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[Project Title] ***NSR***

[*Graphic*]

Noise Study Report

[Project Name]

[General location information]

[District]-[County code]-[Route]-[PM]

[EA or Federal-Aid Project Number]

February 2008

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For individuals with sensory disabilities, this document is available in Braille, large print, on audiocassette, or computer disk. To obtain a copy in one of these alternate formats, please call or write to Caltrans, Attn: [*senior planner's name*], [*branch*], [*mailing address*]; [*senior planner's phone number*] Voice, or use the California Relay Service TTY number, [*insert district TTY number*].

Standards used in this template:

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All new Noise Study Report (NSR) documents prepared for projects on the State Highway System or for Local Assistance projects will be prepared by an Associate Environmental Planner or Transportation Engineer and reviewed and approved by a Senior Environmental Planner or Transportation Engineer.

The style used in this annotated outline is modified from that described in **Style Guide for Environmental Documents,** April 2002 version PDF file (7.3 MB), or later updates. That style guide contains the style definitions and guidance relevant to the EIR/EIS, but not necessarily appropriate for technical documents such as the NSR. Where conflicts are identified, use the format and guidance in this outline as primary guidance, together with the **Scientific Style and Format: The CBE Manual for Authors, Editors, and Publishers, 6th Ed.**

Chapter 12 of the Standard Environmental Reference (SER) (http://www.dot.ca.gov/ser/vol1/sec3/physical/ch12noise/chap12noise.htm) provides content guidance relevant to this document.

Jim Andrews, Senior Transportation Engineer at Caltrans Division of Environmental Analysis, developed this template. Questions and comments regarding this template should be forwarded to Jim Andrews, Caltrans Division of Environmental Analysis, (916) 653-9554.

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Noise Study Report

[Project Title]

[General location information]

[District]-[County code]-[Route]-[PM]

[EA or Federal-Aid Project Number]

[Month Year]

Prepared By: ______________________________ Date: ____________________

Author's Name, Title

Phone Number ______________________________

Office Name ______________________________

District/Region ______________________________

Approved By: ______________________________ Date: ____________________

Supervisor's Name, Title

Phone Number ______________________________

Office Name ______________________________

District/Region ______________________________

For Local Assistance NSRs, the "Prepared By" line should be signed by the person who prepared the NSR. The "Approved By" line should be signed by the Caltrans environmental planner or transportation engineer who approved the report.

NSRs are prepared for Type I projects, as defined by Title 23 Part 772 of the Code of Federal Regulations (23 CFR 772). The Caltrans Noise Analysis Protocol (Protocol) (http://www.dot.ca.gov/hq/env/) (Caltrans 2006) provides Caltrans policy for applying 23 CFR 772. The Technical Noise Supplement (TeNS) (Caltrans 1998) to Caltrans Protocol provides further detailed technical guidance on the preparation of noise studies for highway construction and reconstruction projects, including the definition of technical terms used in the Protocol (http://www.dot.ca.gov/hq/env/noise/pub/tens_complete.pdf).

FHWA defines a Type I project as a proposed Federal or Federal-aid highway project for the construction of a highway on a new location, or the physical alteration of an existing highway which significantly changes either the horizontal or vertical alignment, or increases the number of through-traffic lanes. NSRs evaluate noise impacts of Type I projects and consider noise abatement to determine if FHWA funding requirements for noise abatement are met, as determined by Caltrans. Noise impacts, as defined under 23 CFR 772, can occur even when there is no project-related increase in noise if existing noise levels are high.

Preparation of noise technical memorandum, rather than a full-blown NSR, may be warranted for some projects. A noise technical memorandum should be prepared when the following occurs:

- A Type I project passes the preliminary screening procedure that is required by the Protocol. This screening procedure is used to determine whether additional detailed noise impact analysis is warranted.
- Adverse construction noise is anticipated for a highway project that is not a Type I.

Noise impacts under the National Environmental Policy Act (NEPA) are addressed in the NEPA document rather than the NSR since the purposes of the environmental document and NSR differ. Adverse impacts under NEPA are identified when a project results in a substantial increase in noise considering context and intensity. Therefore, a project that does not have an adverse impact under NEPA could require the consideration of noise abatement under 23 CFR 772 since, as noted above, noise impacts under 23 CFR 772 can occur even when there is no project-related increase in noise if existing noise levels are high. Similarly, the evaluation of noise impacts under the California Environmental Quality Act (CEQA) is also only addressed separately in the CEQA document and not in the NSR.

Even though the NSR does not specifically evaluate noise impacts under NEPA and CEQA, it should contain the technical information that is needed to determine noise impacts under NEPA and CEQA. For example, the NSR should contain predicted noise levels for design year conditions without the project even though this information is not required by the 23CFR772 or the Protocol.

Summary

The Summary includes the results of the noise impact analysis and key conclusions related to noise abatement under the requirements of 23 CFR 772. The Summary should be limited to one to two pages and should not include any tables. Key topics that should be summarized in this section are:

- Purpose of NSR;
- Project location;
- Project purpose and need;
- Project alternatives;
- Land use and terrain in the project area (generally describe the various land uses in the project area such as residential, commercial, parks, and hotels. Generally describe the terrain (such as the area is flat, slopes downhill from the roadway, or shielded by intervening hills);
- Existing noise levels (summarize the range of existing noise levels for each land use type including both background and ambient noise levels);
- Predicted design year noise levels (summarize the predicted design year noise level for each land use type);
- Traffic noise impacts, if any (summarize traffic noise impacts associated with each land use type);
- Noise abatement considered (a summary should be provided that includes the range of heights, lengths, insertion loses, and number of benefited receivers for each area exposed to traffic noise impacts);
- Acoustical feasibility of noise abatement considered (summarize the feasibility of each noise abatement measure considered and identify those areas where abatement is not feasible); and
- Reasonable allowances for feasible abatement (summarize the range of allowances for each feasible noise abatement measure considered).

- Construction noise impacts.

[Begin typing here].

