GORDON BRICKEN & ASSOCIATES
CONSULTING ACOUSTICAL and ENERGY ENGINEERS

February 22, 1991

ENVIRONMENTAL NOISE ANALYSIS

PARADISE HILLS

CITY OF SAN BERNARDINO

Prepared by:

Gordon Bricken
President

/mmb

Prepared for:

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SUMMARY

The project traffic nas the following three characteristics:

1. The project will increase in noise levels on existing roadways but it will be an insignificant amount.

2. The project does not cause any existing segment to exceed 65 CNEL compared to the condition in 1995 without the project.

3. The new access roads will not cause noise levels to exceed 65 CNEL on any adjacent residential area.

4. The new access roads will increase noise levels a significant amount in adjacent residential areas where such areas exist prior to the use of the roadways.

5. Construction noise might produce adverse impacts.

6. A unavoidable increase in ambient noise levels along the new road segments will occur.

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1.0 PROJECT DESCRIPTION

It is proposed to construct 504 single family dwellings on approximately 410 acres north of the California State University at San Bernardino (CSUSB). The area location is noted on Exhibit 1. The site is divided into ten planning areas of which, nine are residential and one is a park. The planning areas are shown in Exhibit 2. No further detail on the project is provided at the present time. There are two access points to the site which are also shown on Exhibit 2. The access roads must be improved. The environmental consequences of the improvement are not included in this analysis.

2.0 SOUND

By nature, sound is a technical subject. Discussion of sound requires special terminology, which is not always familiar to the general public. Therefore, this section describes sound in terms of its characteristics and units of measure, and also the effects of sound on people. This ensures that the subject is easily understood and the meaning of "noise" is carefully defined.

2.1 BASIC PROPERTIES OF SOUND

Sound is technically described in terms of magnitude (also called, amplitude) and the frequency (also called, pitch). The frequency of a sound refers to the number of times per second the sound wave expands and compresses as it travels through the air. The unit of measurement is called the Hertz (Hz). A 100 Hertz sound means that the sound wave expands and compresses 100 times a second. The standard unit of measurement of the magnitude is the decibel (dB). Decibels are based on a logarithmic scale. This scale compresses the wide range of sound levels into a more

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usable range of numbers. The technique is used in the Richter scale of defining the magnitude of an earthquake. The convenience of the logarithmic scale can lead to a misunderstanding of the meaning of change in magnitude as it relates to the actual change in energy. A ten dB change is a tenfold change in energy. A 20 dB change is a hundred fold (10 x 10) change in energy, not a twofold change as would be suggested by the numbers.

The sensitivity of the human ear to changes is affected by the magnitude of sound, the frequency components and the time interval between comparisons. In a test booth, the minimum change detectable at a single frequency within the most sensitive portion of the ears' range is one (1) decibel when the comparative samples are at the same frequency and within a few seconds of each other. As the time interval between comparisons increases, the minimum change in amplitude that can be identified also increases. This is because humans do not have a very acute sound level "memory". If a sound contains more than one frequency component, then detecting the change in magnitude for sound changes closely spaced in time and with identical components also increases. These various factors lead to the fact that for sounds with many frequencies, where the changes occur over years, the change in magnitude must be around three (3) dB for a statistically reliable cross section of people to state that a change has taken place. Even then, the probability of reliable identification is only about 20 percent. By the time the change has risen to 10 dB, the probability has risen to about 90 percent.

While sound "memory" related to magnitude alone is very poor, frequency memory is excellent. In fact, it is because of this frequency memory that humans distinguish sounds from different sources from one another. Once we learn the sound of a crying baby, we will likely never mistake it for a saw no matter how long ago we may have heard either sound. Likewise, changes in the frequency component are easily identified even in conditions where there are competing dissimilar sounds. For example, if we are standing next to the freeway, we could still clearly identify the sound of a small aircraft overhead.

The recording of sound is done by electronic instruments which attempt to simulate, to some extent, the data collected by the human ear. Thus, these instruments record the sound magnitude and the frequency pattern. In collecting the frequency data, the limitations of equipment, cost, and physical properties of sound have meant that frequency information is rarely collected by each individual Hertz. Rather the energy is aggregated for groups of frequencies to produce a value representing all energy present between the upper and lower limits of the frequency band. Following musical convention, the breakdown in bands is by octaves or sub-octaves. The most frequently occurring combinations are 1/10, 1/3 and octave bands. The number of bands decreases as one goes from 1/10 to octave band aggregations. However, there is an even further simplification. It has become common to sum the energy present into a single reading. This gives a single number. Most references to community noise are based on this approach. Thus, when someone states the sound level is "x" dB without qualifying it to be in a certain frequency band, it means that the information represents all the sound energy present.

The human ear is more complex than can be simulated by electronic instruments. For one, the ear is not as sensitive to sound energy at all frequencies. There is no hearing ability in most people below 20 Hz or above 16,000 Hz. Most animals fall into this range, although dogs have a higher upper limit. That is why most people cannot hear dog whistles which are around 20,000 Hz. Occasionally, some people can hear a dog whistle which attests to the fact that there are exceptions. Not only does human ear sensitivity vary with frequency, the sensitivity changes with the magnitude of the sound. The higher the sound pressure level, the less difference in sensitivity with frequency. In attempts to simulate the sensitivity of the human ear, electronic filters have been devised which mimic the sensitivity at various states. Over a period of time, one filter type has become the standard in the measurement of community noise. It is called the "A" filter. Measurements made with the use of the "A" filter are called "A" weighted, or the decibel nomenclature is written "dBA".

Sound levels decrease as a function of distance from the source, atmospheric interference, and absorption along the path. As the sound wave spreads out from the source, the concentration of energy along any one path continually lessens unless attempts are made to compensate for the spreading. This is called wave divergence. As the energy travels along a path, atmospheric effects result in absorption of the sound energy and modification of the energy wave. These phenomena are sensitive to temperature, humidity inversion layers, cloud cover, and wind, all of which are not constant in time or over distance. Under about 500 feet from the source, the atmospheric effects are rarely important. Ground cover produces absorption as well and is usually stable. Thus, the various prediction methods for sound variation with distance account for ground absorption when source and listener are both ten feet or less above the ground.

Terrain and man-made structures will also introduce either absorption along a sound path or will deflect the sound wave in part in another direction giving the effect of increased absorption. This latter class of path effects is usually classed as sound barriers.

Finally, there is the question of sound dosage. The amount of sound exposure produces a number of physiological and psychological reactions in humans and animals. For this reason, it has become common to tie the level and duration together in describing sound. This concept is called "dosage" and is quite common in the medical field with other phenomena. Dosage is the amount of a substance received, usually relative to some time interval. A medicine "dosage" is usually so many tablets or spoonfuls per day. A nuclear dosage is so many Roentgens per hour. In sound, it is common to speak of a sound level in a time interval as well. However, a technique of mathematically combining level and time into a single number has been developed. The most common of the methods is to either use the average sound level per unit of time or a term that represents the sum of all energy present over a unit time. The average level over a unit time is called the Equivalent Sound Level for the unit time (Leq). The sum of all energy in a unit time is called the Sound Exposure Level (SEL). Both terms have no fixed time interval, so the time interval must be identified when reporting the number. To complicate matters even further, attempts have been made to devise 24 hour single number versions of the Equivalent Sound Level or Sound Exposure Level that try to include some accommodation for human psychological reaction. These will be discussed further in the next section.

2.2 EFFECTS OF SOUND ON PEOPLE

Once a sound reaches someone, the sound energy is converted into electrical signals by the brain, and the physical process gives way to the complex process of identification, and the even more complex process of acceptance. Sounds which people do not like are generally classified as "noise". There is no precise definition of "noise". Noise is an "unwanted" sound. What makes a sound "unwanted" varies with people's personalities, their state of mind, the timing of the sound, and a myriad other factors. To paraphrase a well known phrase, "Noise is in the ear of the beholder". Even so, attempts have been made to classify characteristics of sound that might be considered "noise".

2.2.1 Hearing Loss

Hearing loss , in general, is not a concern in community noise problems. The potential for sound induced hearing loss is more commonly associated with occupational sound exposure in high sound environments over many years. The Federal Occupational Safety and Health Administration's acceptable limits range from a low of 90 dBA for eight hours day to a one time limit of 115 dBA a day. Moreover, the condition must be considered chronic and not just a passing condition. "Chronic" is usually taken to mean lasting a year or more. Levels exceeding these limits and conditions are considered "unacceptable" to this agency so are classified as "noise". Sound levels in neighborhoods rarely ever reach these combinations of level and duration on a daily basis for any length of time. Hearing loss lends itself to objective study and definition. As a result, a great deal is understood about the mechanism of hearing loss.

