NOISE ELEMENT

APPROVED BY THE CITY COUNCIL
SEPTEMBER 22, 1998

NOISE

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Purpose and Authority

Government Code Section 65303(f) requires a noise element of all city and county general plans, as follows:

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

A noise element is required as part of the General Plan. The element analyzes and quantifies, to the extent practicable, current and projected noise levels in the community. Information provided by noise exposure contours for both near and long-term levels of growth and traffic activity become a guideline for use in development of the land use element to achieve noise compatible land use. The noise exposure contours also provide baseline noise levels and noise source identification for local noise ordinance enforcement. The noise element includes policies that address existing and foreseeable noise problems. The adopted noise element serves as a guideline for compliance with the state's noise insulation standards.

Noise sources in Hercules considered in this noise element include traffic (on freeways, highways, and major local roadways), railroad operations (both the Union Pacific and Atchison-Topeka and Santa Fe railroads), and local industrial plants. The noise exposure information is presented in terms of noise contours expressed in day/night noise levels or L_{dn}. The L_{dn} means the average equivalent A-weighted sound level during a typical 24-hour day, which includes the addition of 10 decibels to sound levels during the period 10:00 p.m. to 7:00 a.m. to account for the greater sensitivity to noise during late night and early morning hours.

Fundamentals of Noise

Noise Units

Noise may be defined as unwanted sound. Noise is usually objectionable because it is disturbing or annoying. The objectionable nature of sound could be caused by its *pitch* or its loudness. *Pitch* is the height or depth of a tone or sound, depending on the relative rapidity (frequency) of the vibrations by which it is produced. Higher pitched signals sound louder to humans than sounds with a lower pitch. *Loudness* is intensity of sound waves combined with the reception characteristics of the ear. Intensity may be compared with the height of an ocean wave in that it is a measure of the amplitude of the sound wave.

In addition to the concepts of pitch and loudness, there are several noise measurement scales which are used to describe noise in a particular location. *A decibel (dB)* is a unit of measurement which indicates the relative amplitude of a sound. The zero on the decibel scale is based on the lowest sound level that the healthy, unimpaired human ear can detect. Sound levels in decibels are calculated on a logarithmic basis. An increase of ten decibels represents a ten-fold increase in acoustic energy, while 20 decibels is 100 times more intense, 30 decibels is 1,000 times more intense, etc. There is a relationship between the subjective noisiness or loudness of a sound and its intensity. Each 10-decibel increase in sound level is perceived as approximately a doubling of loudness over a fairly wide range of intensities. Technical terms are defined in Table 1.

There are several methods of characterizing sound. The most common in California is the *A weighted sound level or dBA*. This scale gives greater weight to the frequencies of sound to which the human ear is most sensitive. Representative outdoor and indoor noise levels in units of dBA are shown in Table 2. Because sound levels can vary markedly over a short period of time, a method for describing either the average character of the sound or the statistical behavior of the variations must be utilized. Most commonly, environmental sounds are described in terms of an average level that has the same acoustical energy as the summation of all the time-varying events. This energy-equivalent sound/noise descriptor is called L_{eq}. The most common averaging period is one hour.

Term	Definitions
Decibel, dB	A unit describing the amplitude of sound, equal to 20 times the logarithm to the base 10 of the ratio of the pressure of the sound measured to the reference pressure, which is 20 micropascals (20 micronewtons per square meter).
Frequency, Hz	The number of complete pressure fluctuations per second above and below atmospheric pressure.
A-Weighted Sound Level, dBA	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 frequency response of the human ear and correlates well with subjective reactions to noise. All sound levels in this report are A-weighted.
L_{01}, L_{10}, L_{50}, L_{90}	The A-weighted noise levels that are exceeded 1%, 10%, 50%, and 90% of the time during the measurement period.
Equivalent Noise Level, L_{eq}	The average A-weighted noise level during the measurement period.
Community Noise Equivalent Level, CNEL	The average A-weighted noise level during a 24-hour day, obtained after addition of 5 decibels in the evening from 7:00 pm to 10:00 pm and after addition of 10 decibels to sound levels in the night between 10:00 pm and 7:00 am.
Day/Night Noise Level, L_{dn}	The average A-weighted noise level during a 24-hour day, obtained after addition of 10 decibels to levels measured in the night between 10:00 pm and 7:00 am.
L_{max}, L_{min}	The maximum and minimum A-weighted noise level during the measurement period.
Ambient Noise Level	The composite of noise from all sources near and far. The normal or existing level of environmental noise at a given location.
Intrusive	That noise which intrudes over and above the existing ambient noise at a given location. The relative intrusiveness of a sound depends upon its amplitude, duration, frequency, and time of occurrence and tonal or informational content as well as the prevailing ambient noise level.