Table of Contents

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List of Tables

List of Abbreviated Terms

[Abbreviation]	[*Spelled-out term*] [*You can add rows quickly by pressing tab at the end of the last row and using the 'pencil' function or by inserting rows. Type in acronyms as you use them, and then sort them alphabetically. To sort, pull down the "Table" menu, select "Sort," be sure it specifies ascending order, and click on "OK."*]
CEQA	California Environmental Quality Act
CFR	Code of Federal Regulations
CNEL	Community Noise Equivalent Level
dB	Decibels
FHWA	Federal Highway Administration
Hz	Hertz
kHz	Kilohertz
L_{dn}	Day-Night Level
L_{eq}	Equivalent Sound Level
$L_{eq(h)}$	Equivalent Sound Level over one hour
L_{max}	Maximum Sound Level
LOS	Level of Service
L_{xx}	Percentile-Exceeded Sound Level
mPa	micro-Pascals
mph	miles per hour
NAC	noise abatement criteria
NADR	Noise Abatement Decision Report
NEPA	National Environmental Policy Act
NSR	noise study reports
Protocol	Caltrans Traffic Noise Analysis Protocol for New Highway Construction, Reconstruction, and Retrofit Barrier Projects
SPL	sound pressure level
TeNS	Caltrans' Technical Noise Supplement
TNM 2.5	FHWA Traffic Noise Model Version 2.5

Chapter 1. Introduction

The Introduction provides an overview on the purpose of the NSR. This chapter also provides background information on the project, as well as a concise statement of the project's purpose and need.

[Begin typing here].

1.1. Purpose of the Noise Study Report

The purpose of this NSR is to evaluate noise impacts and abatement under the requirements of Title 23, Part 772 of the Code of Federal Regulations (23 CFR 772) "Procedures for Abatement of Highway Traffic Noise". 23 CFR 772 provides procedures for preparing operational and construction noise studies and evaluating noise abatement considered for federal and federal-aid highway projects. According to 23 CFR 772.3, all highway projects that are developed in conformance with this regulation are deemed to be in conformance with Federal Highway Administration (FHWA) noise standards.

The Caltrans Traffic Noise Analysis Protocol for New Highway Construction, Reconstruction, and Retrofit Barrier Projects (Protocol) (Caltrans 2006) provides Caltrans policy for implementing 23 CFR 772 in California. The Protocol outlines the requirements for preparing noise study reports (NSR). Noise impacts associated with this project under the National Environmental Policy Act (NEPA) and the California Environmental Quality Act (CEQA) are evaluated in the project's environmental document [insert name of environmental document and provide reference].

Project Purpose and Need

A brief statement describing the name of the project and project location, including a statement describing the existing facility, together with a clear discussion of the purpose and need for the project, are provided here. This information should be obtained from the Caltrans Environmental Coordinator to ensure that information presented here is consistent with information to be provided in the environmental document.

Caltrans annotated outlines for environmental documents provide detailed guidance on how to prepare the purpose and need statement (http://www.dot.ca.gov/ser/forms.htm).

For illustrative purposes, an abbreviated version of a purpose and need statement is provided below for the alternative that is analyzed in the sample text in Chapters 5, 6, and 7.

1.2. Project Purpose and Need

[Begin typing here].

State Route (SR) 26 is a primary transportation corridor between the City of Clarksville and outlying suburban areas located to the east of the city. West of Main Street, SR 26 has two general purpose lanes and a single high occupancy vehicle (HOV) lane in each direction into downtown Clarksville. East of Main Street, SR 26 has two general purpose lanes in each direction in the project area.

The purpose of the project is to increase the capacity of SR 26 between the Main Street and Maple Avenue interchanges to:

- Improve traffic operations, and
- Improve traffic safety.

Traffic on the main line in the project area is highly congested during peak hours operating at a Level of Service D. High traffic volumes, coupled with localized traffic weaving, are key factors in slowing down the main-line traffic flow to below acceptable levels.

Both eastbound and westbound traffic within the project limits experience accident rates that exceed the average accident rates for similar facilities. The actual accident rates for eastbound and westbound traffic are 52% and 28% higher, respectively, than the statewide average.

Chapter 2. Project Description

The project description includes:

- A detailed description of the components of each alternative under consideration with enough information for the reader to understand how the project alternatives fit into the transportation system of the area;
- A description of the capacity-increasing components of the project (additional lanes, new alignments, new ramps, etc);
- A vicinity map clearly showing how the alternatives relate to the general transportation system;
- A location map showing the alternative alignments being studied and their spatial relationship with receivers in the project area; and
- A discussion of when the action is expected to be constructed.

This information should be obtained from the Caltrans Environmental Coordinator to ensure that information presented here is consistent with information to be provided in the environmental document.

Caltrans annotated outlines for environmental documents provide detailed guidance on how to prepare the project description (http://www.dot.ca.gov/ser/forms.htm). The project description for the NSR does not necessarily need to contain all of the project description components described in the annotated outlines. For example, discussions of alternatives considered but eliminated from further discussion and of permits and approvals needed may not be needed for the NSR. The guidance contained in the annotated outlines will be helpful in developing the information described in the bullets above.

The following is sample text for this chapter. Since the sample below is for illustrative purposes only, only one build alternative is described. This alternative is carried forward in the discussions in Chapters 5, 6, and 7.

[Begin typing here]

Under the Build Alternative, improvements would be made to the SR 26 main line to meet current design standards for a six-lane freeway by adding two 12-foot lanes in the median; constructing a concrete median barrier throughout the length of the project; widening the outside shoulders to 10 feet; and correcting the cross slope to 2% by overlaying concrete asphalt to improve drainage.

The interchange structures at Main Street and Maple Avenue would be removed and reconstructed to accommodate future widening of SR 26 to eight lanes. Ramp meters would be included at all proposed on-ramps.

2.1. No Build

Under the No Build Alternative, no changes would be made to SR 26 in the project area.