2.2.2 SPEECH COMMUNICATION INTERFERENCE

Speech communication interference includes all activities which relate to understanding based on sound. As a point of reference most normal conversation at the listeners ear lies in the 60 to 65 dBA range. Competing sounds begin to reduce the level of intelligibility once they approach the same range, although sometimes the frequency distribution, and not the level, is the more critical factor. At some point which varies with the situation and the people, the competing sound reduces intelligibility so much that the source level must be raised to compensate. At some further point, even this is inadequate, as intelligibility has decreased to the point where understanding is not possible. In this environment at some point, the competing sound is unwanted so becomes it "noise". The degree of interference is related to the frequency of occurrence of the event. However, this relationship is not clear. The practice is to equate the different events by the dosage. As a result, a few short high level events, which cause people to stop speaking, are considered equal to a continuous sound of a lower level but with the same dosage where speaking can continue at elevated levels. While this concept is almost universally accepted in academic and professional fields, it is not accepted well by the average person. In general speech, interference is considered a negative element in the environment, although there are situations where it is welcomed. The assumption in environmental noise is that speech interference is a negative factor. The physical characteristics of speech interference are easily documented and can be objectively defined. Like hearing loss, it has been the subject of long study and experimentation. However, there is no universal agreement on the significance of the data. As a result, the weight of importance given to speech interference in community sound control regulations varies considerably.

2.2.3 SLEEP INTERFERENCE

Sleep interference is one of the major considerations in defining community "noise". Sound level, frequency distribution, duration, repeatable, and variability can make it difficult to fall asleep and may cause momentary shifts in the natural sleep pattern or level of sleep. The subject is only broadly accommodated in community noise considerations. Moreover, the universal assumption is that the problem exists at night which, by definition, occurs between the hours of about 9:00 P.M. and about 8:00 A.M. Thus, intrinsically, a certain proportion of the population is excluded from consideration. Sleep interference has been widely studied, but there is no universal agreement on the interpretation of much of the data. There is sufficient agreement to consider loud sound during sleeping periods as a matter to be addressed in community sound control regulations.

2.2.4 PHYSIOLOGICAL RESPONSES

Physiological responses are usually classed as all other reactions of the human body other that those previously listed. Changes in pulse rate, blood pressure, enzyme production, etc. are measurable parameters that can be charted as a function of various sound parameters. A great deal of literature reports relationships between sound and physical measures. Unfortunately, there is little agreement as to the meaning of the data as to human health, and not many examples of reputable studies. Thus, most of the information has not had any impact on community sound control decisions on any systematic basis. Occasionally, such data is used as the basis of decision by an individual person or agency, but such decisions have had little permanent impact in community sound control regulations.

2.2.5 ANNOYANCE

Annoyance is the most difficult of all noise responses to describe. Annoyance is a very individual characteristic and can vary widely from person-to-person and community-to-community. What one person considers acceptable, another considers intolerable. What one person considers acceptable at one time, may consider it intolerable at another time. The extent of annoyance depends on the characteristic of the sound (i.e. level, duration, frequency components), the degree of activity interference (i.e. speech interference, sleep interference), and the relationship to ambient sounds both in level and time. However, the extent of annoyance is also a function of the attitude of the listener. Factors such as past history, age, relationship to the source, economic status, social status, health status, beliefs, and politics all affect the contemporary attitude. The same factors that affect individual attitudes can be ascribed to groups such as a neighborhood, a city, a region, a state, and a country. The more people within the group, the more the descriptions are framed in statistical terms. Annoyance is a psychological reaction and like much psychological phenomena, does not lend itself to very precise definition. The terminology of annoyance is usually vague and shows a weak relationship to specific sound conditions. For example, studies often refer to a percentage of "highly annoyed", but offer little explanation of the term. The usual definitions of the relationship between sound level and community reaction have no better resolution than about ten decibel units. Thus, if one states that "x" percent of the population will be "highly annoyed" at "y" dB, then, based on accepted studies, the accuracy of the statement is such that the same statement is almost equally valid at "y + 5" and "y - 5" dB depending on the individual group to which it is applied. There is a strong tendency in community noise studies to apply general theorems to specific cases without any study of the relationship between the databases. Some attempts have been made to create adjustment factors based on various community characteristics such as the background sound level, repeatable, seasons, presence of tones, presence of impulses, and previous exposure. Some of the concepts have been adopted into some forms of community noise standards and others have not. The adoption is usually in the form of adjustments to the allowed sound level.

2.2.6 COMMUNITY NOISE STANDARDS

Like most subjects related to human health and behavior, the known information is incomplete. However, out of the that database, for which there is a high level of confidence that such a hearing loss and speech interference occur, and using as much reliable information as has been developed on human behavior as possible, there has developed a general consensus of what levels and elements need to be addressed in community noise regulations and standards. These considerations are:

1. The sound level as expressed in "A" weighted decibels,

2. The duration of the events, or alternately, the number events in a 24 hour period,

3. The frequency of the events or source over a long term period is usually taken as a year.

4. The time of day of the occurrences. The practice is to consider the period 7:00 A.M. to 7:00 A.M. to 7:00 P.M. as the period of lowest sensitivity since most people are at work, and the period 10:00 P.M. to 7:00 A.M. as the period of highest sensitivity since most people are asleep. Some consider the period 7:00 P.M. to 10:00 P.M. as more sensitive than the 7:00 A.M. to 7:00 P.M. period as most people are at home, awake, and listening to television. Others discount this relationship.

There is no universal agreement on accommodating for the presence of tones, impulses, repetitiveness, and other special features of a sound.

Also, there has evolved a theory that adjusts the regulation in relationship to whether or not the jurisdiction has control over the source emission. If the basic sound levels of the sources are set by Federal regulation, then, most jurisdictions consider that local control is limited and set the allowed limits accordingly. If the source can be controlled by the local jurisdiction, then, the regulation becomes more stringent. Thus, it is common to find that a sensitive land use subjected to aircraft (whose source emissions are set by Federal regulation) sound is permitted a higher noise level than one subjected to sound from a local industrial activity. The rationale for this two tier approach is that the local population "expects" more control when the local jurisdiction is permitted to exercise it.

The most common technique used to incorporate all the various considerations is to create a mathematical form that produces a single number into which has been incorporated the considerations of level, frequency distribution, time-of-day, and duration of events (or alternately, number of events). The Federal Government's version of this mathematical form is called the Day-Night Noise Index and abbreviated LDN. Some California jurisdictions use a variant called, the Community Noise Equivalent Level and abbreviated as CNEL. The Day-Night Noise Index is the 24 hour average sound level with penalties applied to sounds between 10:00 P.M. and 7:00 A.M. Any sound within this period is averaged in to the 24 hour total as if it were ten (10) dBA higher than actually exists. The CNEL term differs from the LDN term only in that sounds in the 7:00 P.M. to 10:00 P.M. period are averaged into the 24 hour total as if they were five (5) dBA higher than actually exists. Most of the time the number resulting from the two calculations differs by less than a decibel.

The LDN and CNEL indexes were devised originally as aircraft sound descriptors. They were subsequently adapted to apply to all transportation sources and, later, still to all community sound. The relationship between LDN values and community impact is very broad and best documented for aircraft. For most LDN levels defined as "acceptable", there still exists a fairly significant percentage of the population that considers the conditions "unacceptable". The general practice is to define as "acceptable", LDN values that lie in the 60 to 65 dBA range. "Acceptable" equates to only 15 to 20 percent of the sampled population database as being "highly annoyed". This is considered a reasonable balance between environmental protection and the cost of control.

In community sound regulations modern regulations are framed in one of two ways. They are either structured as land use control measures used in planning applications or structured as Noise Control Ordinances. In this analysis, only the Land Use Compatibility criteria are relevant. Land Use Compatibility criteria are usually written in terms of LDN or CNEL indexes and follow fairly much the standards originally derived for aircraft sources. Rarely is any distinction made between types of noise sources when setting acceptable criteria. Rarely is any accommodation made to special characteristics like presence of tones, or repetitiveness. Although it is not obvious or even widely understood, the land use criteria are motivated and framed on the assumption that sources are transportation noise sources, even though the application is for all sources. As a result, the "acceptable" numbers assume that source control is not feasible and the numbers accommodate for that fact as previously mentioned.

3.0 APPLICABLE NOISE CRITERIA

The following two measures of impact will be considered:

1. The absolute noise level and its relationship to land uses, and
2. The incremental change in noise level.

The Noise Element of the City of San Bernardino stipulates that residential uses are compatible when the noise levels from transportation sources comply with the criteria given in Table 1.

TABLE 1

APPLICABLE NOISE CRITERIA

LOCATION	LEVEL
Exterior	65 dBA CNEL
Interior	45 dBA CNEL

The CNEL term is a 24 hour average noise level with special adjustments for evening and nighttime hours. A more complete explanation is contained in Appendix 1 -- NOISE RATING METHODS.

The General Plan Noise Element contains no guidelines for the meaning of changes in noise level. Therefore, an expanded explanation is in order. The minimum change in level that can be perceived by a human is about 1 dB. This requires a test booth, a single frequency tone, and close spacing in time between the two conditions. A change in any of the three ingredients will increase the change needed to produce reliable identification. Complex noise signals such as roadways, time averaging, and time separation between two distinct states do not affect all people the same way. As a result, perception of change varies such that the practice is to speak of the percentage probability of reliable detection of change. Thus, for a 3 dB change of a complex time varying signal where the two comparative states are separated in time by long periods, the probability of the change being reliably identified is only 30 percent. Or, put another way, only about three (3) people in ten (10) would identify the change. For a ten (10) dB change, the probability of reliable identification is about 95 percent. The practice has grown up to use a three (3) dB change as the threshold of significant impact. While the probability of identification is low, a three (3) dB change represents a doubling of sound energy or traffic volume. In this study, the three (3) dB threshold will be considered to be the onset of significant impact.

