influence of the freeway with the railroad along the South Coast, L_{DN} values of 60 dB(A) or more exist within 1,000 feet of the freeway/railroad corridor.

For arterial streets where vehicle flows are between 10,000 and 20,000 per day and where traffic speed is 45 miles per hour or less, sound levels reach 80-85dB (A) at fifty feet from the roadway. L_{DN} values of 62-68dB (A) are typical at fifty feet, attenuating to 60 dB(A) beyond about 150 feet from the roadway. Appendix C tabulates distances from the roadway within which traffic noise exceeding 60 dB L_{DN} is estimated to exist.

* Distances are referenced to the center of the outer travel lane.

As traffic increases on the County's roadway system, average traffic noise levels will also increase. Mitigating against this increase in traffic, vehicles produced in the future may well be quieter than those available today. Traffic growth projections have been made for the year 1995 as part of the Regional Transportation Plan for Santa Barbara County.[13] These indicate increases in traffic volume that, depending upon location, range from about 15 percent up to 100 percent over existing levels. Projected growth in travel demand is closely related to projections of population, housing, employment, and income. The actual realization of conditions upon which projected traffic increases have been based will be influenced by future decisions regarding development of supplemental water sources for the County, the future availability of petroleum based fuels, and constraints on vehicle travel that may be imposed to meet federal air quality standards.

The U.S. Environmental Protection Agency has pre-emptory authority to regulate noise emission characteristics of motor vehicles. To date, the EPA has promulgated noise regulations only for vehicles with a gross vehicle weight rating in excess of 10,000 pounds and which are used in interstate commerce. The EPA standard restricts noise from these vehicles to 86 dB(A) at speeds of 35 mph or less and 90 dB(A) at speeds greater than 35 mph. Both levels are measured at fifty feet from the path of the vehicle.

The California Motor Vehicle Code contains noise limits on new vehicles offered for sale in the state. These limits become progressively more stringent for some vehicles: the standard for motorcycles manufactured after 1989 is 13 dB(A) less than the standard for those now being produced; the limit on vehicles with a gross vehicle weight rating of 6,000 pounds or more and manufactured after 1987 is 10 dB(A) quieter than the limit on those sold today. All other vehicles manufactured after 1974 are limited to 80 dB(A), and each of these levels is referenced to a distance of fifty feet. At such time as the EPA adopts noise emissions standards affecting vehicles which are already regulated in California, the federal standard will preempt present state law.

The effect of state and federal noise standards on projected truck and passenger car noise output characteristics was examined in a study performed for the Environmental Projection Agency.[14] The study concluded that automobile noise emissions in 1995 would be, on average, 3 dB(A) lower than current vehicles. This gives consideration to the mix of old and new vehicles present in 1995. Truck noise was expected to decrease about 4 dB(A) for trucks moving at highway speeds and about 6 dB(A) for trucks traveling at 35 mph. In Santa Barbara County heavy trucks make up less than 10 percent of total traffic, therefore the combined effect of these reductions in car and track noise would amount to about 3.5 dB(A).

Figure 5 has been prepared to illustrate changes in Day-Night Average Sound Level exposure adjacent to major roadways that would result from increases in traffic volume and decreases in average vehicle noise emissions. The table can be used in conjunction with current traffic counts and projections of 1995 traffic from the Regional Transportation Plan. In this way, one can assess changes in future noise exposure along a particular roadway segment under alternate assumptions of reduction in vehicle

noise emissions.

Figure 5: Change in Noise Exposure for Major Roadways Expressed in L_{DN}*

Increase in Traffic (%) \ Reduction in Average Vehicle Noise Emissions (dB)	0	1	2	3	4	5	6
0	0	-1.0	-2.0	-3.0	-4.0	-5.0	-6.0
5	+.2	-.8	-1.8	-2.8	-3.8	-4.8	-5.8
10	+.4	-.6	-1.6	-2.6	-3.6	-4.6	-5.6
15	+.6	-.4	-1.4	-2.4	-3.4	-4.4	-5.4
25	+1.0	0	-1.0	-2.0	-3.0	-4.0	-5.0
50	+1.8	+.8	-.2	-1.2	-2.2	-3.2	-4.2
75	+2.4	+1.4	+.4	-.6	-1.6	-2.6	-3.6
100	+3.0	+2.0	+1.0	0	-1.0	-2.0	-3.0
150	+4.0	+3.0	+2.0	+1.0	0	-1.0	-2.0

* Table assumes:

1. Truck and passenger vehicle taaffic increase proportionately.

2. No change in distribution of traffic between daytime and nighttime.

3. No change in average vehicle speed.

4. No change in road configuration.

AMBIENT NOISE SURVEY

A survey was initiated to measure ambient sound levels in urban areas of the unincorporated County. The information obtained from this survey supplements that provided by the noise contours prepared for major transportation facilities. While calculated noise contours give valuable information about a regular, predictable noise source such as a freeway or railroad, the objective of this survey was to determine the composite of all noise that is normally present at representative residential locations generally outside the area of coverage of the noise contours. The ambient sound level is a function of land use type, population and dwelling unit density, and distance to major transportation facilities.

For this survey, sound level monitoring was conducted at fifty locations. Since noise-sensitive land uses were of primary interest, most of the sites were chosen in residential areas. It was found that most commercial and industrial land use is located in areas where noise exposure is adequately described by the noise contours for transportation facilities.

With few exceptions, each location was monitored for one-half hour four times over a 24-hour period, providing two hours total monitoring time. To account for expected variation of ambient sound levels during the 24-hour period, one set of measurements was taken either between 7 a.m. and 9 a.m or between 4 p.m. and 6 p.m.; a second set was taken during midday (9 a.m.-4 p.m.); a third in the evening (6-10 p.m.); and a fourth during late night/early morning (10 p.m.-7 a.m.). In this way, enough data were obtained to permit estimation of the Day-Night Average Sound Level (L_{DN}) at each location. The L_{10}, $L_{50,}$ and L_{90} exceedance levels were also estimated for daytime (7 a.m.-10 p.m.) and nighttime (10 p.m.-7 a.m.) periods. In addition to measurement of sound levels, notations were made identifying primary and secondary noise sources that were present.

The tabulated results of this ambient noise survey are in Appendix D. Additional ambient noise data for the Santa Maria-Orcutt area and Lompoc-Vandenberg Village area may be found in the Noise Elements for the City of Santa Maria and City of Lompoc.[15,16]

The tables below summarize L_{DN} ranges found for residential and non-residential sites.

Residential Sites

L_{DN} Range dB(A)	Number of Sites	Percent	Cumulative Percent
45-49	7	18.9	18.9
50-54	18	48.6	67.5
55-59	9	24.4	91.9
60-64	1	2.7	94.6
65-70	2	5.4	100.0

Non-Residential Sites

L_{DN} Range dB(A)	Number of Sites	Percent	Cumulative Percent
45-49	0	0	0
50-54	0	0	0
55-59	5	38.5	38.5
60-64	6	46.2	84.7
65-70	2	15.3	100.0

In general, noise levels in County residential areas are similar to those found throughout the nation in locations qualitatively described by the Environmental Protection Agency as “Quiet Suburban” (Average L_{DN} 50 dB) or “Normal Suburban” (Average L_{DN} 55 dB). However, eleven residential sites (30.5%) had noise exposures greater than 55 dB L_{DN} identified by the EPA as the maximum desirable for residential areas, based on health and welfare criteria. Three sites (8.1%) had noise exposures greater than 60 dB $L_{DN,}$ found by the California Office of Noise Control to be the maximum "Normally Acceptable" for residential use. In all of the locations where L_{DN} levels exceeded 55 dB, the dominant noise source was a freeway, expressway, airport, railroad, or combination of these.

NOISE EXPOSURE INVENTORY

As an index of transportation noise impact on County residents, an inventory of housing units and persons exposed to Day-Night Average Sound Levels exceeding 60 dB was compiled. These estimates were based on the transportation noise contour maps, used in conjunction with land use maps showing the location of housing units, and 1975 Census counts of household size and vacancy. The estimates were compiled for five sub-areas of the unincorporated County:[17]

Santa Maria-Orcutt and Vicinity

Lompoc and Vicinity

Santa Ynez Valley

Goleta-Mission Canyon

Carpinteria-Montecito

County-wide, approximately 8,000 housing units and 21,000 persons are in areas potentially exposed to Day-Night Average Sound Levels exceeding 60 dB. This represents 18% of total housing units and 16% of total population in the unincorporated County. The area most severely impacted is the Goleta Valley, where it is estimated that one out of four housing units is exposed to L_{DN} levels exceeding 60 dB. In the unincorporated area around Lompoc, only about 2% of housing units experience L_{DN} levels in excess of 60 dB. The accompanying table displays these estimates for County sub-areas and for three ranges of noise exposure. Because transportation noise contours are generalized and do not account for noise attenuation provided by topography and other physical barriers, the estimates are considered to be somewhat high.

For comparison, the Environmental Protection Agency estimates that 58% of the nation's population in urban areas (incorporated or unincorporated places with 2,500 or more persons) reside in locations where Day-Night Average Sound Levels exceed 60 dB.[18]

ESTIMATED POPULATION AND DWELLING UNITS EXPOSED
TO VARIOUS RANGES OF DAY-NIGHT AVERAGE SOUND LEVEL

Area	Total Dwelling Units	Total Population	Day-Night Average Sound Level (dB)							
			70+				65-69		60-64	
			Dwelling Units		Population		Dwelling Units	Population	Dwelling Units	Population
			#	% of Total	#	% of Total	# % of Total	# % of Total	# % of Total	# % of Total
Santa Maria-Orcutt and Vicinity	6,989	22,451	0	0	0	0	65 0.9	240 1.1	500 7.2	1,860 8.3
Lompoc and Vicinity	3,079	9,602	0	0	0	0	15 0.5	50 0.5	60 1.9	210 2.2
Santa Ynez Valley	4,548	11,250	0	0	0	0	65 1.4	150 1.3	80 1.8	190 1.7
Goleta-Mission Canyon	23,842	72,034	200	0.8	540	0.7	1,040 4.4	2,570 3.6	4,940 20.7	12,840 17.8
Carpinteria-Montecito	5,515	12,713	160	2.9	340	2.7	500 9.1	1,010 7.9	440 8.0	880 6.9
All Areas	43,973	128,050	360	0.8	880	0.7	1,685 3.8	4,020 3.1	6,020 13.7	15,980 12.5

References

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3. Wilsey and Ham, and Bolt, Beramek and Newman, Inc., Aircraft Noise Impact; Planning Guidelines for Local Agencies, prepared for U. S. Department of Housing and Urban Development and Office of Community Planning and Management (Washington, D.C.: USGPO) 1972.

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5. David Andrews, Santa Maria Public Airport District, April 1978.

6. Jack Brandon, Vandenberg Air Force Base Office of Base Engineers, April 1978.

7. Wilsey and Ham, etc., Op. Cit.

8. Santa Barbara County-Cities Area Planning Council, Regional Transportation Plan for Santa Barbara County, June 1977.

9. Mr. McAlister, Vice President for Public Projects, Southern Pacific Railroad, January 1978.

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12. Swing, Jack W., Development of Ground Transportation Systems Noise Contours for the San Diego Region, prepared for the Comprehensive Planning Organization of the San Diego Region (El Segundo, California: Wyle Laboratories) 1973.

13. Santa Barbara County-Cities Area Planning Council, Regional Transportation Plan for Santa Barbara County 1977-1995, June 1977.

14. Transportation Noise and Noise from Equipment Powered by Internal Combustion Engines, NTID 300.13, prepared for the. Environmental Protection Agency (El Segundo, California: Wyle Laboratories) 1971.

15. J. J. Van Houten and Associates, Technical Background Study for the Noise Element of the City and Valley of Lompoc, April 1974.