Definitions of Acoustical Terms | **Table 1**

Source: ILLINGWORTH & RODKIN, INC./Acoustics • Air Quality

At a Given Distance From Noise Source	A-Weighted Sound Level in Decibels	Noise Environments	Subjective Impression
	140		
Civil Defense Siren (100')	130		
Jet Takeoff (200')	120		Pain Threshold
	110	Rock Music Concert	
Diesel Pile Driver (100')	100		Very Loud
	90	Boiler Room	
Freight Cars (50')		Printing Press Plant	
Pneumatic Drill (50')	80		
Freeway (100')		In Kitchen With Garbage	
Vacuum Cleaner (10')	70	Disposal Running	Moderately Loud
	60	Data Processing Center	
Light Traffic (100')	50	Department Store	
Large Transformer (200')			
	40	Private Business Office	Quiet
Soft Whisper (5')	30	Quiet Bedroom	
	20	Recording Studio	
	10		Threshold of Hearing
	0		

Typical Sound Levels Measured in the Environment and Industry

Table 2

Source: ILLINGWORTH & RODKIN, INC./Acoustics • Air Quality

The scientific instrument used to measure noise is the sound level meter. Sound level meters can accurately measure environmental noise levels to within about plus or minus 1 dBA. Various computer models are used to predict environmental noise levels from sources, such as roadways and airports. The accuracy of the models depends upon the distance the receptor is from the noise source. Close to the noise source, the models are accurate to within about plus or minus 1 to 2 dBA. The accuracy of the model decreases with increased distance from the source.

Since the sensitivity to noise increases during the evening and at night--because excessive noise interferes with the ability to sleep--24-hour descriptors have been developed that incorporate artificial noise penalties added to quiet-time noise events. The *Community Noise Equivalent Level, CNEL*, is a measure of the cumulative noise exposure in a community, with a five dB penalty added to evening (7:00 pm - 10:00 pm) and a 10 dBA addition to nocturnal (10:00 pm - 7:00 am) noise levels. The *Day-Night Average Sound Level,* L_{dn} is essentially the same as CNEL, with the exception that the penalty added to the evening time period is dropped and all occurrences during this three-hour period are grouped into the day-time period. The L_{dn} descriptor is the most common community noise descriptor, where the CNEL is most often used to describe aircraft noise.

Effects of Noise

Hearing Loss. While physical damage to the ear from an intense noise impulse is rare, a degradation of auditory acuity can occur even within a community noise environment. Hearing loss occurs mainly due to chronic exposure to excessive noise, but may be due to a single event such as an explosion. Natural hearing loss associated with aging may also be accelerated from chronic exposure to loud noise. The Occupational Safety and Health Administration (OSHA) has a noise exposure standard which is set at the noise threshold where hearing loss may occur from long-term exposures. The maximum allowable level is 90 dBA averaged over eight hours. If the noise is above 90 dBA, the allowable exposure time is correspondingly shorter.

Sleep and Speech Interference. The thresholds for speech interference indoors are about 45 dBA if the noise is steady and above 55 dBA if the noise is fluctuating. Outdoors the thresholds are about 15 dBA higher. Steady noise of sufficient intensity (above 35 dBA) and fluctuating noise levels above about 45 dBA have been shown to affect sleep. Interior residential standards for multi-family dwellings are set by the State of California at 45 dBA L_{dn}. Typically, the highest steady traffic noise level during the daytime is about equal to the L_{dn} and nighttime levels

are about 10 dBA lower. The standard is designed for sleep and speech protection and most jurisdictions apply the same criterion for all residential uses. Typical structural attenuation is 12-17 dBA with open windows. With closed windows in good condition, the noise attenuation factor is around 20 dBA for an older structure and 25 dBA for a newer dwelling. Sleep and speech interference is therefore possible when exterior noise levels are about 57-62 dBA L_{dn} with open windows and 65-70 dBA L_{dn} if the windows are closed. Levels of 55-60 dBA are common along collector streets and secondary arterials, while 65-70 dBA is a typical value for a primary/major arterial. Levels of 75-80 dBA are normal noise levels at the first row of development outside a freeway right-of-way. In order to achieve an acceptable interior noise environment, bedrooms facing secondary roadways need to be able to have their windows closed, those facing major roadways and freeways typically need special glass windows.

Annoyance. Attitude surveys are used for measuring the annoyance felt in a community for noises intruding into homes or affecting outdoor activity areas. In these surveys, it had been determined that the causes for annoyance include interference with speech, radio and television, house vibrations, and interference with sleep and rest. The L_{dn} as a measure of noise has been found to provide a valid correlation of noise level and the percentage of people annoyed. People have been asked to judge the annoyance caused by aircraft noise and ground transportation noise. There continues to be disagreement about the relative annoyance of these different sources. When measuring the percentage of the population highly annoyed, the threshold for ground vehicle noise is about 55 dBA L_{dn}. At an L_{dn} of about 60 dBA, approximately 2 percent of the population is highly annoyed. When the L_{dn} increases to 70 dBA, the percentage of the population highly annoyed increases to about 12 percent of the population. There is, therefore, an increase in the percentage of people highly annoyed of about 1 percent per dBA between an L_{dn} of 60-70 dBA. Between an L_{dn} of 70-80 dBA, each decibel increase increases by about 2 percent the percentage of the population highly annoyed. People appear to respond more adversely to aircraft noise. When the L_{dn} is 60 dBA, approximately 10 percent of the population is believed to be highly annoyed. Each decibel increase to 70 dBA adds about 2 percentage points to the number of people highly annoyed. Above 70 dBA, each decibel increase results in about a 3 percent increase in the percentage of the population highly annoyed.