One subtlety often overlooked in analyzing the change, is the relationship to the absolute level. If the change produced by the project increases the noise level above the 65 CNEL threshold, then, an impact is judged to exist even if the change itself is less than three (3) dB.

At this stage of the site development, no buildings are plotted in the residential planning areas. Therefore, to assess the on-site impacts, a reference distance of 50 feet from the roadway centerline will be used. Since off-site land uses are not known with any precision this same, the setback will be used to examine impact.

4.0 ENVIRONMENTAL SETTING

The environmental setting is also considered the existing condition before the project is built. Both on-site and off-site conditions are of interest. The off-site conditions are those produced by traffic generated by the project. Thus, the existing off-site analysis focuses on traffic only as this is the only known characteristic of the project that produces off-site affects.

A noise monitor was set up on-site at a location about 50 feet from the existing off-road trail at approximately where Ben Canyon Road intersects Badger Canyon Road as shown on Exhibit 1. There is some small amount of usage of the off-road trail since at the time of the measurement, some sort of activity was being undertaken in Badger Canyon. The 24 hour printout is contained in Appendix 2. A printout of the maximum, minimum, and average noise levels is shown on Exhibit 3. The CNEL value for the sample day was 46 dBA. The plot on Exhibit 3 shows a higher level of noise in the daytime, which is normal. Maximum levels are most likely produced by aircraft over-flights and other events not occurring on the site.

A traffic study, contained in Appendix 3, was done for the project. Since there is no traffic to speak of on the site at present time, the only aspect of interest is off-site traffic. The traffic engineer (J. F. Davidson) did not include 24 hour traffic volumes, but only peak hour volumes. The CNEL calculation is based on a 24 hour period. The peak hour existing movements are given in

Table 2. Only the surface street intersections are listed here since the traffic study did not appear to account for the freeway traffic contributions at the on-ramp at University.

TABLE 2

EXISTING PEAK HOUR TRAFFIC VOLUMES

INTERSECTION	LEG	A.M.	P.M.
Northpark and University	East	1,298	906
	West	1,827	1,341
	South	689	588
	North	434	343
Kendall and University	East	1,237	1,588
	West	1,177	1,410
	South	1,573	1,814
	North	1,419	1,632
Northpark and Little Mountain	East	509	596
	West	596	705
	South	164	234
	North	5	21
Northpark and Mountain	East	512	351
	West	546	363
	South	128	91
	North	16	21

In some cases the A.M. peak hour is larger than the P.M. peak hour and in some cases the reverse is true. The conversion of this data into 24 hour volumes is usually accomplished by assuming that the P.M. peak hour is 10 percent of the 24 hour figure since, as a rule, the P.M. peak hour is the highest of the two peak hour values. Since that is not the case here, the assumption was modified to use the highest of the two figures as the base value. This assures that the estimates will always be the "worst case" condition. As long as the pattern is consistent, no significant error will result in the calculations and estimates of impact. Using the assumption that the 24 hour volume is derived from the higher of the peak hours, the values derived from Table 2 are given in Table 3 on the following page.

TABLE 3

EXISTING 24 HOUR TRAFFIC VOLUMES

INTERSECTION	LEG	ADT
Northpark and University	East	12,980
	West	18,270
	South	6,690
	North	4,340
Kendall and University	East	15,880
	West	14,100
	South	18,140
	North	16,320
Northpark and Little Mountain	East	5,960
	West	7,050
	South	2,340
	North	210
Northpark and Mountain	East	5,120
	West	5,460
	South	1,280
	North	210
Piedmont	-	0
South Access	-	0

The calculation of the CNEL values requires a traffic model allocating the traffic into the three CNEL time periods and accounting for the breakdown of autos and trucks. Usually, any reasonable model is satisfactory as long as it is used in all the calculations. If there is an expectation that changes might occur, then, it becomes more critical to more precisely define the traffic data. The off-site streets appear to have similar characteristics and traffic patterns. Therefore, a single model for the existing case appears appropriate. The model selected is a documented arterial model that is used by the County of Orange. Also, the model is similar to that employed by the County of Riverside. The model is given in Table 4.

TABLE 4

TRAFFIC DISTRIBUTION MODEL

	% DAY	% EVENING	% NIGHT
Auto	75.51	12.57	9.34
Medium Trucks	1.56	09	.19
Heavy Trucks	.64	.02	.08

The noise level calculations for the segments listed in Table are contained in Appendix 2. The results are summarized in Table 5.

TABLE 5

EXISTING CNEL VALUES AT 50 FEET FROM CENTERLINE

INTERSECTION	LEG	CNEL
Northpark and University	East	69.7
	West	71.2
	South	66.8
	North	64.9
Kendall and University	East	70.6
	West	70.0
	South	71.1
	North	70.7
Northpark and Little Mountain	East	66.3
	West	67.0
	South	62.2
	North	51.8
Northpark and Mountain	East	65.4
	West	65.9
	South	59.6
	North	51.8
Piedmont	-	46.0 (1)
South Access	-	46.0 (1)

(1) No traffic volumes apply so the measured value used here.

Twelve of the 18 segments exceed 65 CNEL at the present time. Of course, each segment really represents just the location adjacent to the intersection the way the traffic data was presented. The situation may vary between intersections. For example, traveling east on Northpark, just east of University, the value is 69.7 dBA CNEL. On the west side of Little Mountain, it has dropped to 67.0 dBA CNEL. Crossing over to the east side of Little Mountain, it drops again to 66. Moving along to the west side of Mountain, it drops to 65.9 dBA CNEL and, then, drops again slightly on the east side of Mountain. Thus, from just west of Little Mountain to just east of Mountain, the level is fairly constant. The greatest change occurs between University and Little Mountain. On University, a significant change occurs between Northpark and Kendall where the value goes from 66.8 to 70.7 dBA CNEL.

Residential units adjacent to Northpark and University may exceed the General Plan Compatibility Criteria of 65 CNEL. It depends on whether sound walls exist alongside the roadways.

4.0 PROJECT IMPACTS

The present access plan is noted on Exhibit 4. The total number of trips was specified at 4,671 for a 24 hour period. The A.M. peak is 352, or 7.5 percent ADT. The P.M. peak is 497, or 10.5 percent ADT. Thus, the ten percent (10%) ADT assumption for the existing traffic of the peak appears quite reasonable.

It appears from the traffic data that the Piedmont access carries 45 percent of site traffic daily, and the south access (un-named) access carries 55 percent. The A.M. and P.M. traffic does not necessarily follow this split. The traffic study, when written, posed two alternatives for the south exit, called Alternative 1 and 2. It appears that the decision has been to select a south access that is close to Alternative 1. Thus, only the data for Alternative 1 will be considered in the analysis.

There are three pieces of data that comprise the project set. They are the project volumes, the 1995 "no project" background volumes, and the 1995 "cumulative" volumes. The latter is tne "no project" and "project" 1995 values together. The project generated off-site volumes are given in Table 6 on the following page.

TABLE 6

PROJECT PEAK HOUR OFF SITE TRAFFIC VOLUMES

INTERSECTION	LEG	A.M.	P.M.
Northpark and University	East	104	149
	West	168	224
	South	274	373
	North	3	0
Kendall and University	East	18	1
	West	18	25
	South	230	324
	North	766	375
Northpark and Little Mountain	East	17	26
	West	104	150
	South	70	100
	North	193	274
Northpark and Mountain	East	18	24
	West	18	24
	South	0	0
	North	11	0

The 1995 background values are given in Table 7 on the following page.

TABLE 7

1995 PEAK HOUR OFF-SITE BACKGROUND TRAFFIC VOLUMES
FOR THE ALTERNATIVE 1 SOUTH ACCESS OPTION

INTERSECTION	LEG	A.M.	P.M.
Northpark and University	East	2,000	1,631
	West	2,332	1,711
	South	1,222	1,225
	North	525	437
Kendall and University	East	1,580	2,026
	West	1,529	1,836
	South	2,324	2,752
	North	2,153	2,556
Northpark and Little Mountain	East	1,045	1,308
	West	1,103	1,374
	South	261	372
	North	27	6
Northpark and Mountain	East	889	768
	West	1,033	940
	South	361	398
	North	71	80

The off-site cumulative traffic values (Background + Project) are given in Table 8 on the following page.

TABLE 8

1995 PEAK HOUR OFF-SITE CUMULATIVE TRAFFIC VOLUMES
FOR THE ALTERNATIVE 1 SOUTH ACCESS OPTION

INTERSECTION	LEG	A.M.	P.M.
Northpark and University	East	2,104	1,780
	West	2,500	1,935
	South	1,496	1,598
	North	528	437
Kendall and University	East	1,598	2,052
	West	1,547	1,861
	South	2,554	3,076
	North	2,919	2,931
Northpark and Little Mountain	East	1,062	1,334
	West	1,207	1,524
	South	331	472
	North	220	280
Northpark and Mountain	East	907	792
	West	1,051	964
	South	361	398
	North	67	80

The same rationale will be used for the background and project as was used for the existing case to generate 24 hour numbers. Additionally, Piedmont and the South access will be added on the basis of the split of 45 percent/55 percent of the total number of project generated trips. The background values are given in Table 9, and the Alternative 1 project plus background (cumulative) figures are given in Table 10 (following pages).