16. J. J. Van Houten and Associates, Technical Background Study for the Noise Element for the City of Santa Maria, March 1976.

17. Sub-areas are defined by the unincorporated portions of the following census tracts:

Santa Maria-Orcutt and Vicinity: 18, 20.01, 20.02, 20.03, 20.04, 21, 22.02, 23.02, 24.02, 25

Lompoc and Vicinity: 26 excluding VAFB, 28.01, 28.02, 28.03, 28.04

Santa Ynez Valley: 19.01, 19.02

Goleta - Mission Canyon: 1.01, 1.02, 1.03, 2, 5.01, 5.02, 13.01, 13.02, 29.01 29-29.08, 30.01-30.03

Carpinteria - Montecito: 7, 14, 15, 16.01, 16.02, 17

U. S. Environmental Protection Agency, Information on Levels of Environmental Noise Requisite to Protect Public Health and Welfare with an Adequate Margin of Safety (Washington, D.C.: USGPO) 1974.

NOISE MITIGATION: ALTERNATIVES

Control over environmental noise impact can be exercised either at the point of noise origination or at the point of noise reception. That is, either the thing making noise can be quieted, or those who are exposed to the noise can be shielded in some manner. Reducing noise at its source is clearly the more desirable of these two approaches because it places the cost of noise mitigation on those who are responsible for its generation. However, federal and state pre-emptive legislation limits the ability of the County to directly regulate major noise sources. Therefore, efforts to achieve noise compatibility in land use must concentrate on indirect noise source control and on measures designed to insulate noise-sensitive uses from noise sources.

CONTROL OF NOISE AT ITS SOURCE

Noise source reduction can be accomplished by designing products to make less noise or by locating and using noise products in such a way as to minimize their impact. The federal government has reserved for itself authority to set product noise emission standards.[1] Federal emission standards currently exist only for newly manufactured aircraft, medium and heavy trucks, railroad locomotives and railcars, and portable air compressors. The Environmental Protection Agency has limits under consideration for a number of other devices. Where the EPA has adopted a product noise standard, state and local governments may not enforce noise regulations aimed at the manufacture or sale of such products. Local governments do, however, retain authority to control noise impact through regulations affecting the use or location of noise sources. Thus, while the Board of Supervisors of Santa Barbara County may not enact an ordinance prohibiting the sale of air compressors producing more than, say, 90 dB, they may enact an ordinance restricting locations where air compressors may be used, restricting time of day when they may be used, or restricting the amount of air compressor noise which may "trespass" on any public or private property. Opportunities for the County to exercise control, either direct or indirect, over major noise sources will be discussed here.

AIRCRAFT NOISE

Federal Aviation Regulations (Part 36) sets noise emission standards for new aircraft, and full benefit from these standards will be realized only after many years of attrition of older equipment. In the meantime, other steps can be taken to reduce aircraft noise impact.

At the discretion of the Federal Aviation Administration, aircraft operational procedures (traffic patterns, pattern altitudes, glide slopes) may be modified to reduce noise over sensitive areas.

Airport proprietors may regulate use of their facilities.

1. The airport can be closed to noisier aircraft types.
2. The airport can be closed at night.
3. "Touch and go" operations can be limited at night.
4. A variable landing fee structure can be set up to discourage noisier aircraft types and nighttime operations.
5. Services can be limited to discourage noisier aircraft (for example not supplying turbine fuel to discourage jets and turbo props).

An educational campaign can be initiated to develop a greater sensitivity for noise problems among pilots. Pilots can be encouraged to minimize low altitude “sight seeing" over populated areas; to avoid high propeller r.p.m. settings when unnecessary; to plan approaches and departures consistent with established traffic patterns so as to avoid flight over residential areas.

RAILROAD NOISE

Noise level limitations on train noise adopted by the EPA promise little reduction of noise from this source since limits are actually no less than levels currently experienced in this County. Local governments have no authority to restrict railroad operations. Thus, the only remaining opportunity to reduce railroad noise impact is to control the use of land in the immediate vicinity of the railroad. This will be discussed in a following section.

MOTOR VEHICLE NOISE

The California Vehicle Code contains noise limits applicable to new vehicles at the time of manufacture and noise regulations pertaining to the operation of all vehicles on public roads. Evidence of compliance with the new vehicle standards is required before a vehicle can be registered. Operational limitations include quantitative noise standards, requirements that vehicle muffler systems be maintained in good repair, and prohibitions against modifying exhaust systems so they create more noise than would a stock system.

In the course of taking noise measurements for the Noise Element, casual observation of traffic indicated that a significant percentage of vehicles produce unnecessary amounts of noise. Many of these have exhaust systems with clearly visible modifications. (Volkswagons with "extractor" exhausts are a common example.) Based on these observations, more vigorous enforcement of Vehicle Code noise restrictions unquestionably would reduce traffic noise impact.

The California Highway Patrol has responsibility for enforcement of traffic laws in unincorporated portions of the County. Teams of specially trained and equipped CHP officers are used in California to enforce vehicle noise limits, however, only one such team is assigned to cover all of San Luis Obispo, Santa Barbara, and Ventura Counties. If motor vehicle noise abatement is to be given a higher priority than it now enjoys, either CHP resources must be augmented or the County must initiate its own abatement

program.

Other methods for reducing motor vehicle noise include establishing truck routes, reducing vehicle speeds, and regulating traffic flow. Routing heavy trucks away from residential or other noise-sensitive areas and onto roads where less impact would result can be a very effective solution to high traffic noise levels. Figure 10 illustrates the effect of reducing truck traffic for four-lane roadway segments with average vehicle speeds of 35 and 55 miles per hour. For example, a change from 10 to 5 percent truck traffic traveling at 35 mph will reduce overall highway noise by about 1.5 dB. The values in the table are additive so that a change from 10 to 0% at 35 mph yields a 4.5 (1.5 + 3) dB reduction in traffic noise.

Figure 10

Effect on Traffic Noise of Reducing Truck Traffic[2]

Change in Truck Percentage from:	Reduction in Noise Level (L_{eq} or L_{DN}) in dB	
	35 mph	55 mph
10% to 5%	1.5	1
5% to 0%	3	2

Traffic noise can also be reduced by limiting vehicle speed. Figure 11 shows how traffic noise levels would drop if lower speed limits were enforced. Figure 10 and Figure 11 can be used together to determine the change in traffic noise that would result from both a change in truck percentage and vehicle speed.

Figure 11

Effect on Traffic Noise of Reducing Vehicle Speed[3]

Change in Vehicle Speed (mph):		Reduction in Traffic Noise (L_{eq} or L_{DN}) in dB		
		Truck Mix		
From	To	0%	5%	10%
65	55	2	1	1
65	45	4	1.5	2
55	45	2	1	1
55	35	3.5	2.5	2
45	35	1.5	1.5	1

Accelerating-decelerating traffic produces noise levels as much as 7 to 15 dB higher than an equivalent volume of traffic moving at constant speed.[4] Minimization of stop-and-go traffic on local roads, by using synchronized signals at intersections for example, is thus a fourth method to reduce motor vehicle noise at its source.

One step removed from controlling motor vehicle noise directly at its source is the abatement of traffic noise in the planning and design of roads. The methods of abatement that are available include route selection, acquisition of extra right-of-way width to act as a buffer, depression of the roadway, and the use of noise barriers.

At the time new highways or major local roads are planned, the route selection process should consider the noise sensitivity of lands through which the road will pass. Increasing the distance between the roadway and sensitive receptors such as hospitals, schools, and residential areas will affect transmission of noise to these uses. Acquiring wider rights-of-way will accomplish the same purpose, however, this alternative is relatively inefficient due to the distances required to achieve acceptable noise levels. Referring back to Figure 2 and assuming the highway to be a line source, the distance between the highway and point of noise reception must be doubled to reduce traffic noise by 3 dB. In some cases, horizontal adjustments in alignment may be appropriate in order to take advantage of shielding by natural terrain.

Depressing the roadway below the level of sideline terrain can produce a dramatic reduction in traffic noise radiation. A highway depressed 20 feet below adjacent land provides an 11 dB advantage over an equivalent highway at grade, but only beyond about 100 feet from the roadway where vehicles will be completely screened from view.[5] As one approaches the highway, the advantage of a depressed cross section diminishes because vehicles will come within direct line of sight of positions near the crest of the slope.

Acoustic barriers placed between the roadway and sensitive receptors are an excellent method to limit traffic noise propagation along uninterrupted stretches of road. To be effective, a barrier must be high enough and long enough to at least block line of sight to the vehicle noise source. Where heavy trucks are present this will require a quite tall barrier (11 feet or more), since truck exhaust stacks may be 10 feet above the ground. Effectiveness of the barrier is influenced by the geometry of the source-barrier-receiver relationship. The procedures given in Appendix A will allow estimation of the attenuation that can be produced by an acoustic barrier. Barriers have been designed to provide attenuation of up to 15 dB(A). This value appears to be a maximum practical design limit.[6] The barrier must be quite massive and it must be impervious to air flow. Airborne sound travels readily through any opening and this can severely reduce the effectiveness of any barrier. For this reason wood fencing is virtually worthless as a noise shield.

Earth berms have noise reduction properties comparable to vertical walls which are used as barriers. They have additional advantages: berms can be landscaped so they

are visually more attractive than a vertical barrier of equivalent height and; instead of reflecting noise from one side of the highway to the other, as walls may, and thus increasing the noise heard on the opposite side, they tend to deflect sound upwards. Berms have a disadvantage in the amount of land area needed to create a barrier of sufficient height to block the noise path. A berm 12 feet high with 2 to 1 side slopes would have to be at least 48 feet in cross section at its base. Using a lower berm with a wall on top is a better alternative from a cost and performance perspective.

Plantings in a buffer strip have some capability to absorb and scatter sound waves. However, their effectiveness is quite limited unless the planted area is very wide (100 feet or more) and the trees, shrubs, and ground cover is very dense.[7] It has been suggested that the principal effect of landscaping is psychological. By blocking view of the noise source, plantings can reduce annoyance and complaints about noise. The fact that people cannot see the highway can reduce their awareness of it, even though the noise remains.[8]

COMMERCIAL/INDUSTRIAL NOISE

Controlling noise from a commercial or industrial use is best accomplished at the time the facility is being designed. Often, the site layout and building design can be arranged to reduce noise transmission from the commercial or industrial property. Opportunities may also exist when the physical plant is being extensively remodeled or when the use of an existing facility is being changed. Design considerations include:

- Siting of traffic access points, loading areas, parking lots, and solid waste collection areas.

- Enclosing or baffling machinery which must be placed outdoors.

- Using structures as noise barriers.

- Using solid walls around the perimeter of the site.

When applicable, Environmental Impact Reports provide a vehicle for the analysis of noise impacts and discussion of design alternatives.

Two principle administrative controls can be exercised to limit noise from commercial and industrial uses. The zoning ordinance can impose noise performance standards on new business and industry. A noise control ordinance can be adopted to mitigate existing noise problems in a reasonable manner. Recognizing that new technology is more readily incorporated into new industrial and commercial activities than into existing ones, it is appropriate that performance standards in the zoning ordinance specify lower noise level limits than those in the noise control ordinance applicable to existing uses. County Zoning Ordinance 661 includes noise level limits in three industrial zoning districts: M-1, M-1-A, and M-1-B. Noise performance standards should be incorporated into all industrial and commercial zoning districts. A noise control ordinance is presently

being drafted by a citizens noise abatement committee, appointed by the Board of Supervisors. This proposed ordinance contains noise level provisions for existing industrial and commercial uses.