2.2. Build Alternative—Addition of HOV Lanes

Under the Build Alternative, two HOV lanes (one in each direction) would be constructed in the center median. No outside widening of the existing roadway would be required. Embankment slopes for the proposed interchange improvements would be at a 4:1 slope. The proposed ramps would be constructed to current design standards and would be configured to accommodate a future eight-lane facility on SR 26. Ramp metering would be installed at the east and westbound on ramps at Main Street and Maple Avenue.

Chapter 3. Fundamentals of Traffic Noise

This section provides key information on the fundamentals of traffic noise. Include the following boilerplate language.

The following is a brief discussion of fundamental traffic noise concepts. For a detailed discussion, please refer to Caltrans' Technical Noise Supplement (TeNS) (Caltrans 1998), a technical supplement to the Protocol, that is available on Caltrans Web site (http://www.dot.ca.gov/hq/env/noise/pub/tens_complete.pdf).

3.1. Sound, Noise, and Acoustics

Sound can be described as the mechanical energy of a vibrating object transmitted by pressure waves through a liquid or gaseous medium (e.g., air) to a hearing organ, such as a human ear. Noise is defined as loud, unexpected, or annoying sound.

In the science of acoustics, the fundamental model consists of a sound (or noise) source, a receiver, and the propagation path between the two. The loudness of the noise source and obstructions or atmospheric factors affecting the propagation path to the receiver determine the sound level and characteristics of the noise perceived by the receiver. The field of acoustics deals primarily with the propagation and control of sound.

3.2. Frequency

Continuous sound can be described by frequency (pitch) and amplitude (loudness). A low-frequency sound is perceived as low in pitch. Frequency is expressed in terms of cycles per second, or Hertz (Hz) (e.g., a frequency of 250 cycles per second is referred to as 250 Hz). High frequencies are sometimes more conveniently expressed in kilohertz (kHz), or thousands of Hertz. The audible frequency range for humans is generally between 20 Hz and 20,000 Hz.

3.3. Sound Pressure Levels and Decibels

The amplitude of pressure waves generated by a sound source determines the loudness of that source. Sound pressure amplitude is measured in micro-Pascals (mPa). One mPa is approximately one hundred billionth (0.00000000001) of normal atmospheric pressure. Sound pressure amplitudes for different kinds of noise environments can range from less than 100 to 100,000,000 mPa. Because of this huge range of values, sound is rarely expressed in terms of mPa . Instead, a logarithmic scale is used to describe sound pressure level (SPL) in terms of decibels (dB). The threshold of hearing for young people is about 0 dB, which corresponds to 20 mPa.

3.4. Addition of Decibels

Because decibels are logarithmic units, SPL cannot be added or subtracted through ordinary arithmetic. Under the decibel scale, a doubling of sound energy corresponds to a 3-dB increase. In other words, when two identical sources are each producing sound of the same loudness, the resulting sound level at a given distance would be 3 dB higher than one source under the same conditions. For example, if one automobile produces an SPL of 70 dB when it passes an observer, two cars passing simultaneously would not produce 140 dB—rather, they would combine to produce 73 dB. Under the decibel scale, three sources of equal loudness together produce a sound level 5 dB louder than one source.

3.5. A-Weighted Decibels

The decibel scale alone does not adequately characterize how humans perceive noise. The dominant frequencies of a sound have a substantial effect on the human response to that sound. Although the intensity (energy per unit area) of the sound is a purely physical quantity, the loudness or human response is determined by the characteristics of the human ear.

Human hearing is limited in the range of audible frequencies as well as in the way it perceives the SPL in that range. In general, people are most sensitive to the frequency range of 1,000–8,000 Hz, and perceive sounds within that range better than sounds of the same amplitude in higher or lower frequencies. To approximate the response of the human ear, sound levels of individual frequency bands are weighted, depending on the human sensitivity to those frequencies. Then, an "A-weighted" sound level (expressed in units of dBA) can be computed based on this information.

The A-weighting network approximates the frequency response of the average young ear when listening to most ordinary sounds. When people make judgments of the relative loudness or annoyance of a sound, their judgments correlate well with the A-scale sound levels of those sounds. Other weighting networks have been devised to address high noise levels or other special problems (e.g., B-, C-, and D-scales), but these scales are rarely used in conjunction with highway-traffic noise. Noise levels for traffic noise reports are typically reported in terms of A-weighted decibels or dBA. Table 3-1 describes typical A-weighted noise levels for various noise sources.

Table 3-1. Typical A-Weighted Noise Levels

Common Outdoor Activities	Noise Level (dBA)	Common Indoor Activities
	— 110 —	Rock band
Jet fly-over at 1000 feet		
	— 100 —	
Gas lawn mower at 3 feet		
	— 90 —	
Diesel truck at 50 feet at 50 mph		Food blender at 3 feet
	— 80 —	Garbage disposal at 3 feet
Noisy urban area, daytime		
Gas lawn mower, 100 feet	**— 70 —**	Vacuum cleaner at 10 feet
Commercial area		Normal speech at 3 feet
Heavy traffic at 300 feet	**— 60 —**	
		Large business office
Quiet urban daytime	**— 50 —**	Dishwasher next room
Quiet urban nighttime	**— 40 —**	Theater, large conference room (background)
Quiet suburban nighttime		
	— 30 —	Library
Quiet rural nighttime		Bedroom at night, concert
	— 20 —	
		Broadcast/recording studio
	— 10 —	
Lowest threshold of human hearing	**— 0 —**	Lowest threshold of human hearing

Source: Caltrans 1998.

3.6. Human Response to Changes in Noise Levels

As discussed above, doubling sound energy results in a 3-dB increase in sound. However, given a sound level change measured with precise instrumentation, the subjective human perception of a doubling of loudness will usually be different than what is measured.