TABLE 9

BACKGROUND OFF-SITE 24 HOUR TRAFFIC VOLUMES

INTERSECTION	LEG	ADT
Northpark and University	East	20,000
	West	23,320
	South	12,250
	North	5,250
Kendall and University	East	20,260
	West	18,136
	South	27,520
	North	25,560
Northpark and Little Mountain	East	13,080
	West	13,740
	South	3,720
	North	270
Northpark and Mountain	East	8,890
	West	10,033
	South	3,980
	North	800
Piedmont	-	(1)
South Access	-	(1)

(1) These roads are not in use without the project.

TABLE 10

ALTERNATE 1 OFF-SITE 24 HOUR TRAFFIC VOLUMES

INTERSECTION	LEG	ADT
Northpark and University	East	21,104
	West	25,000
	South	15,980
	North	5,280
Kendall and University	East	20,520
	West	18,610
	South	30,760
	North	29,310
Northpark and Little Mountain	East	13,340
	West	15,240
	South	4,720
	North	2,800
Northpark and Mountain	East	9,070
	West	10,510
	South	3,980
	North	800
Piedmont	-	2,101
South Access	-	2,569

The calculations for CNEL values are contained in Appendix 5 for the Background, and Appendix 6 for the Project. The values at 50 feet from the centerline are given in Tables 11 and 12 on the following pages.

TABLE 11

BACKGROUND OFF SITE CNEL VALUES AT
50 FEET FROM CENTERLINE

INTERSECTION	LEG	CNEL
Northpark and University	East	71.6
	West	72.2
	South	69.4
	North	65.7
Kendall and University	East	71.6
	West	71.1
	South	72.9
	North	72.6
Northpark and Little Mountain	East	69.7
	West	69.9
	South	64.3
	North	52.9
Northpark and Mountain	East	68.0
	West	68.6
	South	64.5
	North	57.6
Piedmont	-	46.0 (1)
South Access	-	46.0 (1)

(1) The CNEL is taken to be the same as the existing on-site value which is also for an undeveloped area in the vicinity because these roads are not in use without the project. The value is 46 CNEL.

TABLE 12

PROJECT OFF SITE CNEL VALUES AT 50 FEET FROM CENTERLINE

INTERSECTION	LEG	CNEL
Northpark and University	East	71.8
	West	72.5
	South	70.6
	North	65.8
Kendall and University	East	71.7
	West	71.2
	South	73.4
	North	73.2
Northpark and Little Mountain	East	69.8
	West	70.4
	South	65.3
	North	63.0
Northpark and Mountain	East	68.3
	West	68.8
	South	64.5
	North	57.8
Piedmont	-	61.8
South Access	-	62.6

By 1995, which is called the Background year, traffic will have increased over the existing situation. Thirteen of the 18 segments will exceed 65 CNEL. This is an increase of one segment from the existing situation.

The project listing in Table 12 indicates that thirteen of the 18 segments exceed 65 CNEL. This is exactly the same number as "without" the project (Background). It may be concluded that the project does not cause any new segments to be impacted over what occurs without the project. In fact, most of the segments impacted in 1991 are also impacted in 1995, regardless of whether the project is constructed. However the north leg of the Northpark and Little Mountain intersection and the south access road are of special interest. These segments may extend past and near some Residential Land Use on the San Bernardino State Campus depending on the final alignment. While no impact will occur in the sense, the levels will be less than 65 CNEL, traffic noise will be introduced into an area of the campus which is not currently exposed.

The changes in the CNEL values are depicted in two Tables. The changes that occur from the present to 1995, "without" the project are given in Table 13. This changes occur as a result of areawide development. The project plays no part in what happens. The situation in 1995, "with" and "without" the project. is shown in Table 14 (following page). In this comparison, the incremental change of the project is identified.

TABLE 13

COMPARISON OF EXISTING TO 1995 NO PROJECT

OFF-SITE CNEL VALUES AT 50 FEET FROM CENTERLINE (1)

INTERSECTION	LEG	CHANGE (2)
Northpark and University	East	1.9
	West	1.0
	South	2.6
	North	0.8
Kendall and University	East	1.0
	West	1.1
	South	1.8
	North	1.9
Northpark and Little Mountain	East	3.4
	West	2.9
	South	2.1
	North	1.1
Northpark and Mountain	East	2.6
	West	2.7
	South	4.9
	North	5.8
Piedmont	-	0.0
South Access	-	0.0

(1) No Project values are the Background values

(2) Change is No Project - Existing. All values shown are positive, namely, No Project larger than Existing.

TABLE 14

COMPARISON OF PROJECT TO "NO PROJECT" OFF-SITE CNEL VALUES AT 50 FEET FROM CENTERLINE(1)

INTERSECTION	LEG	CHANGE
Northpark and University	East	0.2
	West	0.3
	South	1.3
	North	0.1
Kendall and University	East	0.1
	West	0.1
	South	0.5
	North	0.6
Northpark and Little Mountain	East	0.1
	West	0.5
	South	1.0
	North	10.1
Northpark and Mountain	East	0.3
	West	0.2
	South	0.0
	North	0.2
Piedmont	-	15.8
South Access	-	16.6

(1) No Project values are Background values

(2) Change is "Project" - "No Project". All values shown are positive, namely, Project larger than Existing.

The definition of a significant change is one that is 3.0 dBA or higher. From the present to 1995, "without" the project, three (3) segments will experience changes exceeding 3 dBA, five (5) segments will experience 2 to 2.9 dBA changes, seven (7) will experience 1.0 to 1.9 dBA changes, and three (3) segments will change by less than 0.9 dBA. By 1995, then, only a three (3) segments will experience significant changes, although another seven (7) appear very close. In general, about half of the segments will experience changes that may be noticeable.

When the project is built, the situation changes somewhat relative to the "no project" case in 1995. Three (3) segments exceed 3 dBA change, and by a considerable amount (10.1 to 16.6 dBA) compared to the "no project" situation. Of the remaining 15 segments, 13 experience changes less than 1 dBA, and two (2) experience changes between 1 and 2 dBA. The 15 remaining segments are the segments which have developed roadways. In effect, the project has no significant impact in 1995 on any existing roadway segment compared to the situation that will exist in 1995 "without" the project.

The three segments showing significant increases are those segments which do not exist at the present time and are especially constructed for access to the project. Piedmont will pass within 500 feet of planned dormitories on the university campus. The Little Mountain extension will pass within 2,000 feet of existing dormitories on the university campus and 100 feet of Tract 10352. Assuming that the project figures are the only users of these roadways, then, the levels reported in Table 12 are accurate references for the noise levels at these residential uses. The noise levels at each location are given in Table 15.

TABLE 15

POTENTIAL CNEL LEVELS AT OFF-SITE RESIDENTIAL LOCATIONS IN THE VICINITY OF NEW ROADS

ROADWAY	LEVEL AT RESIDENCES
Piedmont	51.8 at dorms
Little Mountain Extension	46.5 at dorms 59.8 at T 10352

The conclusions about the impact of Piedmont and the South Access presume that these roadways are constructed with the project and that the project is really the first development that uses the roadways. This assumption implies that no new development occurs near these rights-of-way between now and 1995. As a result, in all instances, the absolute values as shown in Table 15 are well below the criteria of 65 CNEL.

The impact of the change in the level depends on the timing of the residential development on Tract 10352 and the new dorms in relation to roadway construction and project construction. If the off-site residential developments occur ahead of the project development, then, the increases listed in Table 14 will affect the off-site developments. Thus, while absolute noise levels will be less than allowed, the change in the level will be very significant. If the project is developed before the off-site residential uses are installed, then, there is no experience of the change that will have taken place. Therefore, there is no impact.

Another aspect of the project development is the effect the traffic noise has on the project itself. The traffic engineer did not provide an on-site traffic analysis. However, with only two access points to the tract, the "worst case" that ever occurs is defined at the access points assuming no area traffic uses the roadways within the project boundaries. The highest value occurs where the south access crosses the project boundary. The level at 50 feet from centerline is 62.6 CNEL. This is less than the allowed 65 CNEL. There would be no impact on the project housing.

5.0 CONSTRUCTION NOISE

The project will produce construction noise. However, the actual construction on the site is so far removed from any existing sensitive land use, no significant impacts are going to occur. The construction of the access roads may place construction equipment in the vicinity of sensitive land uses depending on the phasing of the project in relation to the construction of proposed dorms on the university campus and housing in Tract 10352. Also, grading on-site may result in the importation or exportation of fill which translates to heavy truck traffic on some segments. No estimate for this traffic was provided. Should it occur, impacts could be severe since grading construction often begins around 6:00 A.M.