Noise from construction sites represents a special type of industrial noise. Because construction noise is temporary, people are usually more tolerant of it than permanent noise-producing installations. While acoustic "curtains" can be used around some stationary equipment, abatement is difficult because most construction activities cannot be enclosed. The most effective long-term solution to construction noise is to manufacture construction equipment that produces less noise. The U.S. Environmental Protection Agency is just beginning to issue product noise standards which will eventually result in equipment being marketed with lower noise emission characteristics. In the meantime, a reasonable way to limit construction noise impact is to regulate the time of day when construction activities may occur. Curfews on evening, nighttime, and early morning work, exempting emergency work, can be imposed through a general noise control ordinance.

NOISE SOURCES OPERATED BY THE COUNTY

The public works activities of the County involve use of some mechanical equipment producing high noise levels. It would be desirable to establish a program for acquisition of quieter equipment when new or replacement equipment must be purchased. In soliciting bids to purchase equipment, the County should ask suppliers to provide information on equipment noise emission characteristics. In evaluating the cost-efficiency of quieter products, consideration should be given to where and how the equipment will be used. Buying a quieter, but more expensive device may not be beneficial if it is to be used only in a remote location where few people will be affected.

Where the County awards contracts with private firms for construction and maintenance projects and for services such as solid waste collection, the opportunity exists to encourage contractors to use low noise emission equipment. Contractors and firms submitting contract proposals could be informed that noise control is a matter of County policy and that positive action on the part of contractors to minimize noise impact will be expected.

POPULATION NOISE

Noise from typical residential and recreational activities could be termed "population noise." Sources of population noise include such diverse things as: radios, stereos, televisions, musical instruments, workshop and home improvement tools, power gardening equipment, domestic animals, air conditioners, swimming pool equipment, model airplanes, off-road vehicles, playgrounds, organized events, and parties. While these kinds of noise are usually accepted in a residential setting, occasionally they become sources of annoyance to people and subjects of complaint to the County government. When complaints about noise from such activities are received, they are currently handled by the Sheriff's Department and the Health Department. If the

complaint is about something like a loud party, the presence of a Sheriff's officer responding to the complaint is usually sufficient to resolve the situation. If repeated complaints are received about the same activity, a basis may exist for citing the responsible persons for "disturbing the peace" (under Penal Code Section 415). The Health Department responds to many noise complaints where there is no objective standard to determine whether the noise is "reasonable." The Health Department attempts to work with both parties to resolve the problem, but if negotiation fails, no authority exists to demand abatement of the noise.

In response to this problem, many cities and counties have adopted general noise control ordinances. The more effective of these specify quantitative limits on noise which may not be exceeded across a property line or between apartment units. They also include time-of-day restrictions on the operation of certain noisy devices. The Board of Supervisors has appointed a citizens noise abatement committee to draft a noise control ordinance for this County. The committee's proposed ordinance is expected to be ready for review at about the same time the first draft of this Noise Element is being reviewed.

CONTROL OF NOISE AT THE RECEIVER

A balanced approach to environmental noise control involves both the abatement of noise at its source and the isolation of noise sensitive activities from noise sources. Methods for the control of noise impact at the point of noise reception include:

- Zoning for compatible uses in the vicinity of major permanent noise sources.

- Site planning techniques to shield noise sensitive development.

- Design and construction techniques to insulate individual noise sensitive buildings.

- Redevelopment of noise impacted areas with noise compatible uses.

Major noise sources such as freeways, airports, and railroads are regarded as virtually permanent. While in the long-term, technological advances in noise suppression may significantly reduce the impact of these sources, near - and mid-term results achieved by noise source suppression are expected to be largely offset by increases in traffic volume. To achieve noise compatibility in land use, it is therefore imperative that control be exercised over development of noise-sensitive uses in the vicinity of major noise sources. This does not mean that undeveloped land adjacent to a highway, railroad, or airport remain vacant, but rather that these areas be planned for activities which are noise-compatible; or that uses which are not noise-compatible be permitted if measures to reduce on-site noise exposure are incorporated into project designs.

Noise impacted areas can be identified in the County's zoning ordinances to control the development of noise sensitive uses in these areas. An overlay zone is appropriate for this purpose. The overlay zone could be defined to be all land exposed to noise over a

certain level; its boundaries would then be coincident with, for example, the 60 dB contour displayed on the Noise Element contour maps. Alternatively, the overlay zone could be defined to be all land within given distances of a highway, railroad, or airport.

Within the noise overlay zone, either non-compatible uses could be excluded or site planning and building construction requirements could be imposed to reduce noise impact on the site of proposed development. The first alternative has limited applicability.

Not all undeveloped land near a major noise source can, or even should, be reserved for industrial, commercial, agricultural, or other uses that are not noise sensitive. Obviously, there is not sufficient demand for these uses to allow lining both sides of freeways, railroads, and areas around airports with them. Nor would this be a desirable spatial pattern of development. While emphasis must then be placed on designing residential and other sensitive developments so that noise exposure is reduced to an acceptable level on the project site, zoning around airports must be given special attention. Citizen reaction to airport noise tends to be more pronounced than for other transportation noise sources. In a number of Southern California communities, citizen protest over airport noise has resulted in legal action against airport operators, nighttime curfews on aircraft operations, and even planned closure of at least one airport (San Juan Capistrano). In the County Health Department's survey of opinions about noise in the Goleta Valley, jet aircraft were the most frequently cited sources of "severe" noise irritation.[9]

Because it is virtually impossible to shield residential yard spaces from aircraft flyover noise, and because outdoor activities are an important part of residential land use, the siting of dwellings in relation to airports is more critical than for surface transportation facilities. Zoning land around airports in the County to exclude noise sensitive uses is therefore considered to be of primary importance in achieving noise compatibility and in favoring the future integrity of airport operations.

Mandatory acoustical analysis of development plans could be a provision of the noise overlay zone. The purpose of this analysis would be to evaluate noise exposure on the project site and alternatives for on-site mitigation of noise exposure. Depending on the type of development and site specifics, alternatives might consist of:

- Use of setbacks and buffer strips. This is feasible for large lot developments where the site is only marginally noise impacted.

- Use of berms and walls as noise barriers.

- Height restrictions on dwellings adjacent to noise barriers. The advantage gained by constructing a barrier is lost for the second story of a dwelling which overlooks the barrier.

- Clustering dwellings to take advantage of distance or shielding offered by site

topography

- Placing non-sensitive uses such as parking areas, garages, etc. nearest the noise source.

- Orienting buildings so that they act as noise shields for balconies, patios, and yard spaces. This is most effective for two story apartment buildings.

The noise overlay zone might also define an area where special Building Code noise insulation requirements would be applicable. For structures considered to be noise sensitive, the Building Code could require either that specific construction materials and construction details be used, or that an interior noise level performance standard be met according to the design and certification of an acoustical consultant.

If a dwelling were proposed for construction in an area where the exterior noise exposure is 70 dB CNEL and if the requirements of the noise overlay zone were that interior noise levels should not exceed 45 dB CNEL, then the needed 25 dB of building attenuation could be obtained by meeting specific requirements. Alternatively, the Building Code could require the builder to have construction plans certified by an acoustical engineer or consultant to indicate that the interior standard will be met.

The California Noise Insulation Standards, applicable to all dwellings other than detached single family dwellings, require structures to be designed to reduce exterior noise to an interior level of 45 dB CNEL. The Standards indicate that structures planned within areas exposed to exterior levels of 60 dB CNEL must undergo an acoustical analysis performed by an experienced acoustical consultant, who must certify that the interior standard will be met by the proposed structural design. Similar provisions could be extended to tracts of single family homes or other large noise sensitive developments. For these projects, certification by an acoustical consultant is preferable to imposition of inflexible materials and construction specifications, since noise mitigation can be incorporated in the site design, making building insulation redundant.

The physical techniques of building insulation, depending on the amount of attenuation needed, include:

- Increase the mass and stiffness of exterior walls.

- Increase the width of the airspace inside exterior walls.

- Increase the spacing between studs.

- Use staggered studs.

- Add acoustical insulation blankets inside walls.

- Use resilient channels to attach interior wall covering to studs.

- Weatherstrip all doors and windows.

- Reduce window size on walls facing noise source.

- Use unopenable windows. This may necessitate an alternate source of ventilation.

- Increase glass thickness.

- Install double-glazed windows.

- Use solid core exterior doors.

- Eliminate open beam ceilings.

- Minimize penetrations of exterior walls for ducting and electrical boxes.

- Arrange rooms inside dwellings so that bathrooms, kitchens, hallways, and closets are nearer the noise source and more sensitive spaces such as bedrooms and living rooms are further away.

- Use heavy carpeting and drapes, and acoustical ceiling tiles to reduce reverberations within rooms.

Many of these techniques are the same ones currently being employed in new construction to increase thermal insulation. Thus, noise insulation need add little to the building cost.

Redevelopment

A significant number of households in the County are currently exposed to Day-Night Average Sound Levels in excess of 60 dB, and some of these are impacted by LON levels exceeding 70 dB. Most of these households are located along the freeway/railroad corridor of the South Coast. As this housing stock ages and units need to be replaced or rehabilitated, noise mitigation should be included in redevelopment or rehabilitation plans.

The cost of insulating existing dwellings is much higher than providing the same amount of noise insulation in new structures. A study of costs to insulate existing single family dwellings in the Los Angeles area indicated the following average costs:[10]

Minor Dwelling Modifications
Improvement of sound insulation: 7 dB
Cost per square foot of floor area: $3.70*

Moderate Dwelling Modifications
Improvement of sound insulation: 9 dB

Cost per square foot of floor area: $5.56*

Major Dwelling Modifications
Improvement of sound insulation: 17 dB
Cost per square foot of floor area: $14.44*

* Adjusted to 1978 dollars using the January 1978 Consumer Price Index for the Los Angeles-Long Beach Standard Metropolitan Statistical Area (SMSA).

When rehabilitation plans are being considered, the cost of insulating individual dwellings should be weighed against the cost of building noise barriers to protect groups of dwellings. The latter alternative is preferable, since it will provide an acceptable exterior noise environment in residential yard spaces, as well as eliminate the need to insulate dwellings.

References

1. Noise Control Act of 1972 (49 U.S.C., Section 4901 et seq)

2. Based on data from: Swing, Jack W., "Development of Ground Transportation Systems Noise Contours for the San Diego Region," prepared for the Comprehensive Planning Organization of the San Diego Region by Wyle Laboratories, El Segundo, California, 1973.

3. Ibid.

4. U.S. Department of Transportation, Transportation Noise and Its Control, (Washington, D.C.: USGPO) 1972.

5. Beaton, John L. and Bourget, Louis, "Can Noise Radiation from Highways be Reduced by Design?" State of California, Transportation Agency, Department of Public Works, Division of Highways, Materials and Research Department, Sacramento, 1968.

6. U.S. Environmental Protection Agency, Office of Noise Abatement and Control, "A Manual for the Review of Highway Noise Impact," Arlington, Virginia, 1977.

7. U.S. Department of Transportation, Op. Cit.

8. U.S. Department of Transportation, Federal Highway Administration, The Audible Landscape: A Manual for Highway Noise and Land Use (Washington, D.C.: USGPO) 1974.

9. County of Santa Barbara, Health Department, "A survey of Noise in Goleta Valley."

10. Wyle Laboratories, "Guide to the Soundproofing of Existing Homes Against Exterior Noise," 1970.

CONCLUSIONS AND RECOMMENDATIONS

Significant noise impact problems in Santa Barbara County are primarily associated with transportation facilities. Noise in the vicinity of airports, railroads, and major trafficways exceeds health and welfare criteria for noise exposure in relation to residential use. While noise from commercial, industrial, agricultural, and "population" activities may be part of the ambient level at any location, rarely do these generate noise of the same magnitude as transportation sources.