Under controlled conditions in an acoustical laboratory, the trained, healthy human ear is able to discern 1-dB changes in sound levels, when exposed to steady, single-frequency ("pure-tone") signals in the midfrequency (1,000 Hz–8,000 Hz) range. In typical noisy environments, changes in noise of 1 to 2 dB are generally not perceptible. However, it is widely accepted that people are able to begin to detect sound level increases of 3 dB in typical noisy environments. Further, a 5-dB increase is generally perceived as a distinctly noticeable increase, and a 10-dB increase is generally perceived as a doubling of loudness. Therefore, a doubling of sound energy (e.g., doubling the volume of traffic on a highway) that would result in a 3-dB increase in sound, would generally be perceived as barely detectable.

3.7. Noise Descriptors

Noise in our daily environment fluctuates over time. Some fluctuations are minor, but some are substantial. Some noise levels occur in regular patterns, but others are random. Some noise levels fluctuate rapidly, but others slowly. Some noise levels vary widely, but others are relatively constant. Various noise descriptors have been developed to describe time-varying noise levels. The following are the noise descriptors most commonly used in traffic noise analysis.

- **Equivalent Sound Level (L_{eq}):** L_{eq} represents an average of the sound energy occurring over a specified period. In effect, L_{eq} is the steady-state sound level containing the same acoustical energy as the time-varying sound that actually occurs during the same period. The 1-hour A-weighted equivalent sound level (L_{eq}[h]) is the energy average of A-weighted sound levels occurring during a one-hour period, and is the basis for noise abatement criteria (NAC) used by Caltrans and FHWA.

- **Percentile-Exceeded Sound Level (L_{xx}):** L_{xx} represents the sound level exceeded for a given percentage of a specified period (e.g., L_{10} is the sound level exceeded 10% of the time, and L_{90} is the sound level exceeded 90% of the time).

- **Maximum Sound Level (L_{max}):** L_{max} is the highest instantaneous sound level measured during a specified period.

- **Day-Night Level (L_{dn}):** L_{dn} is the energy average of A-weighted sound levels occurring over a 24-hour period, with a 10-dB penalty applied to A-weighted sound levels occurring during nighttime hours between 10 p.m. and 7 a.m.

- **Community Noise Equivalent Level (CNEL):** Similar to L_{dn}, CNEL is the energy average of the A-weighted sound levels occurring over a 24-hour period, with a 10-dB penalty applied to A-weighted sound levels occurring during the nighttime hours between 10 p.m. and 7 a.m., and a 5-dB penalty applied to the A-weighted sound levels occurring during evening hours between 7 p.m. and 10 p.m.

3.8. Sound Propagation

When sound propagates over a distance, it changes in level and frequency content. The manner in which noise reduces with distance depends on the following factors.

3.8.1. Geometric Spreading

Sound from a localized source (i.e., a point source) propagates uniformly outward in a spherical pattern. The sound level attenuates (or decreases) at a rate of 6 decibels for each doubling of distance from a point source. Highways consist of several localized noise sources on a defined path, and hence can be treated as a line source, which approximates the effect of several point sources. Noise from a line source propagates outward in a cylindrical pattern, often referred to as cylindrical spreading. Sound levels attenuate at a rate of 3 decibels for each doubling of distance from a line source.

3.8.2. Ground Absorption

The propagation path of noise from a highway to a receiver is usually very close to the ground. Noise attenuation from ground absorption and reflective-wave canceling adds to the attenuation associated with geometric spreading. Traditionally, the excess attenuation has also been expressed in terms of attenuation per doubling of distance. This approximation is usually sufficiently accurate for distances of less than 200 feet. For acoustically hard sites (i.e., sites with a reflective surface between the source and the receiver, such as a parking lot or body of water,), no excess ground attenuation is assumed. For acoustically absorptive or soft sites (i.e., those sites with an absorptive ground surface between the source and the receiver, such as soft dirt, grass, or scattered bushes and trees), an excess ground-attenuation value of 1.5 decibels per doubling of distance is normally assumed. When added to the cylindrical spreading, the excess ground attenuation results in an overall drop-off rate of 4.5 decibels per doubling of distance.

3.8.3. Atmospheric Effects

Receptors located downwind from a source can be exposed to increased noise levels relative to calm conditions, whereas locations upwind can have lowered noise levels. Sound levels can be increased at large distances (e.g., more than 500 feet) from the highway due to atmospheric temperature inversion (i.e., increasing temperature with elevation). Other factors such as air temperature, humidity, and turbulence can also have significant effects.

3.8.4. Shielding by Natural or Human-Made Features

A large object or barrier in the path between a noise source and a receiver can substantially attenuate noise levels at the receiver. The amount of attenuation provided by shielding depends on the size of the object and the frequency content of the noise source. Natural terrain features (e.g., hills and dense woods) and human-made features (e.g., buildings and walls) can substantially reduce noise levels. Walls are often constructed between a source and a receiver specifically to reduce noise. A barrier that breaks the line of sight between a source and a receiver will typically result in at least 5 dB of noise reduction. Taller barriers provide increased noise reduction. Vegetation between the highway and receiver is rarely effective in reducing noise because it does not create a solid barrier.

Chapter 4. Federal Regulations and State Policies

This section discusses key federal regulations and state policies. Include the following boilerplate language.

This report focuses on the requirements of 23 CFR 772, as discussed below.

4.1. Federal Regulations

4.1.1. 23 CFR 772

23 CFR 772 provides procedures for preparing operational and construction noise studies and evaluating noise abatement considered for federal and federal-aid highway projects. Under 23 CFR 772.7, projects are categorized as Type I or Type II projects. FHWA defines a Type I project as a proposed federal or federal-aid highway project for the construction of a highway on a new location, or the physical alteration of an existing highway which significantly changes either the horizontal or vertical alignment, or increases the number of through-traffic lanes. A Type II project is a noise barrier retrofit project that involves no changes to highway capacity or alignment.

Type I projects include those that create a completely new noise source, as well as those that increase the volume or speed of traffic or move the traffic closer to a receiver. Type I projects include the addition of an interchange, ramp, auxiliary lane, or truck-climbing lane to an existing highway, or the widening an existing ramp by a full lane width for its entire length. Projects unrelated to increased noise levels, such as striping, lighting, signing, and landscaping projects, are not considered Type I projects.