Description of the Noise Environment in Hercules

Noise Sources

The major noise source in Hercules, like most other communities, is traffic. Interstate 80 is the most substantial source of noise. Railroad operations on two different rail lines also contribute significantly to the noise environment. Industrial sources, such as Pacific Refinery, contribute very little to noise level in the community of Hercules. All major noise sources were identified and classified by the level of noise generated as a major noise source (generates a noise level of 60 dBA L_{dn} or greater at distances beyond 300 feet), moderate noise source (generates a noise level of 60 dBA L_{dn} or greater at distances between 150 and 300 feet), and minor noise sources (generate noise levels of 60 dBA L_{dn} or greater at distances between 50 and 150 feet). The noise sources in Hercules are classified as follows:

- Major Noise Sources
  - Interstate 80 through Hercules
  - State Route 4 west of Franklin Canyon
  - San Pablo Avenue between State Route 4 and Sycamore
  - AT&SF Railroad east of Sycamore
  - Union Pacific Railroad through Hercules

- Moderate Noise Sources
  - State Route 4 east of Franklin Canyon
  - San Pablo Avenue east of State Route 4 and west of Sycamore
  - AT&SF Railroad west of Sycamore
  - Sycamore
  - Willow Avenue
  - Refugio Valley Road west of Redwood

- Minor Noise Sources
  - Hercules Avenue
  - Pheasant Way
  - Redwood
  - Lupine
  - Refugio Valley Road east of Redwood

Noise Monitoring

A noise measurement program was conducted during the period December 16-20, 1996. Data collected during this period were supplemented with noise measurement data collected in 1994 along Interstate 80. The purpose of the noise measurement program was to measure the strength of noise sources in the community and sample the noise environment that residences are exposed to. Noise measurement locations were determined in consultation with the City Community and Business Development Department. The measurement locations are shown on the noise contour map.

The noise measurements consisted of long-term measurements (i.e., 24 hours or longer) and short-term measurements (10 to 15 minutes) in duration. Long-term noise measurements are indicated with an "L" (e.g., L1, L2, LA, etc.), while short-term measurements are indicated with an "S" (e.g., S1, S2, S3, etc.). A summary of the long-term noise measurements are presented in Table 3 and the results of short-term measurements are presented in Table 4.

Freeway and Highway Traffic Noise. Noise produced by Interstate 80 was characterized by noise levels measured at Locations L3, LA, LB, LC, LD, and S12. Figure 1 shows the daily trend in noise levels at residential areas on Brighton near Interstate 80. Measurement Locations L2, L5, and S1 were used to characterize noise produced by State Route 4. The daily trend in noise levels at residential areas near State Route 4 are shown in Figure 2.

Arterial Roadway Traffic Noise. Noise produced along San Pablo Avenue was characterized by noise measurements at Locations L1, L4, and S8. The daily trend in noise levels along San Pablo Avenue are shown in Figure 3. Location S8 was affected by Interstate 80 traffic noise. Noise measurement Location L7 characterizes traffic noise along Sycamore near Redwood. Figure 4 shows the daily trend in hourly noise levels at this location.

Local Roadways. Noise levels along local roadways were measured. Location L8 characterizes traffic noise along Refugio Valley Road, Location L9 characterizes noise levels along Pheasant Way, and Location L11 characterizes noise levels along Hercules Avenue. The daily trend in noise levels for these roadways are shown in Figure 5 for Refugio Valley Road and Figure 6 for Hercules Avenue. Short-term noise measurements were made throughout residential areas (S3, S4, S5, S6, S7, S9, and S10) to characterize typical daytime noise levels in residential communities.

Measurement Location	Description	Date	Measured Noise Level (dBA)					Noise Sources
			L_{dn}	L_{eq}	L_{10}	L_{50}	L_{90}	
L1	Along San Pablo Ave. near Hercules Ave. Meter located 110 ft. from the centerline and 30 ft. above the roadway.	12/16-18/96	66	62	66	60	50	Traffic on San Pablo Ave. and trains on the AT&SF rail line.
L2	At end of Sheffield near Rte. 4. Approximately 600 ft. from Rte. 4 centerline.	12/16-18/96	70	67	70	66	56	Traffic on Rte. 4 near Willow Ave.
L3	At north end of Brighton near I-80. Meter placed approximately 1,000 ft. from I-80.	12/16-18/96	65	60	61	58	55	Traffic on I-80 and some local traffic.
L4	Along San Pablo Ave. near Linus Pauling. Meter located 90 ft. from the centerline and 20 ft. above the roadway.	12/16-18/96	65	61	64	57	51	Traffic on San Pablo Ave.
L5	Along Rte. 4 at Claeys Rd. near Palm Ave. Meter located 125 ft. from Rte. 4 centerline.	12/18-19/96	72	68	72	66	53	Traffic on Rte. 4.
L6	Along the AT&SF Railroad, behind City Hall. Meter located 130 ft. from the railroad tracks, about 2,000 ft. from Rte. 4, and about 4,000 ft. from I-80.	12/18-19/96	75	65	59	56	52	Trains on the AT&SF line. Maximum noise levels from trains are 90 dBA.
L7	Along Sycamore at Redwood. Meter located 60 ft. from the centerline of Sycamore.	12/18-19/96	67	63	66	58	48	Traffic on Sycamore and Redwood.
L8	Along Refugio Valley Rd. at Refugio Valley Regional Park. Meter located 60 ft. from the centerline of Refugio Valley Rd.	12/18-19/96	66	62	67	54	37	Traffic on Refugio Valley Rd.
L9	Along Pheasant Way near Tanager. Meter located 35 ft. from the centerline of Pheasant.	12/19-20/96	60	55	55	43	35	Traffic on Pheasant Way and background.
L10	Along Willow Ave. near Mariners Pointe. Meter located 65 ft. from the centerline of Willow Ave.	12/19-20/96	64	59	64	55	44	Traffic on Willow Ave.