In the unincorporated County, it is estimated that as many as 8,000 housing units and 21,000 persons are potentially exposed to transportation noise at Day-Night Average Levels exceeding 60 dB. In locations outside the immediate influence of a major transportation noise source, ambient Day-Night Average Levels typically range from 46 dB - 57 dB. Although localized noise problems will exist in these areas, generally ambient noise levels are acceptable, based on health and welfare criteria.

Controlling the impact of transportation noise must be approached both by quieting vehicles and by protecting sensitive land uses in locations where noise impact is excessive. The first of these approaches is beyond the legal jurisdiction of the County; Federal and State legislation is preemptive in the field of noise source control. The County's primary opportunities to manage transportation noise impact lie in:

1. Planning for compatible uses near existing transportation facilities.

2. Imposing design standards on proposed sensitive development near existing transportation facilities.

3. Incorporating noise control features into the design of new or expanded trafficways to protect existing sensitive areas.

The following recommended County policies concentrate in these areas.

1) In the planning of land use, 65 dB Day-Night Average Sound Level should be regarded as the maximum exterior noise exposure compatible with noise-sensitive uses unless noise mitigation features are included in project designs.[ii]

2) Noise-sensitive land uses should be considered to include:

a) Residential, including single and multifamily dwellings, mobile home parks, dormitories, and similar uses.

b) Transient lodging, including hotels, motels, and similar uses.

c) Hospitals, nursing homes, convalescent hospitals, and other facilities for long-term medical care.

d) Public or private educational facilities, libraries, churches, and places of public assembly.

3) For protection of sensitive activities, as well as the airports, noise-sensitive land uses, other than hotels and motels insulated to the level prescribed in the State Noise Insulation Standards, should not be permitted within the 65 dB CNEL contour of any airport as projected in the County Airport Land Use Plan. In no case shall institutional land uses, such as schools, hospitals, convalescent homes, and other in-patient health care facilities, be permitted within the boundaries of such 65 dB CNEL contour.[iii]

4) Residential use should be avoided within the 65 dB CNEL contour of any airport and under airport traffic patterns.

5) Noise-sensitive uses proposed in areas where the Day-Night Average Sound Level is 65 dB or more should be designed so that interior noise levels attributable to exterior sources do not exceed 45 dB L_{DN} when doors and windows are closed. An analysis of the noise insulation effectiveness of proposed construction should be required, showing that the building design and construction specifications are adequate to meet the prescribed interior noise standard.

6) Residential uses proposed in areas where the Day-Night Average Sound Level is 65 dB or more should be designed so that noise levels in exterior living spaces will be less than 65 dB L_{DN}. An analysis of proposed projects should be required, indicating the feasibility of noise barriers, site design, building orientation, etc., to meet the prescribed exterior noise standard.

The 65 dB L_{DN} standard for exterior living areas may be exceeded for the conversion of apartment units to condominiums if the following findings may be made:

a) The units were constructed prior to 5 March 1979, the original adoption date of the Comprehensive Plan Noise Element;

b) The measures necessary to reduce the noise exposure in exterior living areas below 65 dB LDN would be technically infeasible, prohibitively expensive, and/or aesthetically undesirable;

c) Noise levels in interior living areas will not exceed 45 dB LDN;

d) Any prospective buyer of a converted unit shall be notified, prior to entering any sale contract, if any private or common exterior living areas associated with the unit for sale are exposed to noise level s of 65 dB LDN or greater. The specific details of this notice shall be established in a condition of approval of the tentative parcel or tract map for the condominium conversion;

e) Any converted units and associated common areas subject to airport noise exposures of 65+ dB LDN shall be subject to an avigation noise easement acceptable to the airport operator;

f) The State Department of Real Estate's Public Report for the converted units shall disclose that the units are within a 65+ dB LDN (or CNEL) noise area, shall identify the primary source(s) of noise affecting the units, and shall refer to any avigation noise easement required by subparagraph 'e' of this Policy. [iv]

7) The County should consider adopting a noise impact overlay district in its zoning ordinances to administer noise mitigation requirements for noise-sensitive uses.

The boundaries of this district should include areas near railroads, airports, and major roadways where noise levels are estimated to be 65 or more dB L_{DN}. Procedures used to generate Noise Element contour maps should be used to define the district boundaries. Provisions of the district should include:

a) The ordinance should be applicable to noise-sensitive uses defined in the ordinance.

b) Noise levels on the site of proposed development should be determined by measurement.

c) If noise levels on the site of proposed development are found to be 65 or more dB L_{DN} noise mitigation should be a condition of project approval.

d) Noise mitigation should consist of insulation of structures so that interior noise levels do not exceed 45 dB L_{DN} and, for residential projects, measures to reduce noise levels below 65 dB L_{DN} in exterior living spaces.

8) The Resource Management Department, Public Works Building and Safety Division, and Health Department Environmental Health Division should develop administrative procedures for determining project compliance with the State Noise Insulation Standards.

9) Noise level limits, applicable to new noise sources, should be incorporated into all commercial and industrial zoning districts and into conditional use permit requirements.

Presently, the M-l, M-l-A, and M-l-B district regulations include noise level limits (70 dB, 50 dB, and 50 dB, respectively). All of these, interpreted as maximum limits never to be exceeded, are unrealistically low in relation to ambient levels normally present in industrial locations. A committee appointed by the Board of Supervisors has drafted a noise control ordinance which recommends noise limits for existing industrial and commercial uses. Zoning ordinance noise level provisions should be made compatible with the recommendations of this

committee.

10) In the planning and design of major transportation routes and facilities, noise impacts on existing or planned land uses should be carefully considered so that noise-related land use conflicts are minimized.

11) Noise mitigation capable of achieving Federal Highway Administration noise criteria should be incorporated into the design of new County roads.

12) The County should support State efforts to provide remedial acoustical protection for existing sensitive uses impacted by noise from State highways.

13) The Board of Supervisors should recommend to the City of Santa Barbara that measures be taken to assure compliance of the Santa Barbara Municipal Airport with California Airport Noise Standards.

Approximately 280 housing units are located within the 65 dB CNEL contour established for the Airport. California Airport Noise Standards require that, by January 1, 1986, no residential dwellings (except acoustically treated units) exist within the Airport's 65 dB CNEL contour. The City of Santa Barbara should begin planning now to meet these requirements.

14) A study of potential growth of airport traffic should be initiated to anticipate future noise impact from this source.

15) The County should adopt a noise control ordinance for resolution of noise complaints.

16) A noise control officer function should be created within the County government to coordinate County noise control efforts and centralize responsibility for:

- Noise analyses for environmental impact assessments.
- Noise analyses to implement California Noise Insulation Standards.
- Noise analyses in relation to Federal Highway Administration Noise Standards.
- Recommendations to the Planning Commission and Board of Supervisors regarding noise control in land use decisions.
- Enforcement of zoning ordinance noise control provisions.
- Enforcement of a noise control ordinance.

Because noise is primarily a health-related concern, the Health Department could

be designated to assume these responsibilities. Adequate staff and equipment should be provided.

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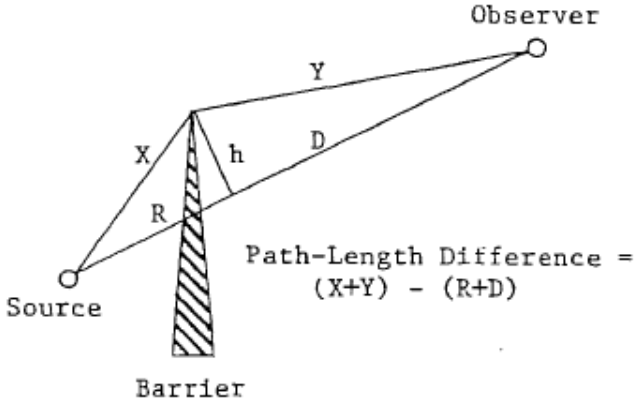
APPENDICES

APPENDIX A: Simple Procedure to Evaluate a Given Barrier



1. Get, by any convenient means, the values of the following quantities: h, the height of the barrier above the line-of-sight from source to observer (feet); R and D, the slant distances, along the line-of-sight, from the barrier to the source and observer, respectively.*

2. Enter Chart A of Figure 1 with the value of h on the left-hand scale; move right to intersect the curve corresponding to R (or D, whichever is smaller).

3. Move down to Chart B, to intersect the curve corresponding to the value of D/R (or *R/D,* whichever is larger).

4. Move right to intersect the scale of Chart C, to find the value for the barrier shielding in decibels.

Note: Use a source height of 2' above the roadway for autos, 8' for trucks and 15' for diesel locomotives.

The effective distance from the source to the receiver may be calculated by entering Figure 2.

* Specifically, R and D are the two segments into which h breaks the line-of-sight.