6.0 MITIGATION

The project traffic has three characteristics:

1. There will be an increase in the noise levels on the existing roadways, but it will be an insignificant amount.

2. The project does not cause any existing segment to exceed 65 CNEL compared to the condition in 1995 "without" the project.

3. The new access roads will not cause the noise levels to exceed 65 CNEL on any adjacent residential area.

4. The new access roads will increase the noise levels by a significant amount in the adjacent residential areas where such areas exist prior to the use of the roadways.

Since the project does not create any new conditions exceeding 65 CNEL, no mitigation is required.

Construction impacts were not identified off-site with clarity due to the lack of operational data. There is the potential that restricting the start-up time on-site and off-site could be needed.

7.0 UNAVOIDABLE ADVERSE IMPACTS

There is a potential for a significant increase in the ambient noise levels on the university campus and in Tract 10352.

EXHIBIT 1
SITE LOCATION MAP

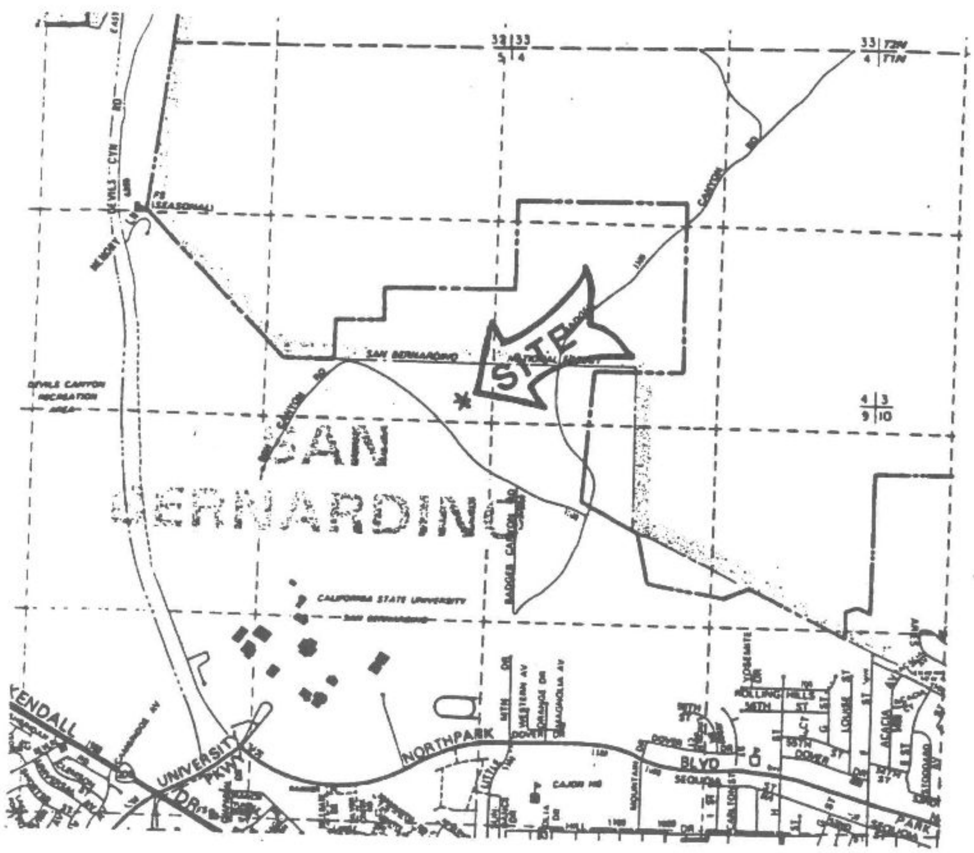


EXHIBIT 2
AREA MAP

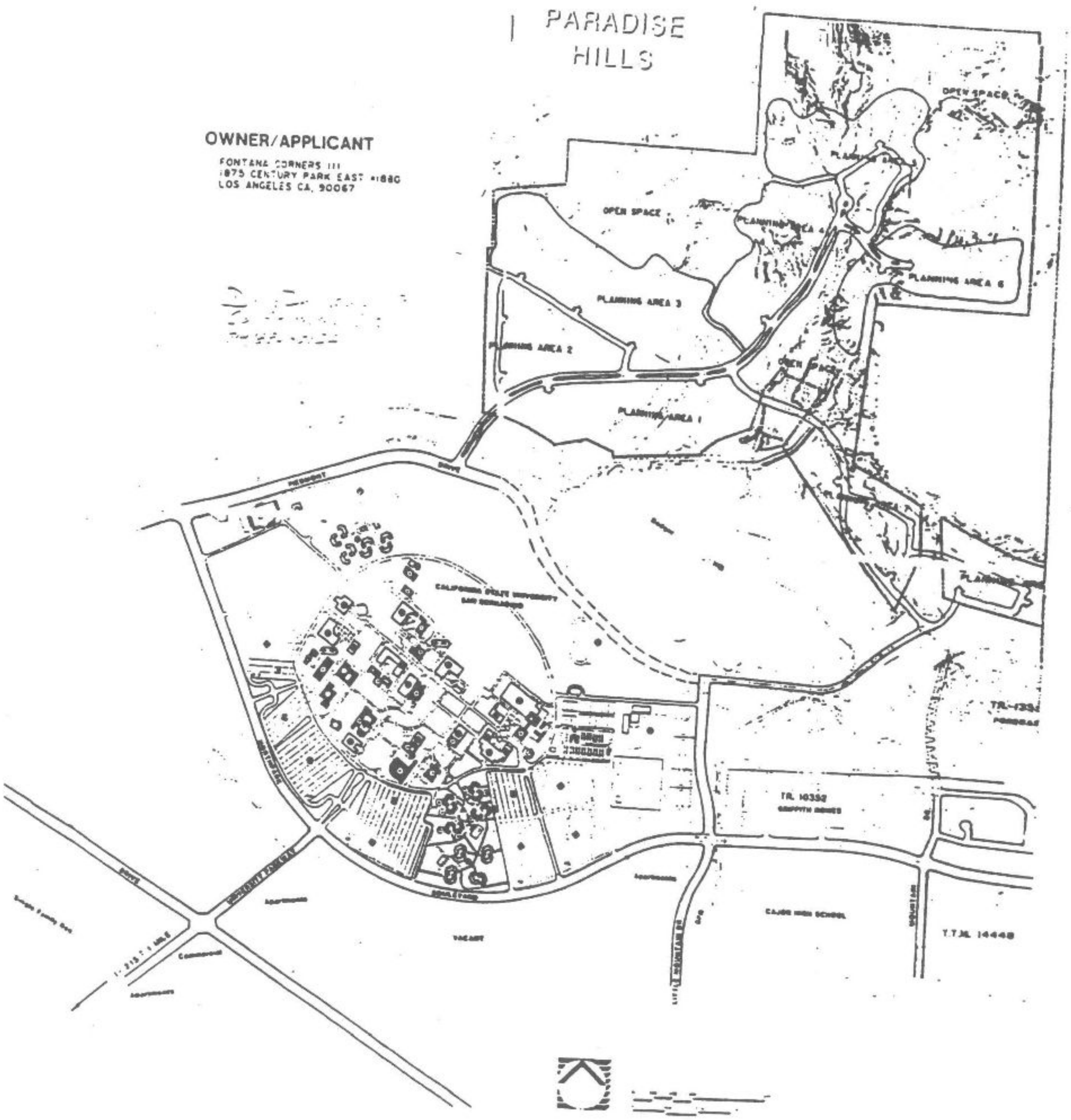
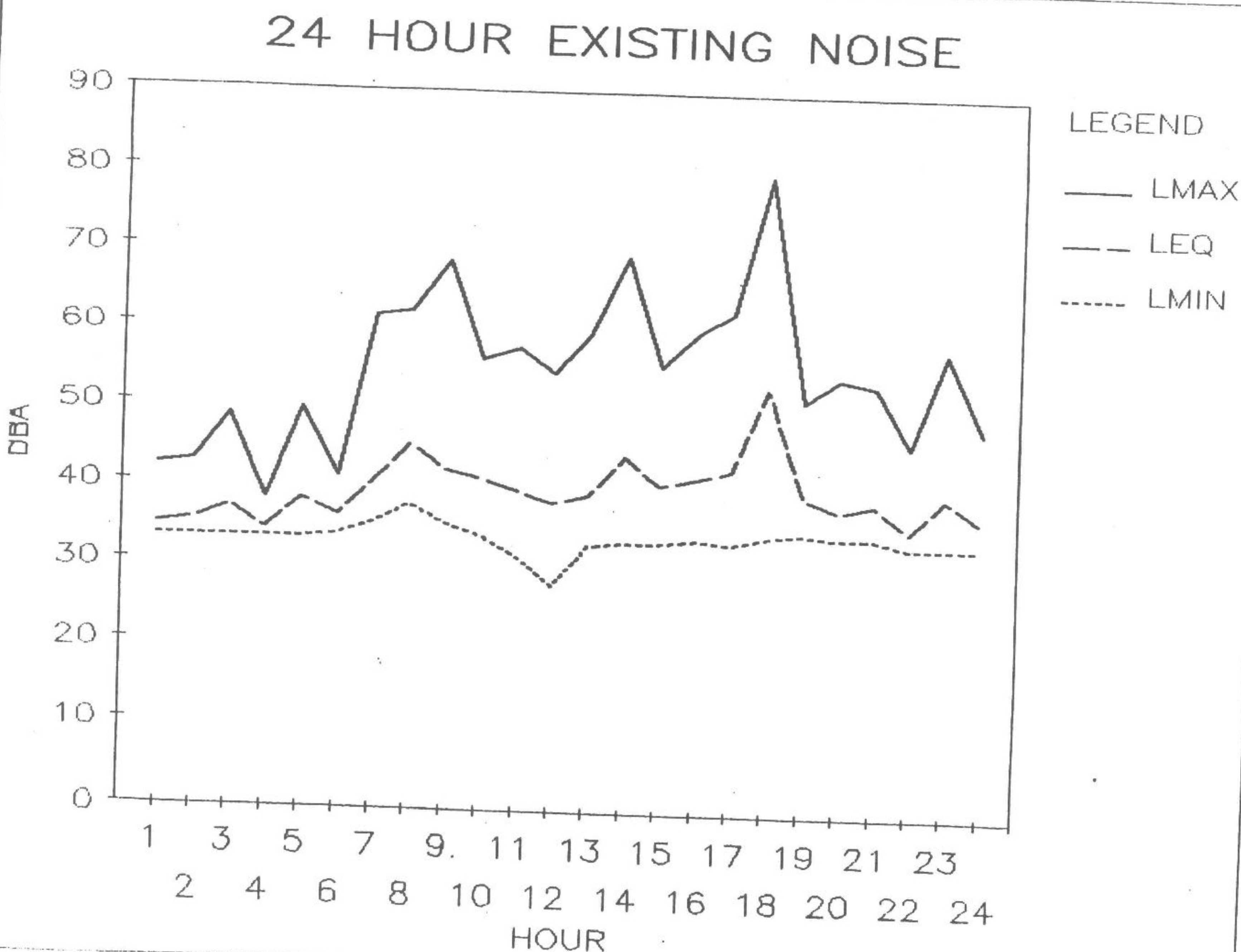