Summary of Long-Term Noise Measurement **Table 3** (Pg 1 of 2)

Measurement Location	Description	Date	Measured Noise Level (dBA)					Noise Sources
			L_{dn}	L_{eq}	L_{10}	L_{50}	L_{90}	
L11	Along Hercules Ave. near Skelly. Meter located 30 ft. from the centerline of Hercules Ave.	12/19-20/96	65	61	65	53	44	Traffic on Hercules and surrounding roads.
L12	Along Railroad Ave. and the Union Pacific Railroad. Meter located 45 ft. from the centerline of Railroad Ave. and 100 ft. from the railroad tracks.	12/19-20/96	68	62	54	45	39	Trains and distant traffic. Maximum noise levels from trains are 95 dBA.
LA	Near I-80, south end of Mission Springs near Village Parkway. Approximately 200 ft. from the centerline of I-80.	Jan. 1994	74	--	--	--	--	Traffic on I-80.
LB	Near I-80 on Ponderosa Trail. Behind soundwall in residential backyard. Meter placed approximately 500 ft. from I-80.	Jan. 1994	65	--	--	--	--	Traffic on I-80.
LC	Near I-80 on Ponderosa Trail. Above soundwall in residential backyard. Meter placed approximately 500 ft. from I-80.	Jan. 1994	71	--	--	--	--	Traffic on I-80.
LD	Near I-80 on Peridot Ct. Meter located in backyard behind fence above I-80, approximately 300 ft. from the edge of the roadway.	Jan. 1994	60	--	--	--	--	Traffic on I-80.

Summary of Long-Term Noise Measurements

Table 3 (Pg. 2 of 2)

Source: ILLINGWORTH & RODKIN, INC./Acoustics • Air Quality

Location	Description	Start Time[1]	Measured Noise Level (dBA)				Noise Sources
			L_{eq}[2]	L_{10}[3]	L_{50}[3]	L_{90}[3]	
S1	Along Rte. 4 at Franklin Canyon 210 ft. from the centerline	12:45 pm	59	62	58	52	Rte. 4 traffic
S2	Along Refugio Valley Rd. at Refugio Valley Park 125 ft. from the centerline of Refugio Valley Rd.	1:40 pm	54	57	52	47	Refugio Valley Road traffic
S3	Open space area west of City Hall	2:30 pm	61	62	60	59	Rte. 4 and I-80 traffic. Site exposed to train noise, which was not measured.
S4	Along Falcon near Sparrow 30 ft. from centerline of Falcon	1:15 pm	55	56	41	36	Traffic on Falcon
S5	Nutmeg near Redwood & Sequoia	1:30 pm	44	47	42	39	Background sources
S6	Along Redwood 30 ft. from centerline of Redwood	1:45 pm	63	68	53	43	Redwood traffic
S7	Edinburgh near Brighton	2:00 pm	54	59	51	43	Traffic on I-80
S8	West end of Sycamore 300 ft. from centerline of San Pablo Ave 1,200 ft. from centerline of I-80	2:20 pm	62	63	60	58	San Pablo Ave. traffic I-80 traffic
S9	N. Wildwood near Devenwood at swimming pool complex	2:40 pm	47	51	42	40	Distant traffic
S10	Aethena near Atlas 55 ft. from centerline of Aethena	2:55 pm	51	53	41	37	Aethena traffic and distant traffic
S11	West end of Palm near Bayberry	3:50 pm	57	59	54	52	Rte. 4 traffic

Summary of Short-Term Noise Measurements **Table 4 (Pg. 1 of 2)**

Location	Description	Start Time[1]	Measured Noise Level (dBA)				Noise Sources
			L_{eq}[2]	L_{10}[3]	L_{50}[3]	L_{90}[3]	
S12	North end of Newbury	4:15 pm	54	56	53	51	I-80 traffic
S13	Near Union Plant 2,000 ft. from Union Plant and 4,000 feet from Rte. 4	4:45 pm	51	52	51	49	Rte. 4 traffic Union Plant

(12)

[1] Noise measurements made over 10- or 15-minute periods during December 19-20, 1996.

[2] L_{eq} -- The average A-weighted noise level during the measurement period.

[3] L_{10}, L_{50}, L_{90} -- The A-weighted noise levels that are exceeded during the measurement period 10, 50, and 90 percent of the time, respectively.

Summary of Short-Term Noise Measurements

Table 4 (Pg. 2 of 2)

Source: ILLINGWORTH & RODKIN, INC./Acoustics • Air Quality

FIGURE 1

NOISE LEVELS NEAR INTERSTATE 80 (L3)