NOMOGRAM FOR CALCULATING BARRIER ATTENUATION

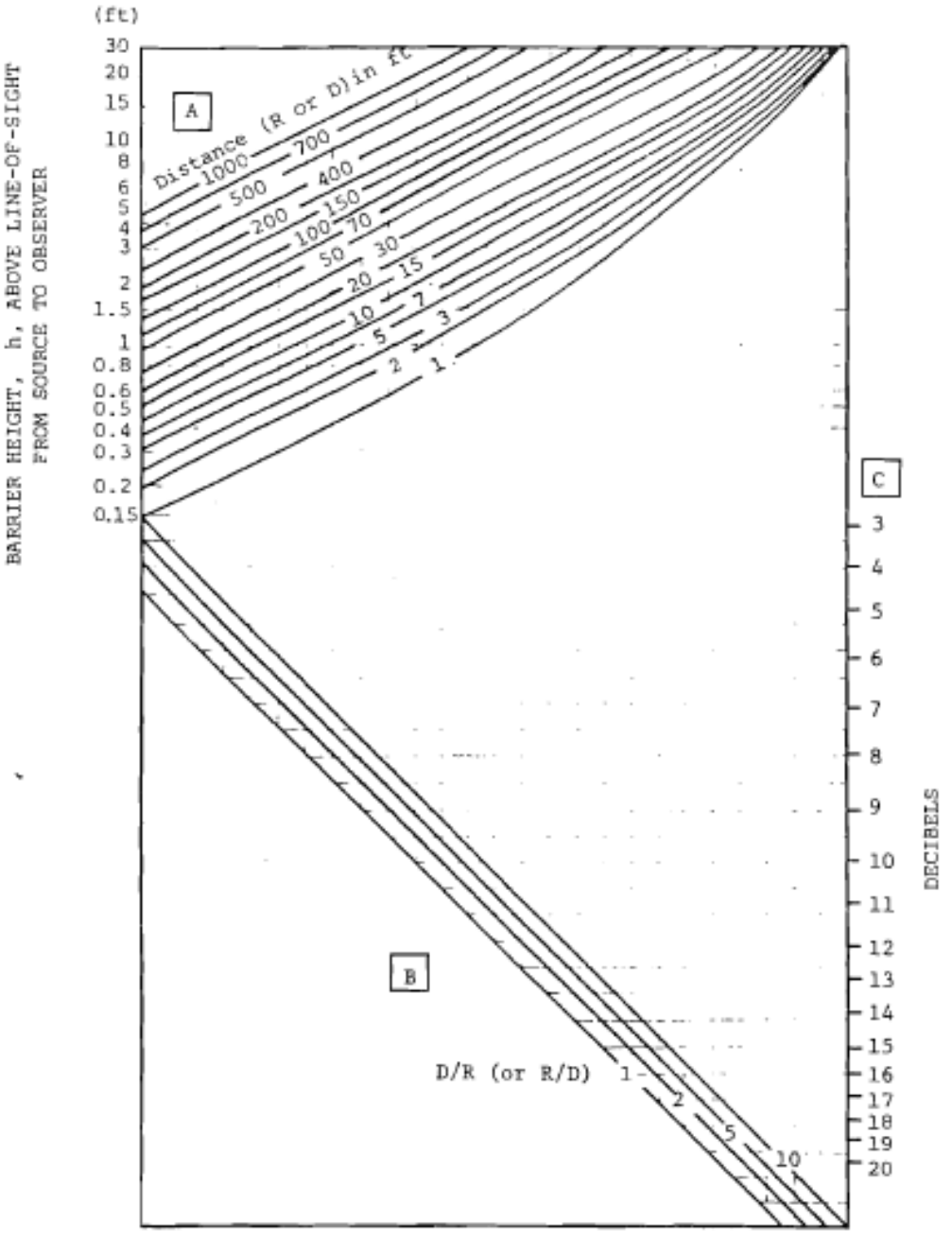


Figure 1

NOMOGRAM FOR CALCULATING EFFECTIVE DISTANCE FROM ROADWAY

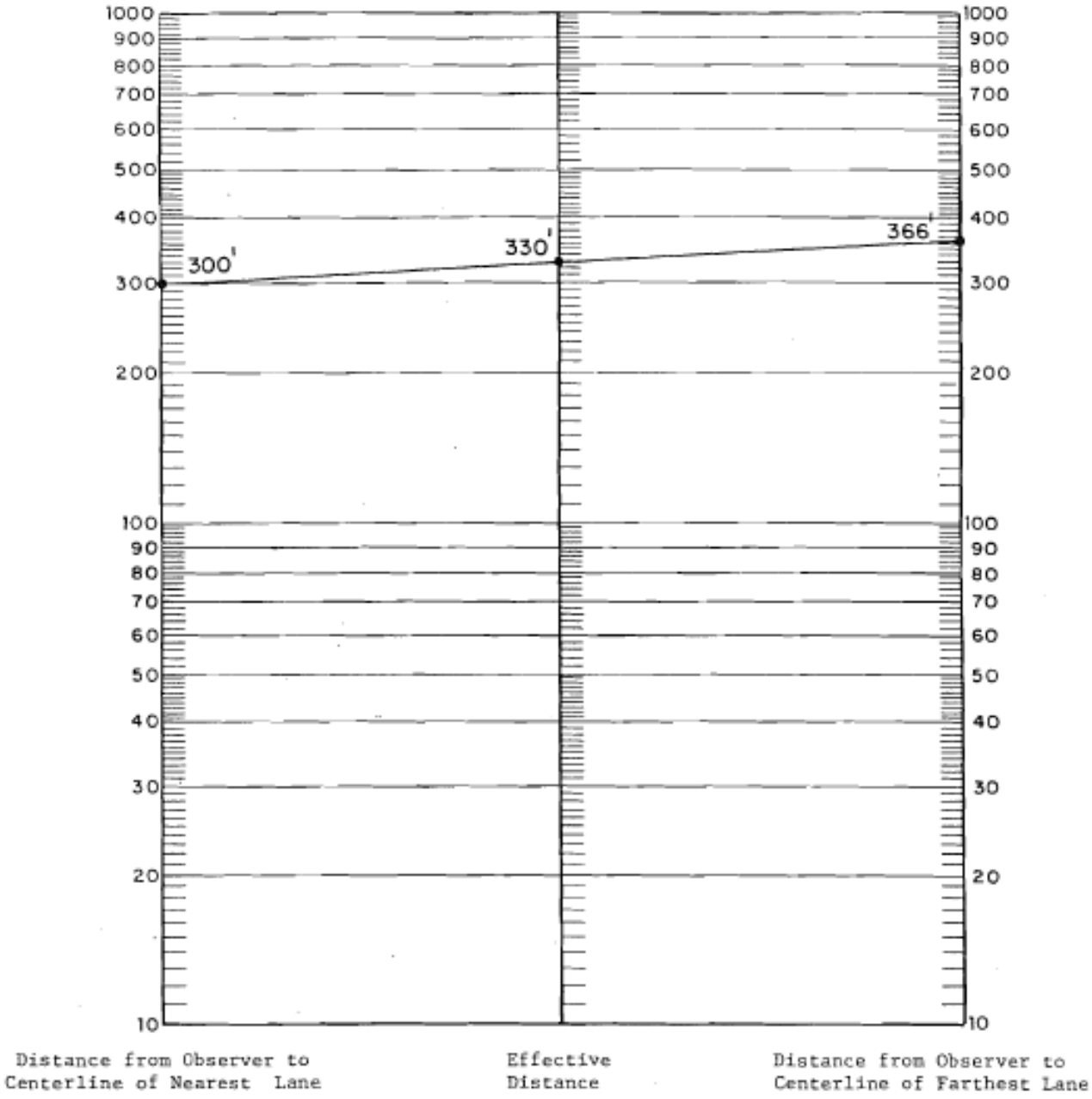


Figure 2

APPENDIX B: CNEL Estimates for Railroads

Track Section	CNEL 60 or Greater Estimated Within Specified Distance From Track
Southern Pacific Main Line	
Guadalupe to Brown Road	600'
Brown Road to Lompoc-Casmalia Road	700'
Lompoc-Casmalia Road to Glen Annie Road	600'
Glen Annie Road to Las Positas Road	600'
Las Positas Road to Santa Barbara Station	800'
Santa Barbara Station to Hot Springs Road	900'
Hot Springs Road to Ventura County Line	600'
Southern Pacific Lompoc Branch	
Surf to Lompoc	300'
Lompoc to White Hills	300'
Santa Maria Valley Railroad	
Guadalupe to Betteravia	300'
Betteravia to Blosser Road	300'
Blosser Road to Miller Street	400'

APPENDIX C: L_{DN} Estimates for Major Roadways

Route and Segment*	Classification	L_{DN} 60 or Greater Estimated Within Specified Distance From Roadway**
U. S. Highway 101		
Ventura County Line to El Rincon Interchange	Freeway	500'
El Rincon Interchange to Jct Rte 225 SW	Freeway	600'
Jct Rte 225 SW to Mission St.	Freeway	700'
Mission St. to Jct Rte 154	Freeway	800'
Jct Rte 154 to Fairview Ave.	Freeway	700'
Fairview Ave. to Glen Annie Rd.	Freeway	600'
Glen Annie Rd. to Hollister Ave.	Freeway	300'
Hollister Ave. to Jct Rte 246	Freeway	250'
Jct Rte 246 to Jct Rte 135	Freeway	250'
Jct Rte 135 to Clark Ave.	Freeway	250'
Clark Ave. to Betteravia Rd.	Freeway	300'
Betteravia Rd. to Donovan Rd.	Freeway	500'
Donovan Rd. to Jct Rte 135 N	Freeway	400'
Jct Rte 135 N to San Luis Obispo County Line	Freeway	500'
State Highway 1		
Jct Rte 101 to Jct Rte 246 E	2-Lane Expressway	100'
Jct Rte 246 W to Santa Ynez River Bridge	Major Road	150'
Santa Ynez River Bridge to S Jct Casmalia Rd.	Arterial	150'

*Only segments where L_{DN} is 60 dB or greater beyond 50' from the roadway are listed.
**Distances are referenced to the center of the outer travel lane.

Route and Segment	Classification	L_{DN} 60 or Greater Estimated Within Specified Distance From Roadway
S Jct Casmalia Rd. to Purisma Rd.	2-Lane Expressway	100'
Vandenberg Access Rd. to Jct Rte 135 N	Freeway	150'
State Highway 135		
Orcutt N Jct Rte 1 to Clark Ave.	Expressway	150'
Clark Ave. to Foster Rd.	Expressway	200'
Foster Rd. to Santa Maria Way	Expressway	250'
Santa Maria Way to Jct Rte 166	Arterial	400'
Jct Rte 166 to Donovan Rd.	Arterial	250'
Donovan Rd. to Jct Rte 101	Arterial	200'
State Highway 154		
Zaca Jct Rte 101 to Jct Rte 246	2-Lane Expressway	100'
Jct Rte 246 to Jct Rte 192	2-Lane Expressway	150'
Jct Rte 192 to Jct Rte 101	Freeway	150'
State Highway 166		
Guadalupe Jct Rte 1 to Blosser Rd.	Arterial	150'
Blosser Rd. to Jct Rte 101	Arterial	200'
State Highway 192		
Jct Rte 154 to Mountain Dr.	Arterial	100'
State Highway 217		
Entrance UCSB to Hollister Ave.	Freeway	150'
Hollister Ave. to Jct Rte 101	Freeway	200'
State Highway 225		
Jct Rte 101 to Cliff Dr.	Arterial	150'

Route and Segment	Classification	L_{DN} 60 or Greater Estimated Within Specified Distance From Roadway
State Highway 246		
Leege Rd. to Lompoc W City Limit	2-Lane Expressway	100'
Lompoc W City Limit to E Jct Rte 1	Major Road	100'
Milepost 26.02 to Jct Rte 101	Expressway	100'
Jct Rte 101 to Fifth St.	Expressway	150'
Fifth St. to Jct Rte 154	2-Lane Expressway	100'
Betteravia Road		
Black Rd. to Blosser Rd.	Major Road	150'
Blosser Rd. to Jct Rte 101	Arterial	150'
Blosser Road		
Donovan Rd. to Skyway Dr.	Major Road	150'
Bradley Road		
Lakeview Rd. to Clark Ave.	Major Road	100'
Burton Mesa Road		
Jct Rte 1 to Constellation Rd.	Arterial	100'
Cathedral Oaks Road		
Fairview Ave. to Jct Rte 154	Arterial	100'
Clark Avenue		
Jct Rte 1 to Jct Rte 101	Major Road	100'
El Colegio Road		
Storke Rd. to UCSB Entrance	Arterial	100'

Route and Segment	Classification	L_{DN} 60 or Greater Estimated Within Specified Distance From Roadway
Fairview Avenue		
Airport Entrance to Hollister Ave.	Arterial	100'
Hollister Ave. to Calle Real	Arterial	150'
Calle Real to Cathedral Oaks	Arterial	100'
Hollister Avenue		
Modoc Rd. to Patterson Ave.	Arterial	150'
Patterson Ave. to Ward Memorial Blvd.	Arterial	100'
Ward Memorial Blvd. to Pebble Beach Dr.	Arterial	150'
Hot Springs Road		
Jct Rte 101 to Olive Mill Rd.	2-Lane Major Road	100'
Olive Mill Rd. to E. Valley Rd.	Collector	100'
Lakeview Road		
Jct Rte 135 to Bradley Rd.	Collector	100'
Lompoc-Casmalia Road		
Pine Canyon Rd. to Burton Mesa Rd.	Expressway	150'
Burton Mesa Rd. to Jct Rte 1	Expressway	200'
Los Carneros Road		
El Colegio Rd. to Calle Real	Arterial	150'
Patterson Avenue (Goleta)		
Hollister Ave. to Jct Rte 101	Arterial	150'
Jct Rte 101 to Cathedral Oaks Rd.	Arterial	100'
San Ysidro Road		
Jct Rte 101 to Jct Rte 192	Collector	100'