Under 23 CFR 772.11, noise abatement must be considered for Type I projects if the project is predicted to result in a traffic noise impact. In such cases, 23 CFR 772 requires that the project sponsor "consider" noise abatement before adoption of the final NEPA document. This process involves identification of noise abatement measures that are reasonable, feasible, and likely to be incorporated into the project, and of noise impacts for which no apparent solution is available.

Traffic noise impacts, as defined in 23 CFR 772.5, occur when the predicted noise level in the design year approaches or exceeds the NAC specified in 23 CFR 772, or a predicted noise level substantially exceeds the existing noise level (a "substantial" noise increase). 23 CFR 772 does not specifically define the terms “substantial increase” or “approach”; these criteria are defined in the Protocol, as described below.

Table 4-1 summarizes NAC corresponding to various land use activity categories. Activity categories and related traffic noise impacts are determined based on the actual land use in a given area.

Table 4-1. Activity Categories and Noise Abatement Criteria

Activity Category	NAC, Hourly A-Weighted Noise Level (dBA-L_{eq}[h])	Description of Activities
A	57 Exterior	Lands on 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
B	67 Exterior	Picnic areas, recreation areas, playgrounds, active sport areas, parks, residences, motels, hotels, schools, churches, libraries, and hospitals
C	72 Exterior	Developed lands, properties, or activities not included in categories A or B above
D	—	Undeveloped lands
E	52 Interior	Residences, motels, hotels, public meeting rooms, schools, churches, libraries, hospitals, and auditoriums

In identifying noise impacts, primary consideration is given to exterior areas of frequent human use. In situations where there are no exterior activities, or where the exterior activities are far from the roadway or physically shielded in a manner that prevents an impact on exterior activities, the interior criterion (Activity Category E) is used as the basis for determining a noise impact.

4.2. State Regulations and Policies

4.2.1. Traffic Noise Analysis Protocol for New Highway Construction and Reconstruction Projects

The Protocol specifies the policies, procedures, and practices to be used by agencies that sponsor new construction or reconstruction of federal or federal-aid highway projects. The NAC specified in the Protocol are the same as those specified in 23 CFR 772. The Protocol defines a noise increase as substantial when the predicted noise levels with project implementation exceed existing noise levels by 12 dBA. The Protocol also states that a sound level is considered to approach an NAC level when the sound level is within 1 dB of the NAC identified in 23 CFR 772 (e.g., 66 dBA is considered to approach the NAC of 67 dBA, but 65 dBA is not).

The TeNS to the Protocol provides detailed technical guidance for the evaluation of highway traffic noise. This includes field measurement methods, noise modeling methods, and report preparation guidance.

4.2.2. Section 216 of the California Streets and Highways Code

Section 216 of the California Streets and Highways Code relates to the noise effects of a proposed freeway project on public and private elementary and secondary schools. Under this code, a noise impact occurs if, as a result of a proposed freeway project, noise levels exceed 52 dBA-L_{eq}(h) in the interior of public or private elementary or secondary classrooms, libraries, multipurpose rooms, or spaces. This requirement does not replace the "approach or exceed" NAC criterion for FHWA Activity Category E for classroom interiors, but it is a requirement that must be addressed in addition to the requirements of 23 CFR 772.

If a project results in a noise impact under this code, noise abatement must be provided to reduce classroom noise to a level that is at or below 52 dBA-L_{eq}(h). If the noise levels generated from freeway and nonfreeway sources exceed 52 dBA-L_{eq}(h) prior to the construction of the proposed freeway project, then noise abatement must be provided to reduce the noise to the level that existed prior to construction of the project.

Chapter 5. Study Methods and Procedures

Study methods used in the preparation of the NSR are discussed in this chapter. The following methods should be described:

- Methods for identifying land uses and selecting noise measurement and modeled receiver locations.
- Field measurement procedures.
- Noise prediction methods.
- Process for evaluating noise abatement.

Each of these steps is described in more detail below.

Describe the Methods for Identifying Land Uses and Selecting Noise Measurement and Modeled Receiver Locations

This section describes the process used to select modeled receiver and noise measurement locations, including the following:

- Types of land uses in the project area relative to the FHWA activity categories;
- Extent of frequent human use at the land uses in the project area;
- Geometry of the project relative to nearby existing and planned land uses;
- Locations where traffic noise impacts are expected to be the worst;
- Reasons why a receiver represents a larger area; and
- Acoustical equivalence (areas are usually acoustically equivalent if their shielding and geometric relationship to the highway are the same).

Land uses in the project area are categorized in terms of FHWA activity categories (see Table 4-1). Receiver locations to be measured and modeled for the analysis are selected to represent various land uses in the project area. Since it is often not practical to place a modeled receiver at each individual residence or building (such as church and/or school), a limited number of locations may need to be selected that represents groups of buildings with similar land uses. It is also often not practical to conduct noise measurements at every modeled receiver location. Therefore, a limited number of noise measurement locations may need to be selected that represent the various land uses in the project area. Refer to TeNS for guidance on receiver selection.

Measurement locations outside the direct project area are useful for documenting existing community background noise levels. After the project is built, this information can be helpful in defending against unsubstantiated public claims that noise barriers constructed as part of a project increased noise levels at distant receivers. Measurement locations outside the direct project area are discussed, as appropriate.

It is often convenient to group land uses along the project corridor by major sub-areas. These sub-areas can be defined by common land uses, acoustical equivalence, major cross streets, topography, and/or other physical features in the area. Existing land uses, noise barriers, or topography that provides acoustical shielding are identified and discussed.

Describe Field Measurement Procedures

This section describes field measurement procedures that can serve several purposes for the noise analysis. Refer to TeNS for detailed guidance on measurement procedures.

Most commonly, short-term sound level measurements are taken adjacent to an existing roadway along with simultaneous collection of traffic counts and speeds. The count and speed data is then input to the noise model so that the measurements and modeled results can be compared. The differences between the measured and modeled noise levels can then be used to adjust the model or develop calibration factors.