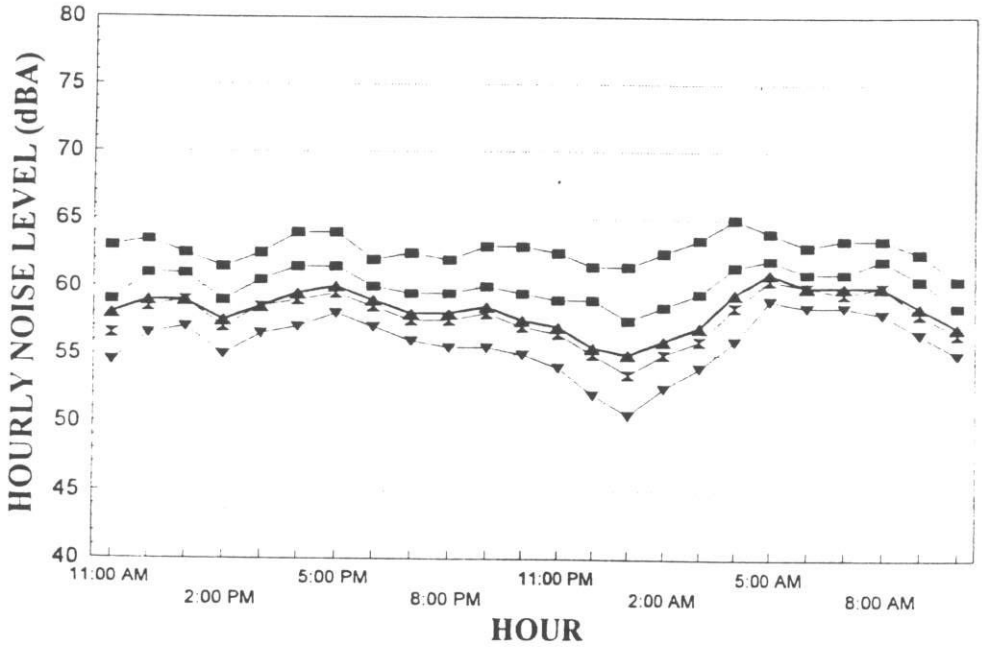
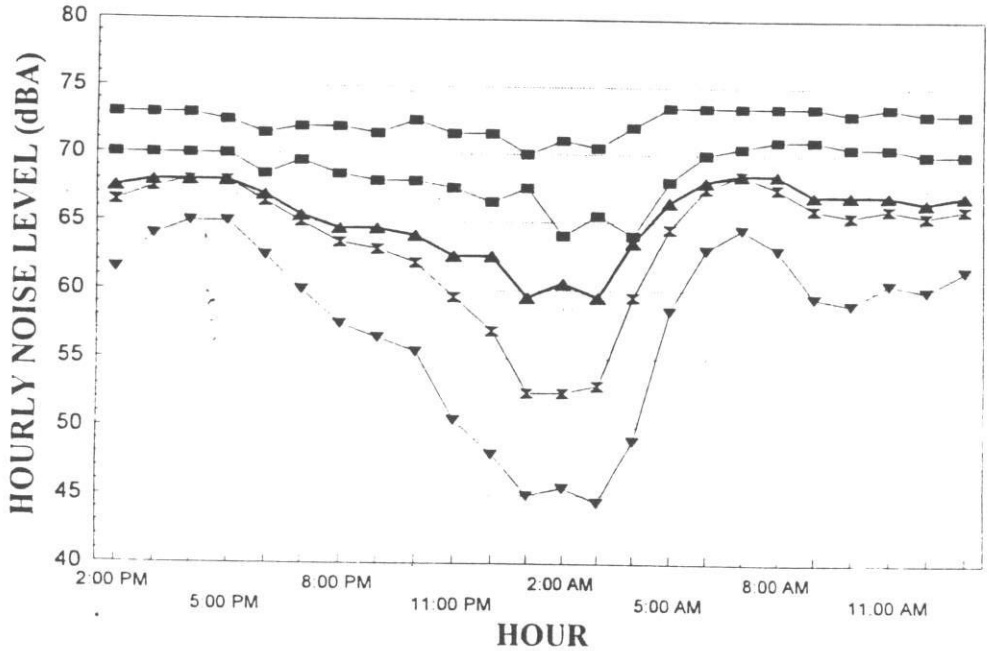


FIGURE 2

NOISE LEVELS ALONG STATE ROUTE 4 (L2)



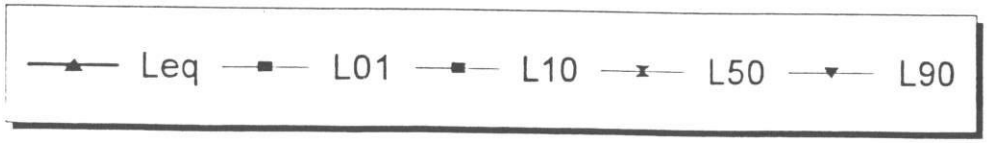


FIGURE 3

NOISE LEVELS ALONG SAN PABLO AVE. (L1)