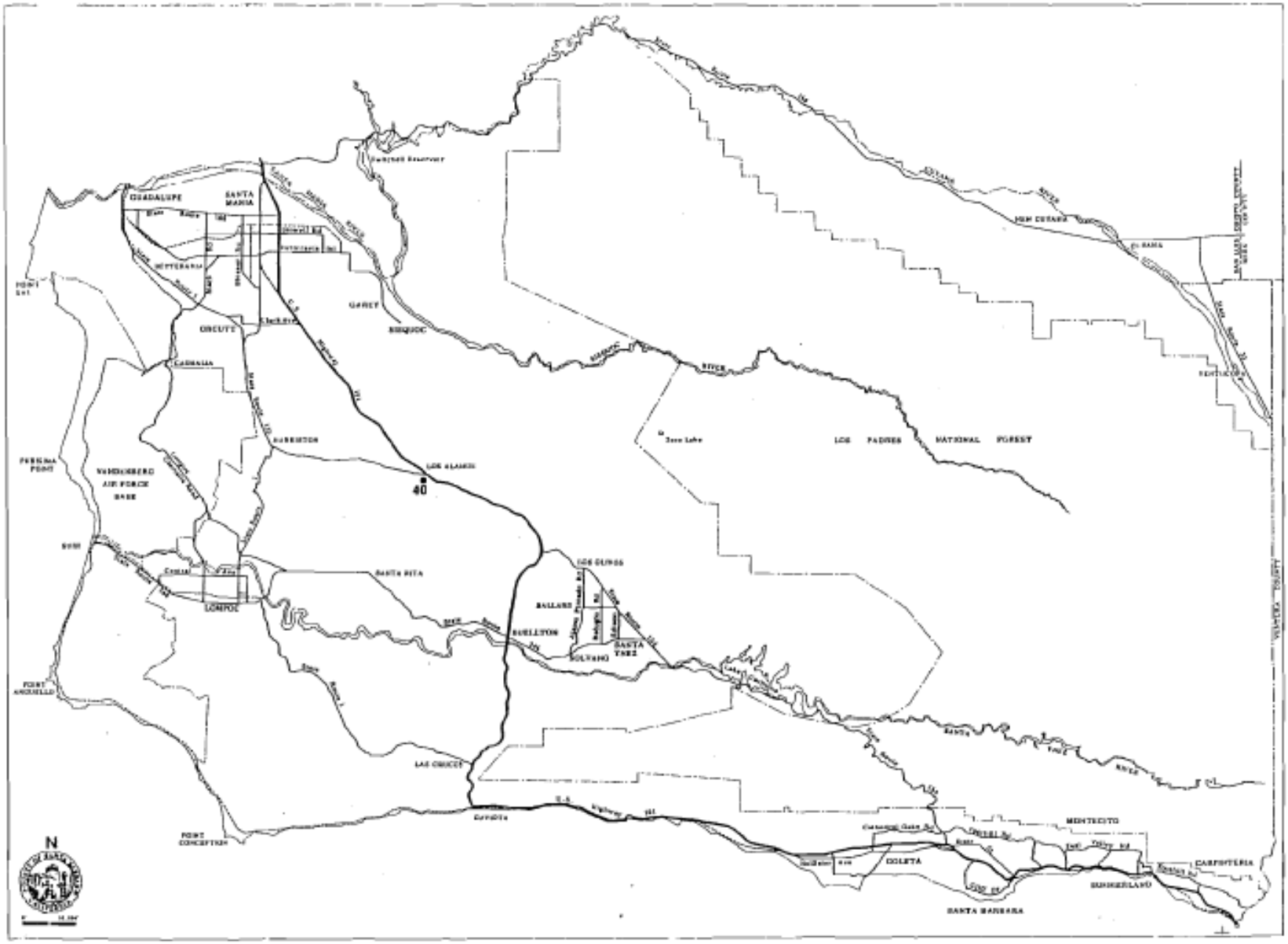
Route and Segment	Classification	L_{DN} 60 or Greater Estimated Within Specified Distance From Roadway
Storke/Glen Annie Road		
El Colegio Rd. to Del Norte Dr.	Arterial	100'
Turnpike Road		
Hollister Ave. to Cathedral Oaks Rd.	Arterial	100'
Vandenberg Road		
Lompoc Casmalia Rd. to Jct Rte 1	Expressway	150'

APPENDIX D: Ambient Noise Survey

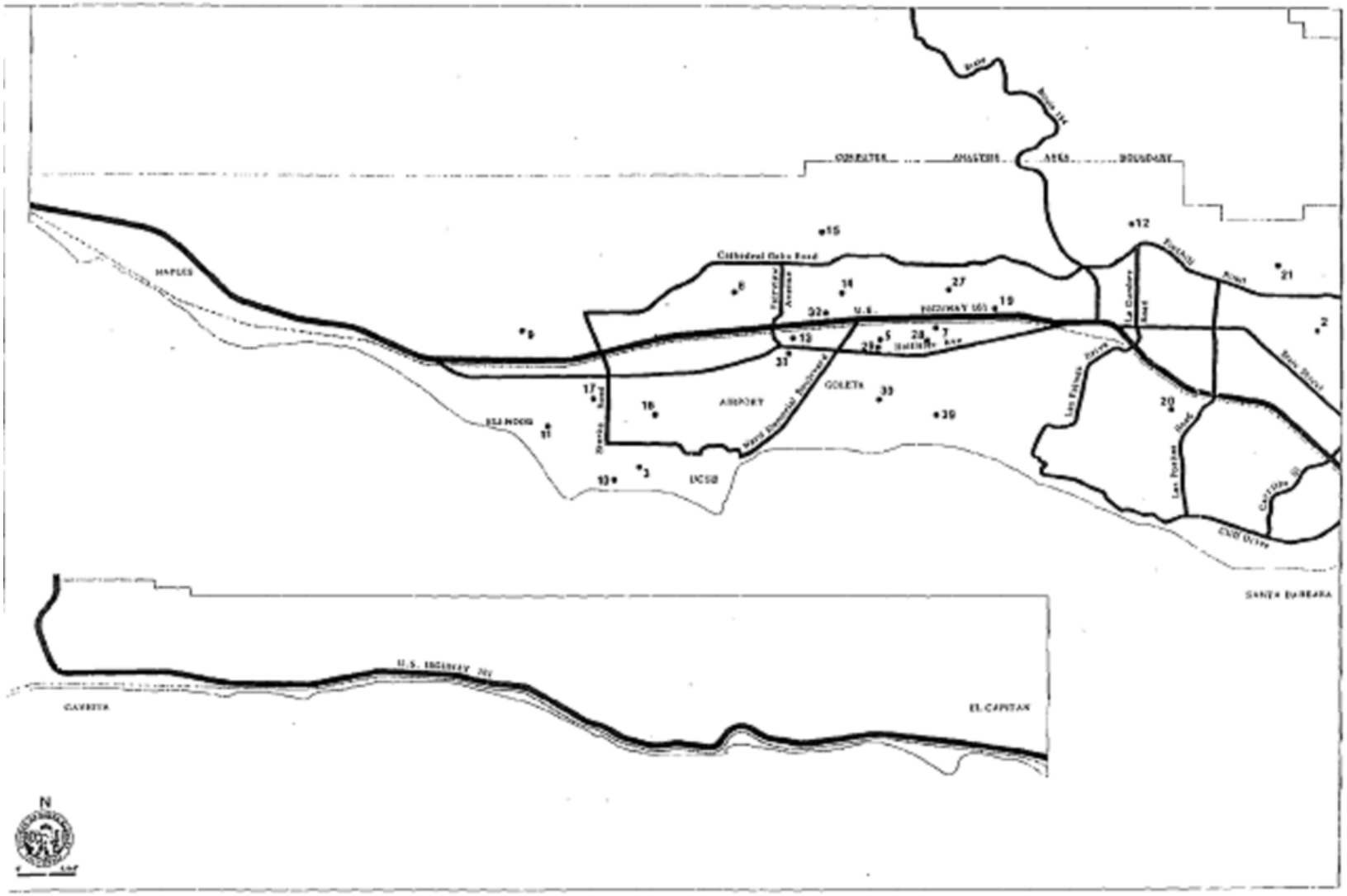
Station Number	Census Tract	Location	Day L_{90}	Day L_{50}	Day L_{10}	Night L_{90}	Night L_{50}	Night L_{10}	Estimated L_{DN}
1	9	Roof of Engineering Building, NW corner of Anapamu & Santa Barbara	47	56	63	40	49	56	61
2	4	NE corner of Emerson & Padre	38	41	47	31	34	38	46
3	29.01	S side Abrego Rd. between Camino del Sur & Pescadero	39	46	56	38	40	44	54
4	16.01	Casitas Pass E of Linden	Invalid						
5	30.03	Santa Ana Ave. W of Santa Ana Place	40	47	54	35	38	43	54
6	7	S side Scenic Drive	53	60	63	47	55	59	65
7	30.03	SW Turnpike Rd. & Southern Pacific RR	48	55	62	40	52	58	68
8	29.06	NW Muirfield & Valdez	38	44	53	35	38	43	51
9	29.08	S of Evergreen & Spruce	39	44	56	36	39	44	53
10	29.02	E side Camino Lindo between Pasado & Trigo	36	45	53	38	41	43	51
11	29.04	SW Canon Green & Phelps	36	46	54	37	40	45	58
12	1.03	End of Debra Drive	36	39	47	35	36	38	46
13	30.01	E side of Magnolia between Mandarin & Southern Pacific RR	42	50	59	40	45	53	58
14	29.05	W side of Merida Drive across from Toltec	42	47	53	39	44	51	54

Station Number	Census Tract	Location	Day L_{90}	Day L_{50}	Day L_{10}	Night L_{90}	Night L_{50}	Night L_{10}	Estimated L_{DN}
15	29.07	NW Cambridge & Via Salerno	35	43	54	37	40	45	54
16	29.03	NW Los Carneros & UCSB Married Students Housing access road	46	52	59	39	45	53	61
17	29.04	W side of Storke Road behind Fire Station	38	47	54	43	47	52	64
18	17	SE Whitney & Temple	46	51	58	48	50	55	59
19	1.01	Health Department parking lot	52	65	70	48	55	62	68
20	13.01	Church parking lot S of Veronica Springs & Torino	44	49	55	39	44	55	57
21	5.01	N side of Ben Lomand between Cheltenham & Palomino	33	39	47	31	34	38	47
22	17	N side of Shepherd Mesa	37	43	50	34	36	38	46
23	16.01	W side of Cravens Lane S of Cemetery	50	54	60	41	43	45	57
24	15	N side of Park Hill Ln	37	41	49	31	34	36	49
25	14	S side of Olive Mill Ln W of Olive Mill Rd	41	48	54	46	48	52	57
26	7	W side of Chelham Way	36	41	51	32	34	38	46
27	1.01	N side of Cervato Way Arongo Drive	41	43	48	42	44	46	50
28	30.03	W side of Turnpike shopping center	51	54	61	46	53	59	64
29	30.03	W side of Magnolia shopping center	52	59	68	46	51	57	64
30	30.01	Patterson Ave S of Ekwill	51	54	63	46	48	53	64
31	30.01	W side of Orange between Hollister & Gaviota	54	58	63	50	54	60	64