EXHIBIT 3


24 HOUR EXISTING NOISE
DBA
0
10
20
30
40
50
60
70
80
90
HOUR
1
2
3
4
5
6
7
8
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23
24
LEGEND
LMAX
LEQ
LMIN

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A P P E N D I X 1

NOISE RATING METHODS

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NOISE RATING METHODS

The A-weighted decibel of "A" scale on the sound level meter is often used in the measurement of noise because the weighting characteristics of this scale approximate the subjective response of the human ear to a broad frequency band noise source by discriminating against the very low and the very high frequencies of the audible spectrum.

Since community noise is seldom constant, varying from moment to moment and throughout the day, the "A" weighted noise level needs to be further described to provide meaningful data. The Environmental Protection Agency, Federal Department of Transportation, foreign countries and private consultants are now using three time-exceeded percentile figures to describe noise, which are:

(1) L_{90} is the noise level which is exceeded 90% of any sample time period (such as 24 hours) and is used to describe the background or ambient noise level.

(2) L_{50} is the noise level which is exceeded 50% of the time. It is the median level.

(3) L_{10} is the noise level which is exceeded 10% of the time and is a good descriptor of fluctuating noise sources, such as vehicular traffic. It indicates the near-maximum levels which occur from grouped single events. Being related to the subjective annoyance to community noise, it is a good design tool

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in the planning of acoustical barriers.

More recent noise assessment methods are based on the equivalent energy concept where $L_{eq(x)}$ represents the average energy content of a fluctuating noise source over a sample period.

The subscript (x) represents the period in which the energy is computed and measured. Current practice references the quantity to either one (1) hour, eight (8) hours, or twenty-four (24) hours. When referenced to one (1) hour, L_{eq} is also sometimes called HNL (Hourly Noise Level).

Since L_{eq} is the summation of the functional products of noise level and duration, many combinations of noise level, duration time and time history can make up the same L_{eq} value. Thus, an $L_{eq(24)}$ equals 50 means only that the average noise level is 50 dB. During the 24-hour period there can be times when the noise level is higher than 50 dB, and times when it is lower.

If the period of the measurement is only a single event, the energy content is not averaged. The energy expression for a single event is simply the sum of the functional product of the noise level and duration time of the event. This term is called L_e or SENEL (Single Event Noise Exposure Level). The summation of L_e values averaged over one hour is $L_{eq(1)}$, $L_{eq(8)}$, and $L_{eq(24)}$, etc.

L_{eq} is further refined into L_{dn} (Level Day-Night) and CNEL (Community Noise Equivalent Level), where noises that occur during certain hours of the day are weighted (or penalized) because they are considered subjectively more annoying during these time periods:

(1) L_{dn} is the sound level in dBA which corresponds to the average energy content of the noise being measured over a 24-hour period including a 10 dBA weighting penalty for sound levels which occur during the nighttime hours of 10:00 P.M. to 7:00 A.M. This is a rating method recommended by the Environmental

Protection Agency because it takes into account those subjectively more annoying noise events which occur during the sleeping hours.

(2) CNEL is the sound level in dBA which corresponds to the average energy content of the noise being measured over a 24-hour period including a five (5) dBA penalty for noise which occurs during the evening hours of 7:00 P.M. to 10:00 P.M., and a ten (10) dBA weighting penalty for noise that occurs during the night-time hours of 10:00 P.M. to 7:00 A.M. For typical highway vehicular traffic situations, computer analysis has shown that CNEL and L_{dn} correlate within 0.5 dBA.

The percentile figures L_{10}, L_{50}, and L_{90} can be directly scaled from a graphical recording of the measured noise over a particular time period. They are also convenient to implement in automatic measurement equipment. Energy parameters L_e, L_{eq}, L_{dn}, and CNEL require expensive and complicated equipment. As a result, engineers have devised ways of estimating L_{eq} (and hence, L_{dn}) using standard instrumentation and methods.

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APPENDIX 2

24 HOUR PRINTOUT

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DATA REPORT

LARSON-DAVIS LABS -- MODEL 700
10/11/90 16:05:36 SN 700B0842 PAGE 1

Dose	0.0
Proj	0.0
SEL	92.9
LVL	42.9
Time	0028:01:51
Lmin	27.5
Lmax	50.0
Lpk	112.0
OVLD	00
RMS Ex	0000
Pk Ex	0000
R/S	01
Memory	5170.0
L02	46.0
L08	43.0
L25	38.5
L50	36.0

SETUP DATA

****

Detc SLOW
Wght A
Pk Unwgt =0

Crit 90.0
Thld 32.0
Exch 3
LDL =0

RMS Thld 115.0
Pk Thld 140.0
Hyst 0

Run date 10/10
Stop date 00/00
Run time 1 11:00
Stop time 1 99:00
Run time 2 99:00
Stop time 2 99:00

Excd =0

Intv =1
Time 01:00
Auto-Stop =0
Ln =1

Hist =0
Save Pk =0
Per 60.0

Cal 27.5
Ver 1.410

INTV REPORT

LARSON-DAVIS LABS -- MODEL 700
10/11/90 16:05:37 SN 700B0842 PAGE 2

	Cnt	LVL	SEL	Lmax	Lpk	Lmin	Date	Time	Dur	Ex	Pk	Ov	L02	L08	L25	L50
	1	36.0	73.5	54.5	69.5	37.5	10 OCT	11:00:01	1:00 h:m	0	0	0	47.0	41.0	36.0	34.0
	2	39.0	74.5	59.5	70.5	32.5	10 OCT	12:00:01	1:00 h:m	0	0	0	45.5	41.5	36.5	34.5
	3	44.0	79.5	69.5	84.5	33.0	10 OCT	13:00:01	1:00 h:m	0	0	0	48.0	42.5	38.5	35.0
	4	40.5	76.0	55.5	73.5	33.0	10 OCT	14:00:01	1:00 h:m	0	0	0	49.0	45.0	39.5	36.0
	5	41.5	77.0	60.0	70.0	33.5	10 OCT	15:00:01	1:00 h:m	0	0	0	49.0	45.0	40.5	37.0
44.8	6	42.5	78.0	62.5	80.0	33.0	10 OCT	16:00:01	1:00 h:m	0	0	0	50.0	46.0	41.5	37.5
	7	53.0	88.5	80.0	112.0	34.0	10 OCT	17:00:01	1:00 h:m	0	0	0	60.0	49.5	45.0	40.0
	8	39.5	75.0	51.5	68.5	34.5	10 OCT	18:00:01	1:00 h:m	0	0	0	46.5	43.0	39.5	38.0
>	9	37.5	73.0	54.5	66.5	34.0	10 OCT	19:00:01	1:00 h:m	0	0	0	42.5	38.5	37.0	36.0
37.2	10	38.5	74.5	53.5	69.5	34.0	10 OCT	20:00:01	1:00 h:m	0	0	0	46.0	41.0	38.0	36.5
>	11	35.0	71.0	46.0	72.5	33.0	10 OCT	21:00:01	1:00 h:m	0	0	0	39.5	37.0	35.5	34.5
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37.3	17	34.0	69.5	38.0	61.5	33.0	11 OCT	3:00:01	1:00 h:m	0	0	0	36.0	35.0	34.0	33.5
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	22	42.0	77.5	68.5	82.0	35.0	11 OCT	8:00:01	1:00 h:m	0	0	0	46.0	43.5	39.5	38.0
	23	41.0	76.5	56.0	68.5	33.5	11 OCT	9:00:01	1:00 h:m	0	0	0	48.5	45.5	40.5	37.0
	24	39.5	75.0	57.5	68.0	31.0	11 OCT	10:00:01	1:00 h:m	0	0	0	48.5	42.5	38.0	35.5