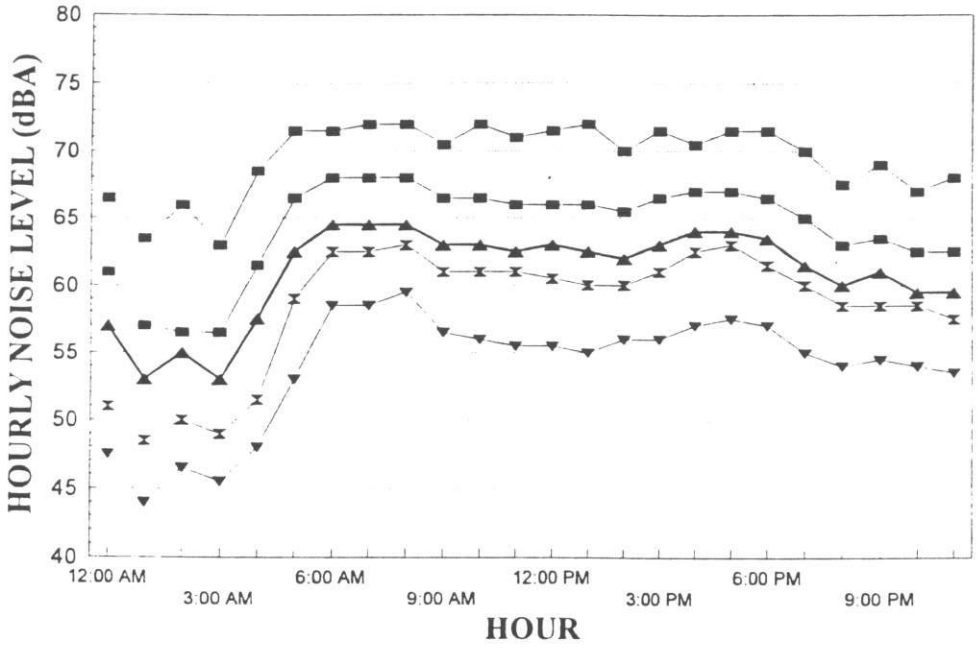
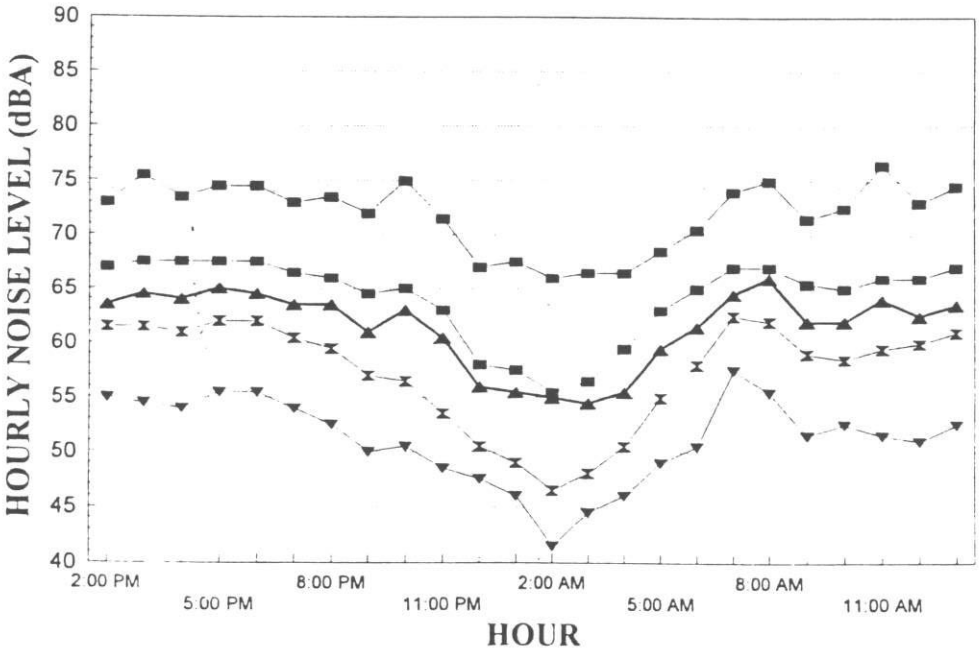


FIGURE 4

NOISE LEVELS ALONG SYCAMORE (L7)



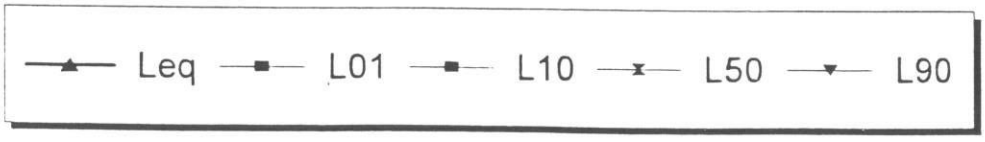


FIGURE 5
NOISE LEVELS IN REFUGIO VALLEY (L8)