Short-term measurements can also be used to characterize ambient noise conditions at locations away from the project area or, in the case of a new project alignment, at locations adjacent to the proposed alignment. In these situations, since there are no simultaneous traffic counts to be collected, no adjustment or calibration of the model is conducted with these measurements.

Long-term measurements (typically 24 hours a day for several days) are used to characterize the diurnal traffic noise pattern at selected locations in the project area. This data can be used to identify the worst noise hour and to develop relationships between non-worst-hour and worst-hour noise levels. This information can be used to estimate worst-hour noise levels from levels measured during non-worst hour times.

The discussion on field measurement procedures includes the following:

- Description of instrumentation (with serial numbers) and measurement setups,

- Short- and long-term noise measurement and other data collection procedures,
- Traffic count and speed collection methods,
- Meteorological observation methods, and
- Data reduction methods.
- Additional detailed information such as copies of field notes, photographs, measurement sketches, and other data from the field investigation should be provided in an appendix.

Describe Noise Prediction Methods

Traffic and construction noise modeling methods used to predict noise levels are described in this section. The discussion on noise modeling methods should include the following:

- Description of the traffic noise and construction noise models used, primarily the FHWA Traffic Noise Model (TNM) for traffic noise and the Roadway Construction Noise Model (RCNM) for construction noise;
- Description of any other supplementary models used;
- Description of mapping used to develop the model (aerial photos, layout maps, profiles, etc);
- Description of tools used to develop TNM input data (digitizing tables, CAD tools); and
- Summary of operational assumptions used in the analysis (such as forecasted traffic volumes, speeds, and construction equipment operational assumptions).

Short and concise summaries of data are provided in the body of the text. Detailed data summaries, such as design year traffic assumptions are provided in the NSR appendices.

Describe the Process for Evaluating Noise Abatement

This section discusses methods used to evaluate noise impacts and abatement. The discussion includes:

- Narrative discussion of the criteria used for identifying traffic noise impacts under 23 CFR 772 (“approach or exceed NAC”, “substantial increase”, or both);

- A description of how the feasibility of abatement is determined; and
- A description of how reasonable cost allowances are determined.

The following is sample text for this chapter.

[Begin typing here].

5.1. Methods for Identifying Land Uses and Selecting Noise Measurement and Modeling Receiver Locations

A field investigation was conducted to identify land uses that could be subject to traffic and construction noise impacts from the proposed project. Land uses in the project area were categorized by land use type, Activity Category as defined in Table 4-1, and the extent of frequent human use. As stated in the Protocol, noise abatement is only considered for areas of frequent human use that would benefit from a lowered noise level. Although all developed land uses are evaluated in this analysis, the focus is on locations of frequent human use that would benefit from a lowered noise level. Accordingly, this impact analysis focuses on locations with defined outdoor activity areas, such as residential backyards and common use areas at multi-family residences.

The geometry of the project relative to nearby existing and planned land uses was also identified.

Short-term measurement locations were selected to represent each major developed area within the project area. A single long term measurement site was selected to capture the diurnal traffic noise level pattern in the project area. Short-term measurement locations were selected to serve as representative modeling locations. Several other non-measurement locations were selected as modeling locations.

5.2. Field Measurement Procedures

A field noise study was conducted in accordance with recommended procedures in TeNS. The following is a summary of the procedures used to collect short-term and long term sound level data.

5.2.1. Short-Term Measurements

Short-term monitoring was conducted at four locations on Thursday, January 19, 2006 and Wednesday, January 25, 2006, using Larson-Davis Model 812 Precision Type 1 sound level meters (serial numbers 0430 and 0239). Measurements were taken over a

15-minute period at each site. Short-term monitoring was conducted at Activity Category B land uses. The short-term measurement locations are identified in Figure 5-1.

During the short-term measurements, field staff attended each meter. Minute-to-minute L_{eq} values collected during the measurement period (typically 15 minutes in duration) were logged manually, and dominant noise sources observed during each individual 1-minute period were also identified and logged. Using this approach, those minutes when traffic noise was observed to be a dominant contributor to noise levels at a given measurement location could be distinguished from one-minute noise levels where other non-traffic noise sources (such as aircraft and lawn equipment) contributed significantly to existing noise levels. The calibration of the meter was checked before and after the measurement using a Larson-Davis Model CA250 calibrator (serial number 0125).

Temperature, wind speed, and humidity were recorded manually during the short-term monitoring session using a Kestrel 3000 portable weather station. During the short-term measurements, wind speeds typically ranged from 1 to 4 miles per hour (mph). Temperatures ranged from10–14°C (50–57°F), with relative humidity typically 70–90%.

Traffic on SR 26 was classified and counted during short-term noise measurements. Vehicles were classified as automobiles, medium-duty trucks, or heavy-duty trucks. An automobile was defined as a vehicle with two axles and four tires that are designed primarily to carry passengers. Small vans and light trucks were included in this category. Medium-duty trucks included all cargo vehicles with two axles and six tires. Heavy-duty trucks included all vehicles with three or more axles. The posted speed on SR 26 was 65 mph.

5.2.2. Long -Term Measurements

Long-term monitoring was conducted at one location (LT-1) using a Larson-Davis Model 720 Type 2 sound level meter (serial numbers 0506). The purpose of these measurements was to identify variations in sound levels throughout the day. The long-term sound level data was collected over five consecutive 24-hour periods, beginning Thursday, January 19, 2006, and ending Wednesday, January 25, 2006.

Long-term monitoring location LT-1 was located at the residence at 485 Chestnut Drive on the north side of SR 26, approximately 200 feet from the SR 26 edge-of-pavement (refer to Figure 5-1). This is the same location where ST-2 measurements were taken.