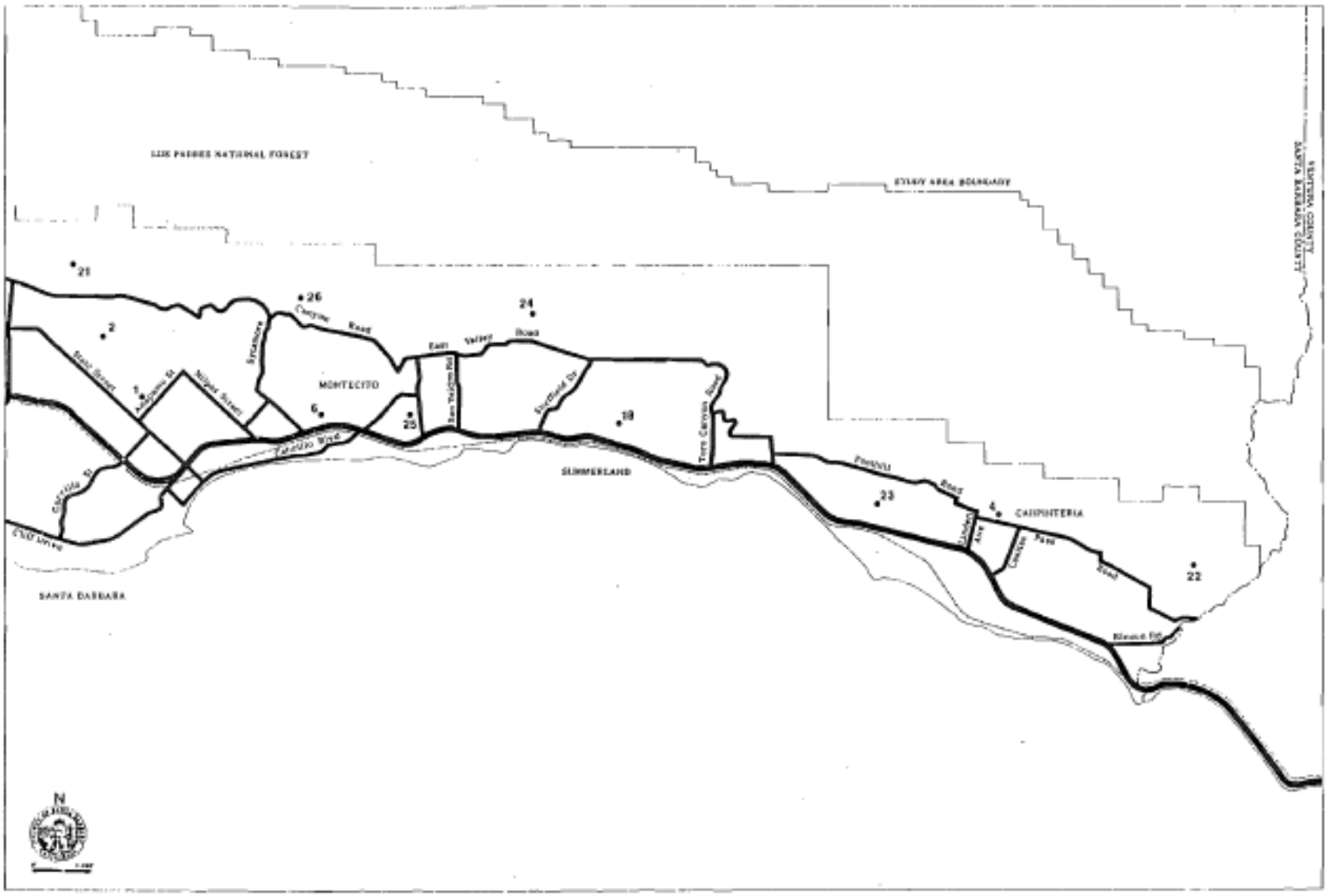
Station Number	Census Tract	Location	Day L_{90}	Day L_{50}	Day L_{10}	Night L_{90}	Night L_{50}	Night L_{10}	Estimated L_{DN}
32	29.05	N side of Calle Real W of Kingston	60	62	66	52	59	65	67
33	19.02	SW corner Oak & Second	36	44	54	34	36	41	53
34	19.02	E side of Faraday at Willow	37	43	51	36	39	47	54
35	19.02	Via Juana S of Hwy 246	42	46	53	39	41	46	54
36	19.02	E side of Edison between Numancia & Sagunto	45	51	58	36	40	50	56
37	19.01	SE Kendale Road & Kendale Place	40	43	48	34	36	41	50
38	19.01	E of Ave. of Flags at end of Second Street	46	51	58	43	45	54	56
39	30.02	W end of Vieja Drive	37	44	55	34	42	52	58
40	19.01	SW corner of Perkins & Helena	41	46	51	36	40	43	50
41	20.02	End of Hummel Drive	44	46	50	41	44	46	53
42	20.01	SW corner of Raymond & Dakota	45	48	56	44	45	48	56
43	20.03	S of Waller Park at Goodwin Road	43	49	56	42	44	52	56
44	20.03	Edenbury Drive & Hampshire Place	41	45	52	39	41	50	55
45	20.04	N side of Crescent Ave. W of Imperial	43	47	50	40	42	45	51
46	28.01	N 'H' behind Valley Drive In Theater	46	51	56	38	40	43	55
47	28.01	SE corner Calle Siete & Via Lato	36	42	52	36	38	50	52
48	28.01	S side Onstatt Rd W of Rucker Rd	39	46	52	39	43	46	52
49	28.04	SW of Olive Ave & 'U'St	40	43	50	35	38	43	49
50	28.01	S side Burton Mesa W of Constellation	42	48	57	40	45	53	57
51	28.02	SE corner Pine &	42	44	50	36	40	43	51