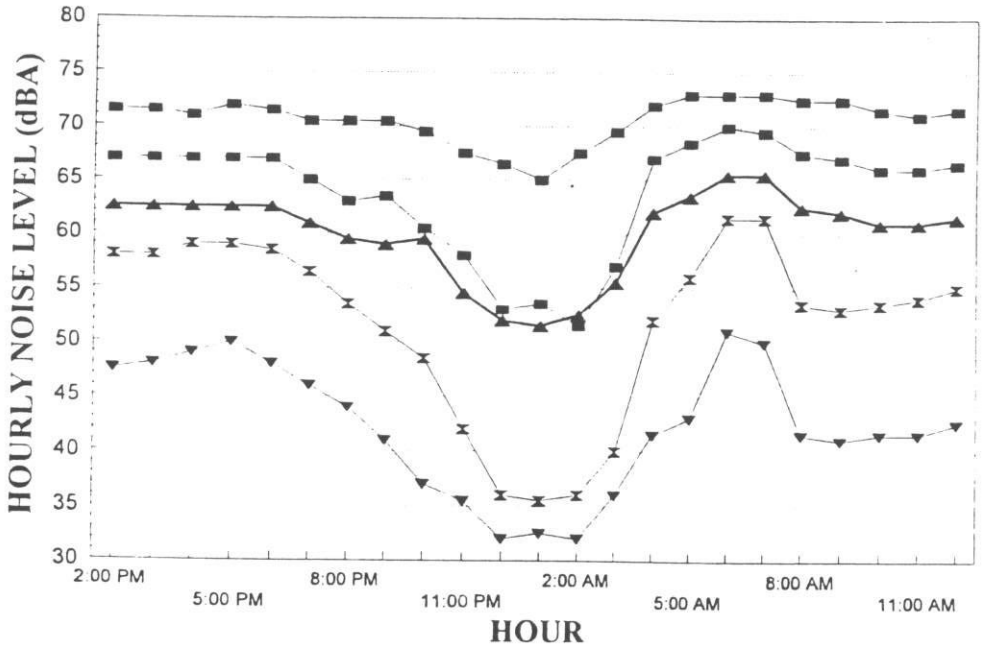
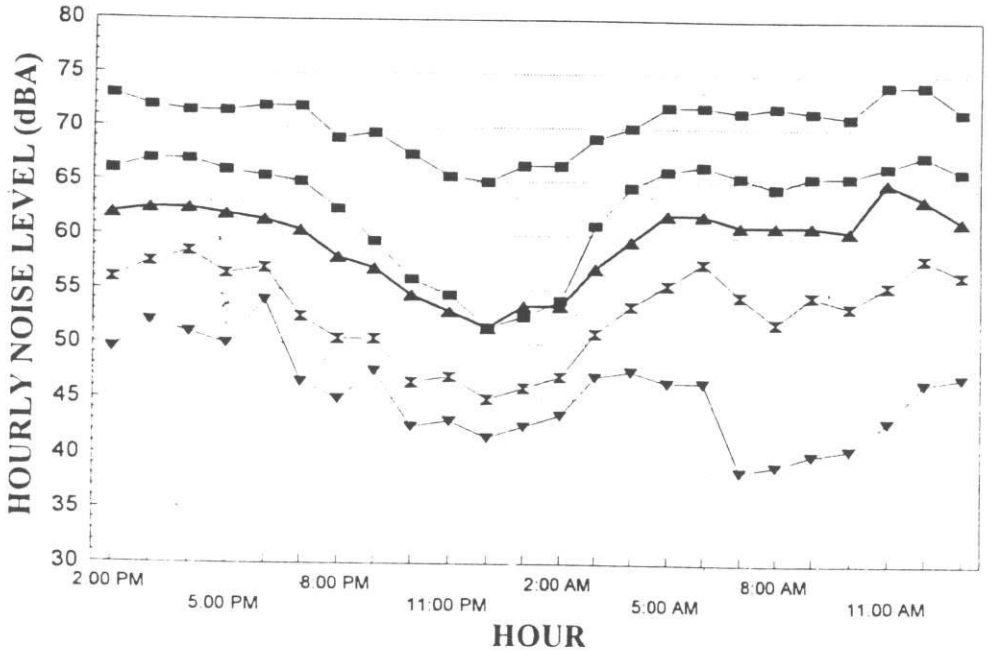


FIGURE 6
NOISE LEVELS ALONG HERCULES (L11)



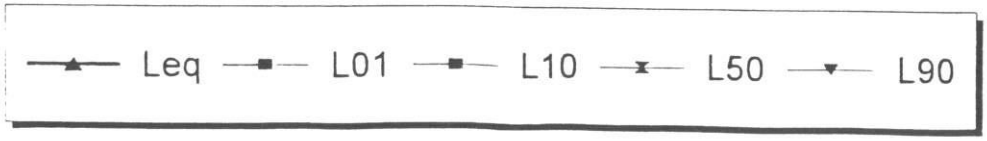


FIGURE 7
NOISE LEVELS NEAR THE AT&SF RR (L6)