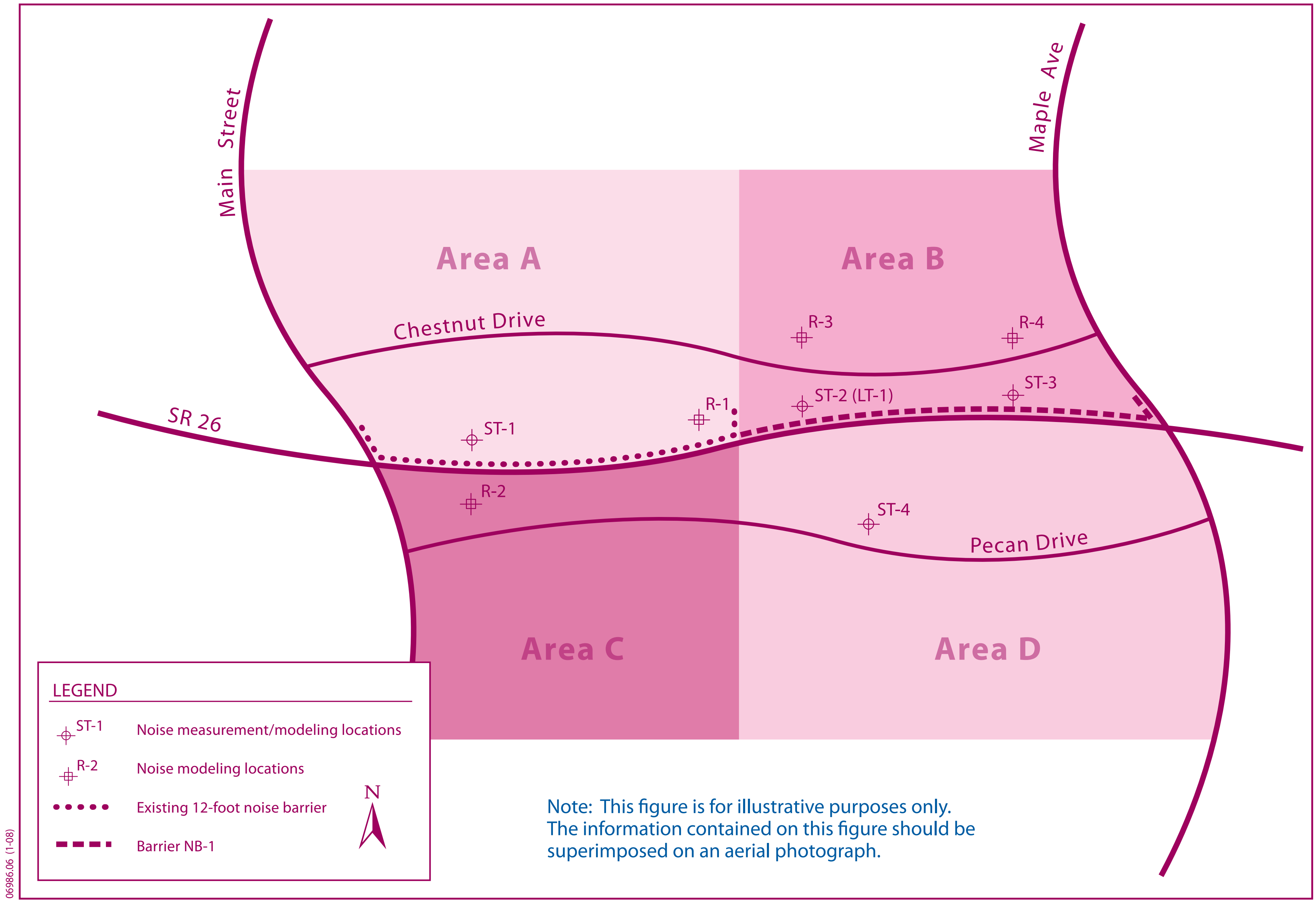


Figure 5-1
Analysis Areas, Noise Monitoring Positions, and Location of Evaluated Noise Barrier

5.3. Traffic Noise Levels Prediction Methods

Traffic noise levels were predicted using the FHWA Traffic Noise Model Version 2.5 (TNM 2.5). TNM 2.5 is a computer model based on two FHWA reports: FHWA-PD-96-009 and FHWA-PD-96-010 (FHWA 1998a, 1998b). Key inputs to the traffic noise model were the locations of roadways, shielding features (e.g., topography and buildings), noise barriers, ground type, and receivers. Three-dimensional representations of these inputs were developed using CAD drawings, aerials, and topographic contours provided by the County Transportation Authority.

Traffic noise was evaluated under existing conditions, design year no-project conditions, and design year conditions with the project alternative. Loudest-hour traffic volumes, vehicle classification percentages, and traffic speeds under existing and design-year (2030) conditions were provided by Acme Traffic Engineers for input into the traffic noise model. The highest average traffic volumes on SR 26 are predicted to occur during the PM; therefore PM peak hour traffic volumes were used in the model. Tables A-1 to A-3 in Appendix A summarize the traffic volumes and assumptions used for modeling existing and design-year conditions with and without the project alternative.

The loudest hour is generally characterized by free-flowing traffic at the highway design speed (i.e., Level of Service [LOS] C or better). Although the addition of median lanes on SR 26 will improve LOS, most segments on SR 26 are forecast to be at LOS D or worse during peak hours. For this analysis, it is assumed that each lane has a maximum capacity of 2,000 vehicles per hour at the design speed of the highway. Therefore, for the design year six-lane case, total modeled volumes in each direction were capped at 12,000 vehicles per hour.

To validate the accuracy of the model, TNM 2.5 was used to compare measured traffic noise levels to modeled noise levels at field measurement locations. For each receiver, traffic volumes counted during the short-term measurement periods were normalized to 1-hour volumes. These normalized volumes were assigned to the corresponding project area roadways to simulate the noise source strength at the roadways during the actual measurement period. Modeled and measured sound levels were then compared to determine the accuracy of the model and if additional calibration of the model was necessary.

5.4. Methods for Identifying Traffic Noise Impacts and Consideration of Abatement

Traffic noise impacts are considered to occur at receiver locations where predicted design-year noise levels are at least 12 dB greater than existing noise levels, or where predicted design year noise levels approach or exceed the NAC for the applicable activity category. Where traffic noise impacts are identified, noise abatement must be considered for reasonableness and feasibility as required by 23 CFR 772 and the Protocol.