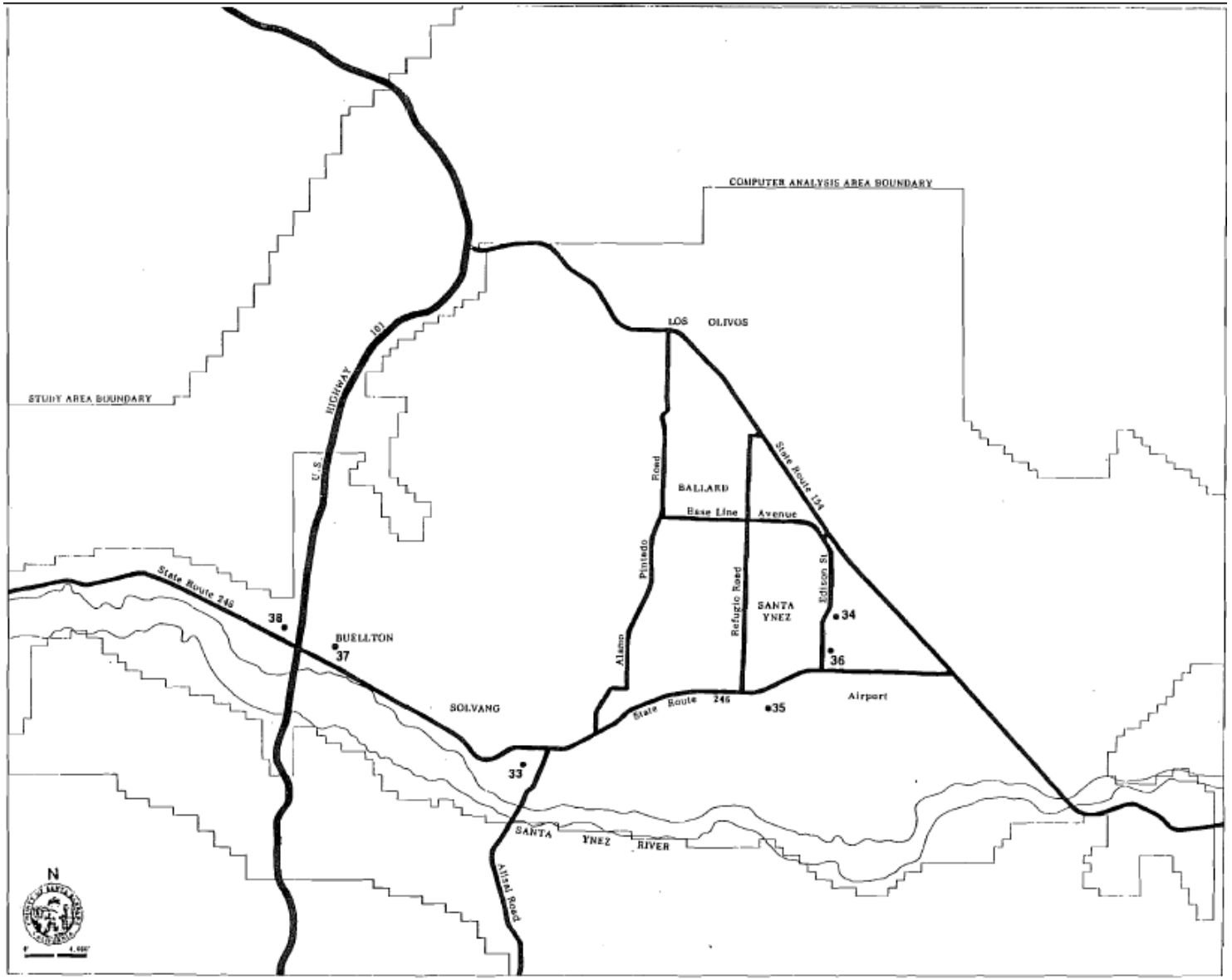
AMBIENT NOISE SURVEY
SITE LOCATIONS



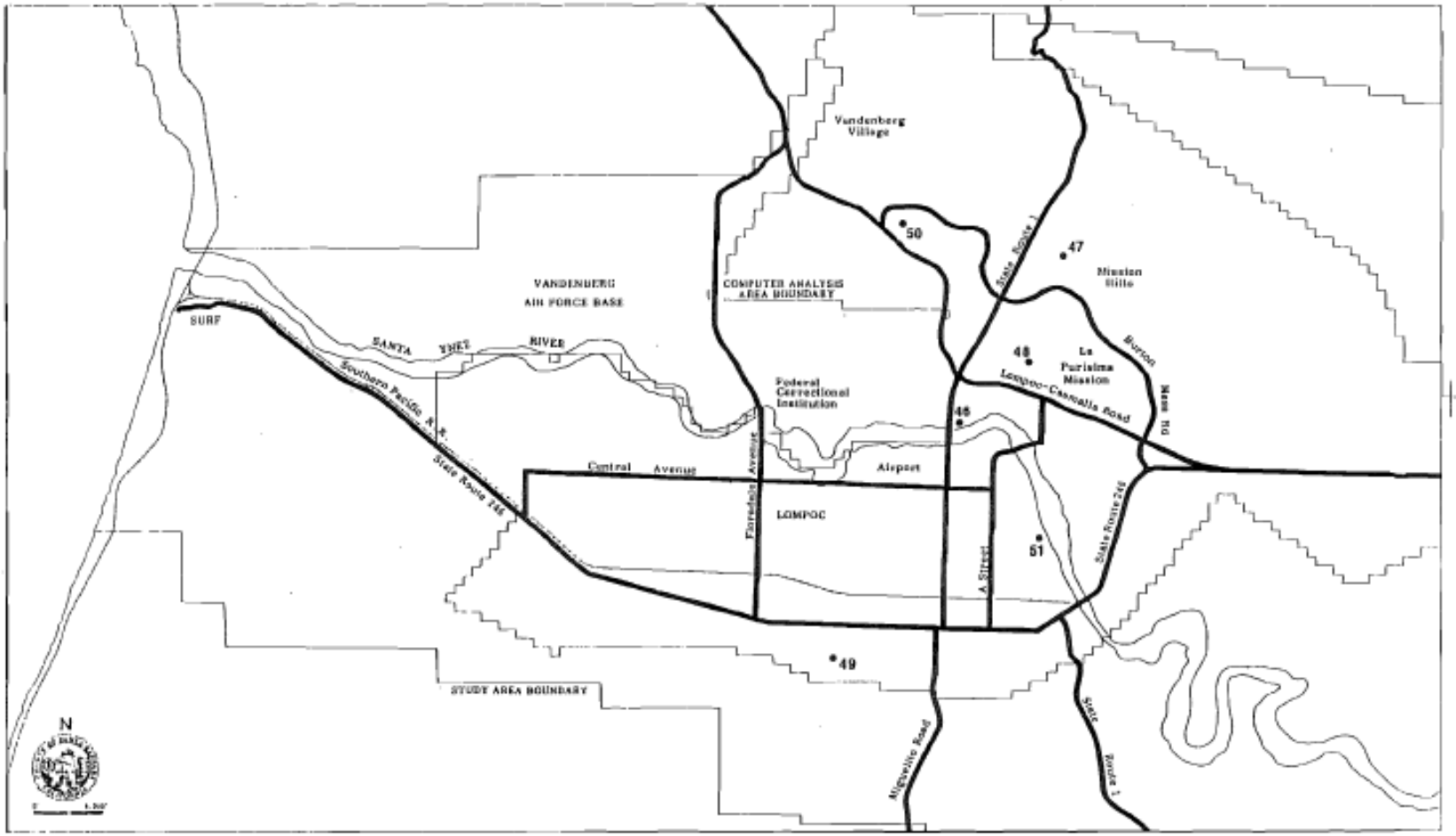
AMBIENT NOISE SURVEY
SITE LOCATIONS



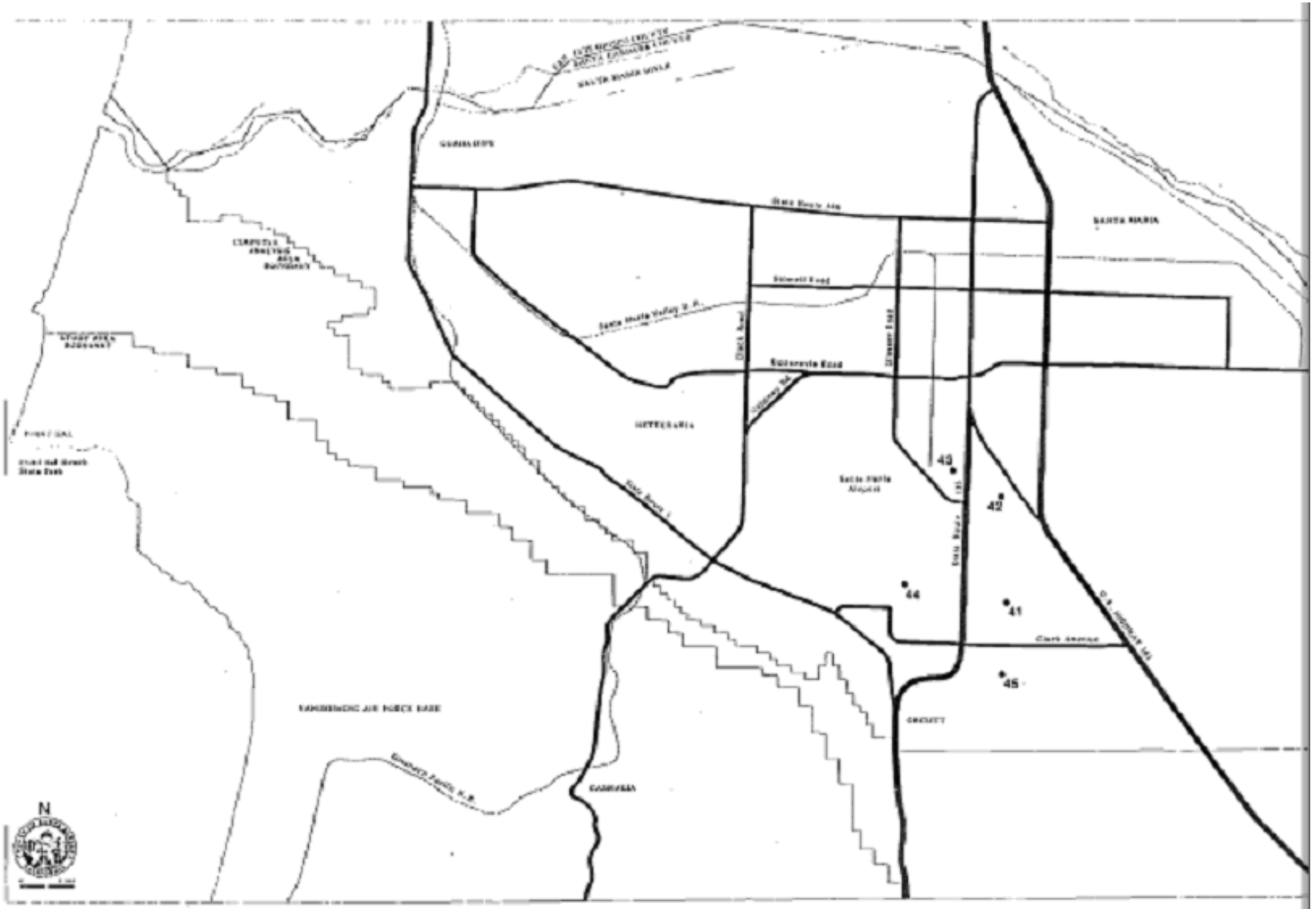
AMBIENT NOISE SURVEY
SITE LOCATIONS



AMBIENT NOISE SURVEY
SITE LOCATIONS



AMBIENT NOISE SURVEY
SITE LOCATIONS



AMBIENT NOISE SURVEY
SITE LOCATIONS

APPENDIX E: Summary of Federal and California State Noise Legislation

Responsibility for the control of noise is divided among the Federal, State, and local levels of government. This outline is intended to provide information on noise legislation at the Federal and State levels. Its purpose is to assist in understanding the role of local government in noise abatement since that role is in many instances circumscribed by preemptory State and Federal legislation.

FEDERAL LEGISLATION AND POLICY

I. Noise Control Act of 1972

A. Provides for division of powers among Federal, State and local governments.

1. Primary Federal responsibility is for prescribing noise emission limits on newly manufactured products.

a) Product standards adopted to date affect newly manufactured railroad locomotives, medium and heavy trucks used in interstate -commerce, and portable air compressors.

b) Product standards scheduled for adoption in 1977 affect motorcycles, buses, track wheel loaders, truck mounted refrigeration units, and compactors.

c) Products now under study for possible regulation include automobiles, snowmobiles, light trucks, tires, pneumatic and hydraulic impact tools, lawnmowers, chainsaws, road builders, and motorboats.

2. State and local governments retain authority to regulate the use, operation, or movement of products.

a) State and local governments may not impose noise level regulations on Federally regulated products which affect the manufacture or sale of the product.

b) Regulation directed at the owner or operator of the product which affects the times, location, or manner of operation of the product is permissible.

B. Noise Control Act recognizes the roles of the Department of Transportation and the Federal Aviation Administration in noise management.

1. The Federal Aviation Administration has authority to set noise emissions standards for aircraft.

    a. Regulations adopted in 1968 resulted in new generation jets (Boeing 747, Lockheed L-10ll, Douglas DC-l0) being significantly quieter than older jets.

    b. Recent modifications to these regulations will further reduce noise levels from newly certificated jets.

    c. The FAA is also responsible for prescribing aircraft operational changes (use of preferential runways, holding and maneuver altitudes, glide slopes, and traffic patterns) for the purpose of reducing noise impact.

3. State and local governments are prohibited from regulating aircraft noise emission levels.

    a. Airport operators may:

        1) Control ground operations (aircraft engine runups for example)

        2) Instigate preferential noise abatement runways after consultation with FAA.

        3) Restrict use of the airport to certain types of aircraft and restrict hours of operation or numbers of operations per hour.

4. The Department of Transportation is responsible for enforcing in-use noise regulations currently affecting interstate rail and truck carriers.

5. The Department of Transportation, Federal Highway Administration has adopted "design noise levels" applicable to all highway projects receiving funds from the Federal-aid system.

    a. Affected highway projects must include noise abatement measures in the highway design to reduce highway noise to a specified level which is defined relative to the type of land use adjacent to the highway.

    b. Abatement measures may include shifts in alignment or grade, acquisition of property to provide a buffer zone, construction of noise barriers, and insulation of selected structures such as schools, hospitals, churches, or libraries.

II. Department of Housing and Urban Development

A. Policy Circular 1390.2 states that HUD will refuse financial support of new construction on sites with "unacceptable" noise exposure.

B. Programs affected include several types of low-income housing assistance, interest subsidies, direct loans, and various forms of loan guarantees including the FHA Mortgage Insurance program.

III. Occupational Safety and Health Act of 1970

A. Concerns noise as an on-the-job hazard to hearing.

B. Specifies maximum noise exposure levels for workers.

1. Exposure levels are currently under review for possible revision to lower values.

C. Requires employers to carry out a continuing program of hearing conservation through audiometric testing, reduction of noise levels at the source, and reduction of individual exposures or provision of protective ear equipment.

STATE LEGISLATION AND POLICY

I. Motor Vehicle Code

A. Regulations directed at sellers of motor vehicles.

1. Section 27200 and following prohibits the registration and sale of new motor vehicles (except off-highway) which do not meet specified maximum noise level limits. This regulation would not be applicable to vehicles for which noise emission standards have been adopted in conformance with the Federal Noise Control Act of 1972.

2. Section 38280 prohibits the sale of new off-highway motor vehicles which do not meet specified noise limits.

3. Section 24005 makes it unlawful to sell, install or replace a muffler system not in conformance with other Vehicle Code provisions.

4. Section 24007 prohibits a retail seller from selling a new or used vehicle not complying with the Code.

B. Regulations directed at operators of motor vehicles.

1. Sections 23130 and 23130.5 specify that a motor vehicle may not be

operated so as to exceed stated noise limits.

2. Section 27150 specifies that every motor vehicle shall be equipped with adequate, properly maintained muffler.
3. Section 27151 prohibits modification or replacement of an exhaust system so as to increase the noise emitted over that from the original equipment.

4. An Attorney General's opinion states that cities and counties may not enforce vehicle noise standards which are non-identical with the Motor Vehicle Code.

II. Harbor and Navigation Code--Section 654.05 regulates noise emission from motorboats operated on inland waters with the maximum level dependent on the year of manufacture of the boat engine.

III. Airport Noise Standards--California Administrative Code, Title 4 defines a "noise impact boundary" around most airports in terms of noise contours. By 1986 airports must include only defined "compatible" land uses within the noise impact boundary.

IV. Noise Insulation Standards for Residential Buildings--California Administrative Code, Title 25, Article 4 establishes minimum noise insulation performance standards for new hotels motels, apartment houses, and dwellings other than detached single-family dwellings. The Code refers to both insulation between adjoining dwelling units and insulation from exterior sources such as freeways or airports.

V. Freeway Noise Abatement Near Schools--Streets and Highways Code Section 216 provides that where existing private or public elementary or secondary schools become noise impacted from construction of a new freeway, the Department of Transportation must undertake a program of noise abatement.

VI. Nuisance Noise -- Penal Code Section 415 prohibits loud and unusual noise that disturbs the peace if done deliberately.

Glossary

Decibel, dB:

A unit for describing the amplitude of sound equal to 20 tines 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
Sound Level:

The sound pressure 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.

L_{10}:

The A-weighted sound level exceeded 10 percent of the sample tine. Similarly, L_{50}, L_{90}, L_{99}, etc.

Equivalent
Energy Level,
L_{eq}:

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, L_{eq} is typically computed over 1, 8, and 24 hour sample periods.

CNEL:

Community Noise Equivalent Level. The average equivalent A-weighted sound level during a 24-hour day, obtained after addition of five decibels to sound levels in the evening from 7 pm to 10 pm and after addition of 10 decibels to sound levels in the night before 7 am and after 10 pm.

L_{dn}

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 before 7 am and after 10 pm.

NOTE: CNEL and L_{dn} represent daily levels of noise exposure averaged on an annual basis, while L_{eq} represents the equivalent energy noise exposure for a

shorter tine period, typical one hour.

Noise Exposure Contours:

Lines drawn about a noise source indicating constant energy levels of noise exposure. CNEL and L_{dn} are the metrics utilized herein to describe community exposure to noise.

Ambient Noise Level:

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.

CITATIONS

[i] Resolution No. 79-134 (Case No. 76-GP-4) Adopted March 5th, 1979 (Adopting Resolution of Noise Element)

[ii] Resolution No. 81-84 (Case No. 80-GP-11) Amended February 23rd 1981 (Changed Day-Night Average Sound Level from 60db to 65db.)

[iii] Resolution No. 86-84 (Case No. 85-GP-9) Amended February 11th 1986 (Added in 65dB CNEL Contour stipulation.)

[iv] Resolution No. 84-345 (Case No. 83-GP-14) Amended July 30, 1984 (Added sub policy points A-F to policy #6 (formerly policy #4))