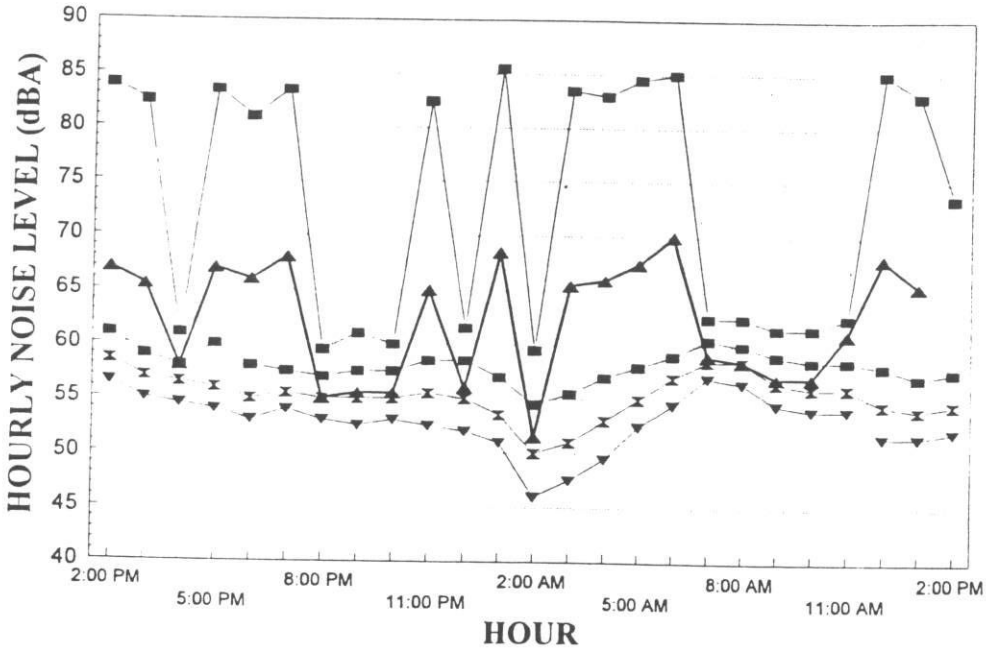
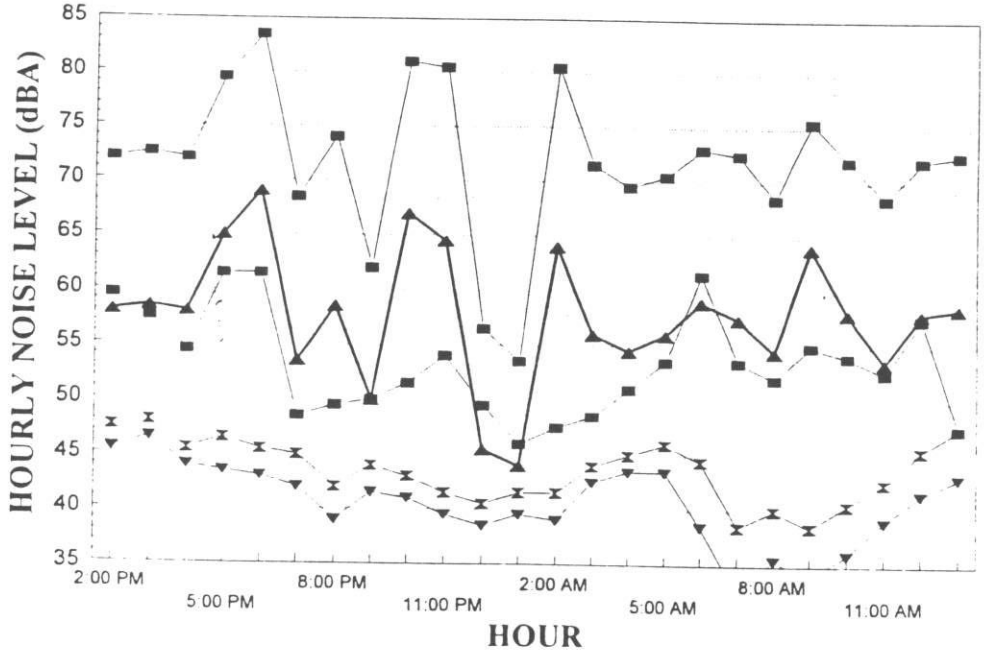
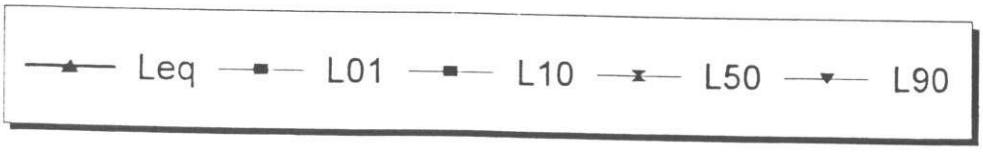


FIGURE 8
NOISE LEVELS ALONG THE UP RR (L12)





Train Noise. Location L6 was used to characterize train noise along the AT&SF Railroad. Location L6 is also exposed to traffic noise from State Route 4 and Interstate 80. The daily trend in hourly noise levels at this location are shown in Figure 7. At this location, approximately 21 trains passed by during the 24-hour measurement period. Late night and early morning train passages result in the relatively high L_{dn} noise levels. Noise from train activity on the Union Pacific Railroad was measured at Location L12. The hourly trend in noise levels produced by train activity along this rail line are shown in Figure 8. About 20 to 25 trains passed by during the 24-hour measurement period.

Stationary Sources. The noise survey did not identify any substantial stationary sources in Hercules. Pacific Refinery appeared not to be operating during the noise monitoring period. Although the Union Carbon Plant is outside the Hercules City limits, noise measurements were made in the vicinity of the plant (Location S13) to characterize this source of noise. This measurement indicated that the Plant produces a noise levels of 60 dBA L_{dn} at a distance of about 500 to 1,000 feet from the plant.

Future Noise Environment

Much of Hercules is developed, therefore significant increases in traffic noise along local roadways is not anticipated. Currently, widening along Interstate 80 is underway that would add two additional traffic lanes. This could lead to an increase in traffic noise of up to 1 dBA. There are plans to increase traffic capacity on State Route 4 east of Hercules (through Franklin Canyon). This could increase State Route 4 traffic noise by about 3 dBA in Franklin Canyon and 1 to 2 dBA west of Willow Avenue. Train noise is too difficult to predict in the future, since the amount of rail traffic is dependent on many factors. It is likely that noise generated along these two rail lines will not change substantially.

Noise Contour Map

The noise measurements were used to develop a noise contour map of Hercules (Figure 9). These noise contours serve as a guide for establishing a pattern of land uses in the land use element that minimizes the exposure of residences in Hercules to excessive noise. The contours represent day/night (L_{dn}) noise levels in 5 dBA increments for noise levels of 60 dBA L_{dn} or greater. Noise data computations used to draw the existing noise contours are shown in Table 7. Noise measurement locations are also shown on the noise contour map.