CNEL = 45.7

A P P E N D I X 3

TRAFFIC MAPS

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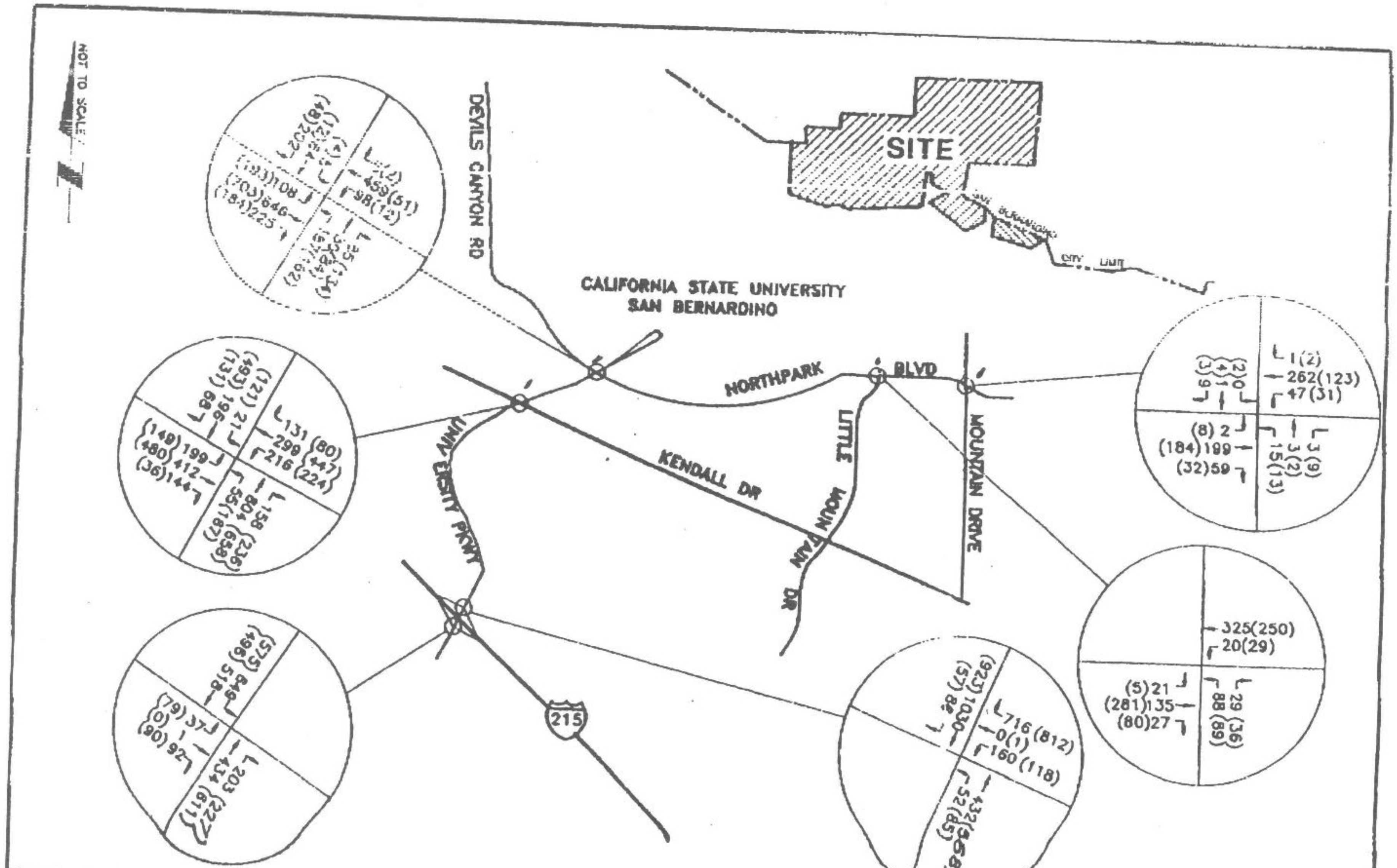


NOT TO SCALE

LEGEND

XXX (YYY)
AM PEAK PM PEAK

FIGURE 3
EXISTING TRAFFIC VOLUMES

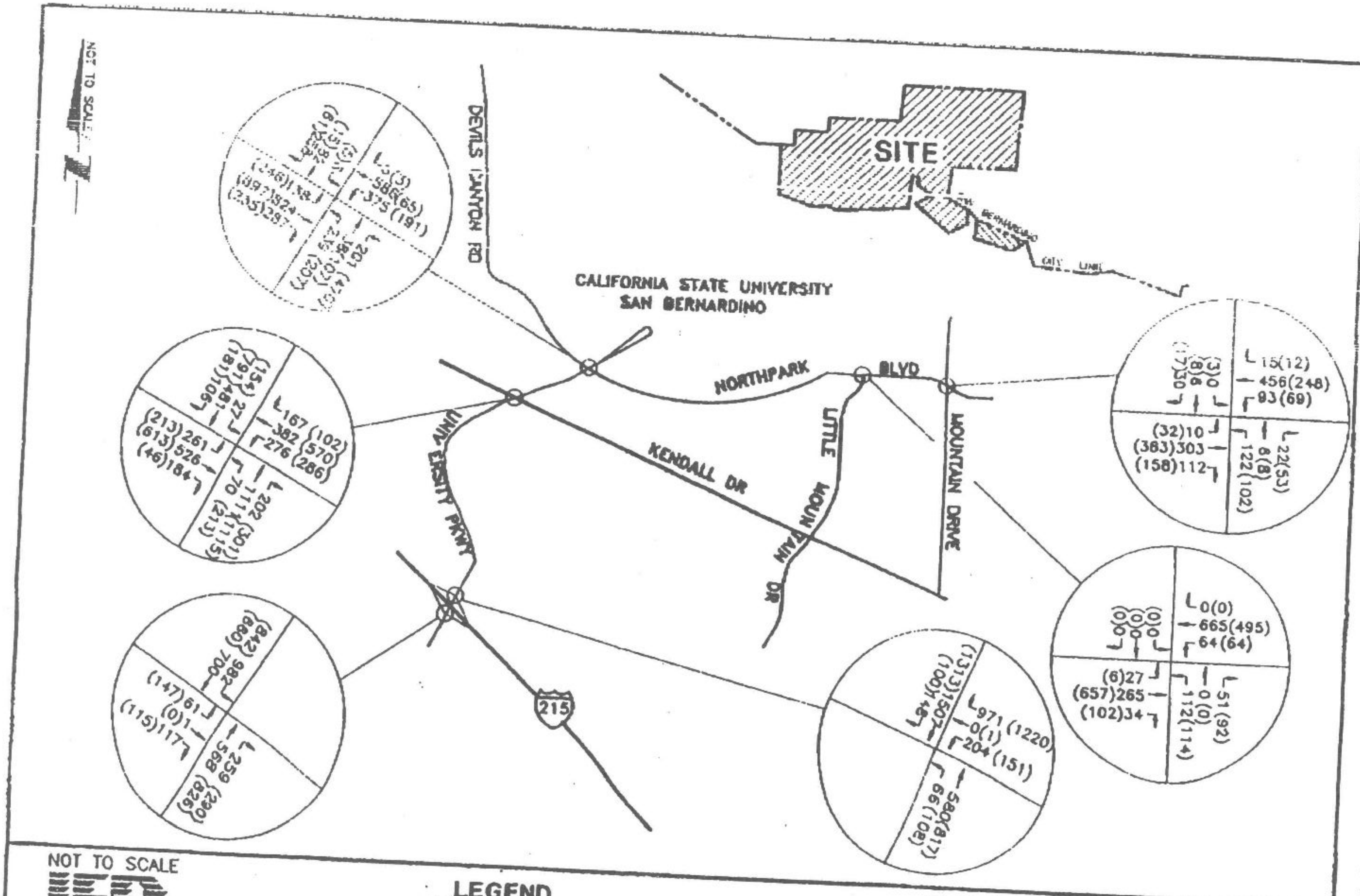
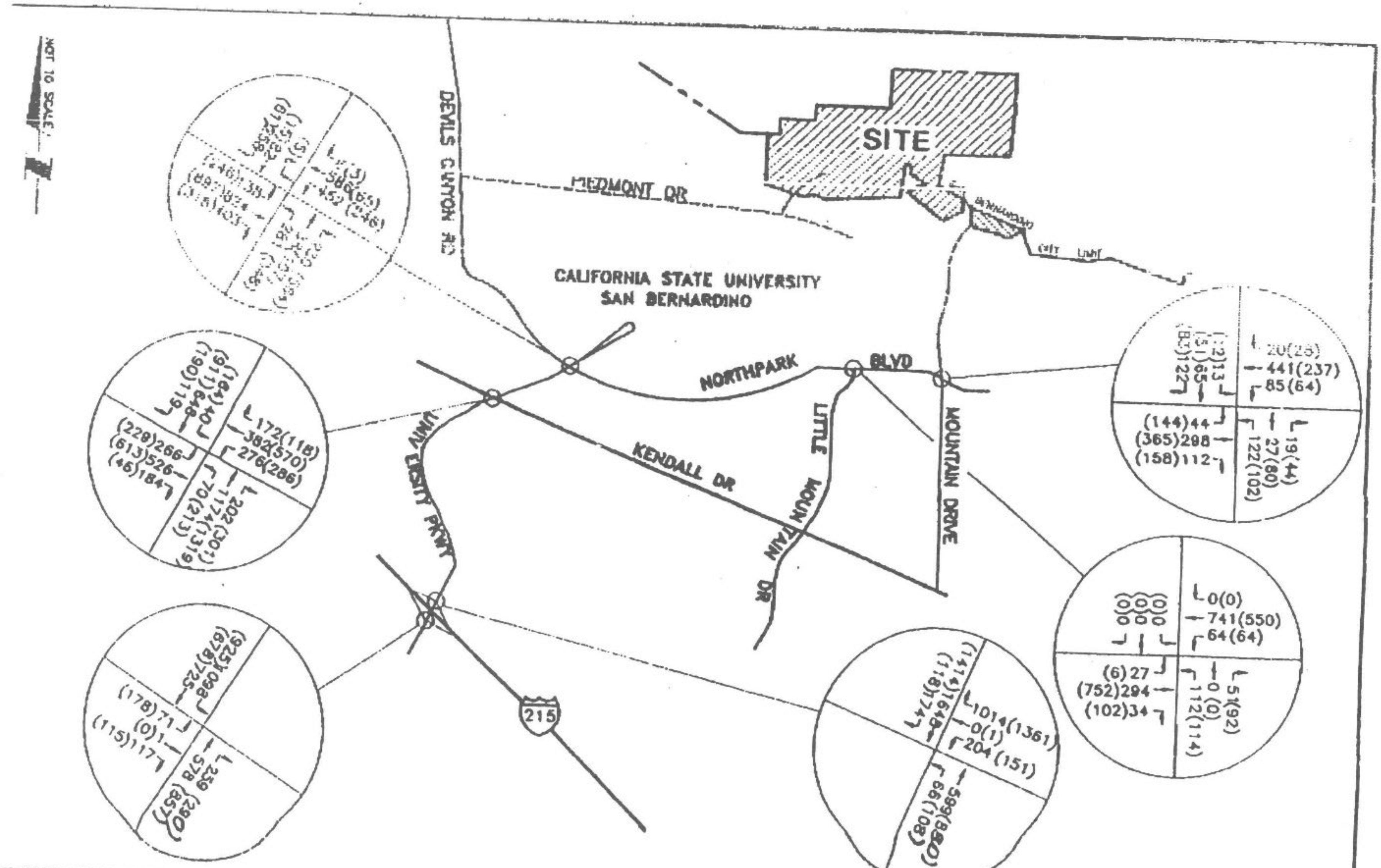


FIGURE 4
1995 BACKGROUND TRAFFIC VOLUMES



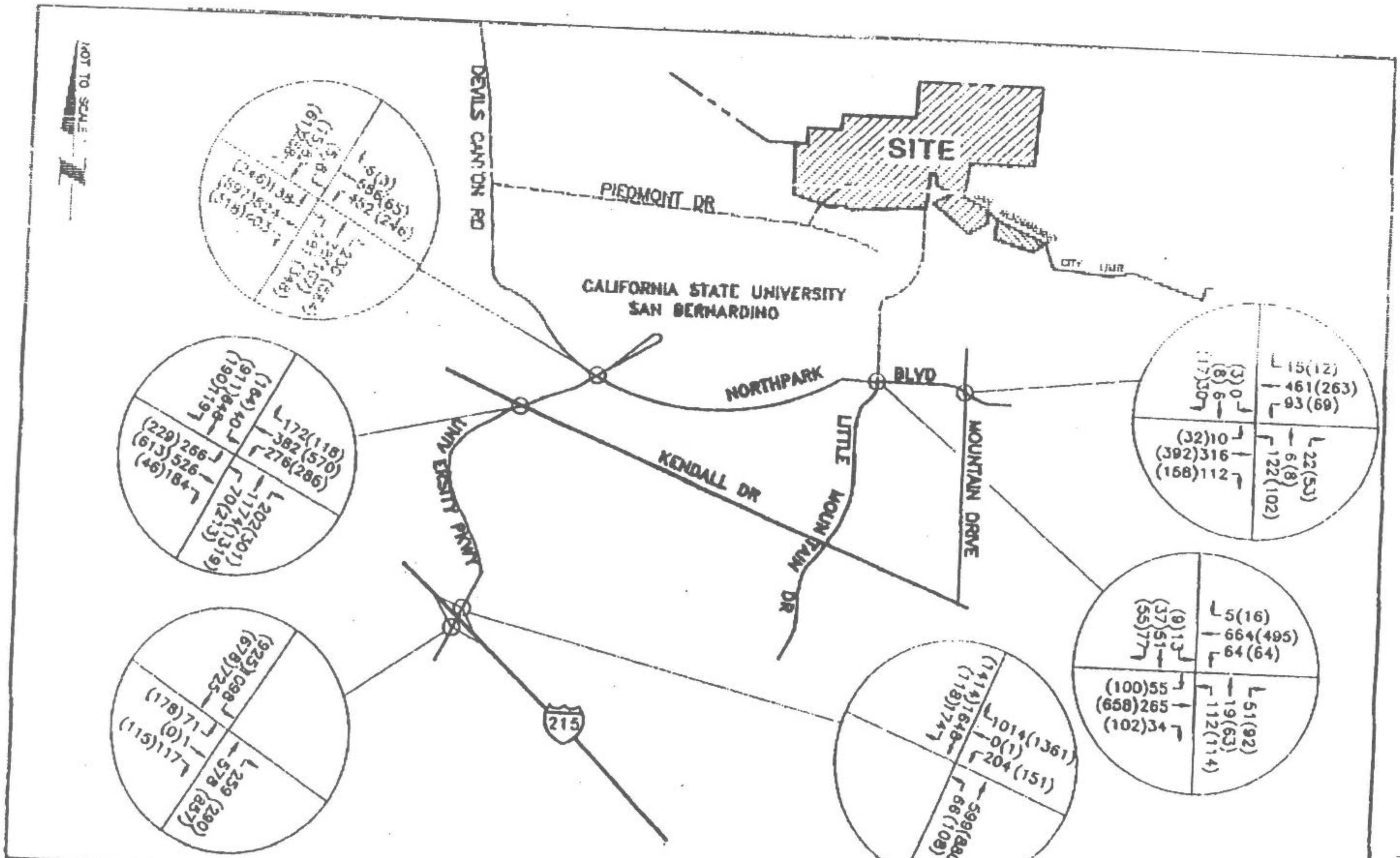
NOT TO SCALE

IFD

LEGEND

XXX AM PEAK (XXX) PM PEAK

FIGURE 10
1995 CUMULATIVE TRAFFIC VOLUMES (ALT 2)



NOT TO SCALE

LEGEND

XXX AM PEAK (YYY) PM PEAK

FIGURE 9
1995 CUMULATIVE TRAFFIC VOLUMES (ALT 1)

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APPENDIX 4

EXISTING TRAFFIC CALCULATIONS

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FHWA RD-77-108 HIGHWAY NOISE PREDICTION MODEL

PROJECT NAME	:PARADISE HILLS
SITE LOCATION	:SAN BERNARDINO
DESCRIPTION	:NORTHPARK AND MOUNTAIN/EXISTING/NORTH LEG
SITE TYPE	:HARD

INPUT DATA

	AUTO	MEDIUM TRUCK	HEAVY TRUCK
SPEED	45	45	45
% DAY	75.51	1.56	.64
% EVENING	12.57	0.09	0.02
% NIGHT	9.34	.19	.08
% VOLUME	100	100	100
VOLUME 210			

----AVERAGE HOURLY NOISE LEVELS AT 50 FEET----

	DAY	EVENING	NIGHT	24 HOUR	CNEL
AUTO	48.90	47.13	41.07	47.00	50.26
MEDIUM TRK.	42.28	35.91	34.38	39.98	43.05
HEAVY TRK.	43.07	34.04	35.29	40.69	43.76
TOTAL	50.60	47.64	42.77	48.56	51.76

NOISE LEVEL AT SPECIFIED DISTANCES

DISTANCE	CNEL
50	51.76
75	50.00
100	48.75
125	47.79
150	46.99
175	46.32
200	45.74
225	45.23
250	44.78
275	44.36
300	43.98
325	43.64
350	43.31
375	43.01
400	42.73
450	42.22
500	41.76
550	41.35
600	40.97
650	40.63
700	40.30
750	40.00
800	39.72