According to the Protocol, abatement measures are considered acoustically feasible if a minimum noise reduction of 5 dB at impacted receiver locations is predicted with implementation of the abatement measures. In addition, barriers should be designed to intercept the line-of-sight from the exhaust stack of a truck to the first tier of receivers, as required by the Highway Design Manual, Chapter 1100. Other factors that affect feasibility include topography, access requirements for driveways and ramps, presence of local cross streets, utility conflicts, other noise sources in the area, and safety considerations. The overall reasonableness of noise abatement is determined by considering factors such as cost; absolute predicted noise levels; predicted future increase in noise levels; expected noise abatement benefits; build date of surrounding residential development along the highway; environmental impacts of abatement construction; opinions of affected residents; input from the public and local agencies; and social, legal, and technological factors.

The Protocol defines the procedure for assessing reasonableness of noise barriers from a cost perspective. A cost-per-residence allowance is calculated for each benefited residence (i.e., residences that receive at least 5 dB of noise reduction from a noise barrier). The 2007 base allowance is $36,000. Additional allowance dollars are added to the base allowance based on absolute noise levels, the increase in noise levels resulting from the project, achievable noise reduction, and the date of building construction in the area. Total allowances are calculated by multiplying the cost-per-residence by the number of benefited residences. If the total allowance for all evaluated noise barriers is more than 50% of the estimated construction cost, the allowance per residence is modified to a reduced value.

Chapter 6. Existing Noise Environment

Information relating to the existing noise environment is summarized here. The following information should be included:

- Existing land uses,
- Noise measurement results, and
- Traffic model development based on measurement results.

Existing Land Uses

Existing land uses in the project area are identified and categorized by land use type and activity category.

Noise Measurement Results

In general, noise measurement results presented in the body of the report is short and concise. More detailed information or lengthy data summaries are provided in the NSR appendices. The more detailed information may include:

- Sound level measurement results;
- Equipment calibration information/certificates;
- Traffic counts and speeds;
- Meteorological data;
- Site mapping and topography; and
- Detailed information on measurement locations (site photos, aerial photographs, etc).

Brief summary tables of short-term and long-term measured results may be presented in the body of the NSR.

Traffic Model Development Based on Measurement Results

A table that compares measured traffic noise levels with traffic noise levels modeled from collected traffic data is provided. Reasons as to why model calibration has or has not been implemented are discussed. If model calibration has been conducted, details on the process are described.

The following is sample text for this chapter.

[Begin typing here].

6.1. Existing Land Uses

A field investigation was conducted to identify land uses that could be subject to traffic and construction noise impacts from the proposed project. Single-family residences, multi-family residences, a church, and an hotel were identified as Activity Category B land uses in the project area. Numerous commercial uses in the area are Activity Category C land uses.

As required by the Protocol, although all developed land uses are evaluated in this analysis, noise abatement is only considered for areas of frequent human use that would benefit from a lowered noise level. Accordingly, this impact analysis focuses on locations with defined outdoor activity areas, such as residential backyards and common use areas at multi-family residences.

Land uses in the project area have been grouped into a series of lettered analysis areas that are identified in Figure 5-1. Each of these analysis areas is considered to be acoustically equivalent.

- **Area A:** Area A is located on the north side of SR 26 east of Main Street. A residential subdivision (Activity Category B) is located in this area. This area is generally flat. Backyards face the highway. A sound barrier with a nominal height of 12 feet is located between SR 26 and the residential area. (Refer to Figure 5-1).
- **Area B:** Area B is located on the north side of SR 26 west of Maple Avenue. A residential subdivision (Activity Category B) is located in this area. This area is generally flat. Backyards face the highway. No sound barriers or topographical shielding occur between the highway and the residential uses. (Refer to Figure 5-1).
- **Area C:** Area C is located on the south side of SR 26 east of Main Street. Commercial land uses (Activity Category C) are located in this area. The ground generally slopes away from the highway in this area. Developed areas are lower than the highway. No sound barrier or topographical shielding occurs between the highway and the commercial area. Outdoor areas immediately adjacent to the

commercial land uses are parking lots. Therefore, no outdoor areas associated with the commercial uses are considered to be areas of frequent human use. (Refer to Figure 5-1).

- **Area D:** Area D is located on the south side of SR 26 west of Maple Avenue. A church and an hotel (Activity Category B) are located in this area. No sound barrier or topographical shielding occurs between the highway and this area. All of the outdoor uses areas are parking lots. Therefore, no exterior areas of frequent human use occur in this area. (Refer to Figure 5-1).

6.2. Noise Measurement Results

The existing noise environment in the project area is characterized below based on short- and long-term noise monitoring that was conducted.

6.2.1. Short-Term Monitoring

Table 6-1 summarizes the results of the short-term noise monitoring conducted in the project area.

Table 6-1. Summary of Short-Term Measurements

Position	Address	Area	Land Uses	Start Time	Duration (minutes)	Measured L_{eq}	Autos	Medium Trucks	Heavy Trucks	Observed Speed (mph)
ST-1	123 Chestnut Drive	A	Residential	9:22 a.m.	15	61.2	428	14	5	66
ST-2	485 Chestnut Drive	B	Residential	10:15 a.m.	15	68.2	465	12	6	64
ST-3	685 Chestnut Drive	B	Residential	2:30 p.m.	15	68.9	422	13	4	64
ST-4	159 Pecan Drive	D	Church, motel	3:24 a.m.	15	69.2	480	10	3	67

Note: Refer to Figure 5-1 for measurement locations and boundaries of each area.

6.2.2. Long-Term Monitoring

Long-term monitoring was conducted at one location (LT-1) using a Larson-Davis Model 720 Type 2 sound level meter (serial numbers 0506). The purpose of these measurements was to describe variations in sound levels throughout the day, rather than absolute sound levels at a specific receptor of concern. The long-term sound level data was collected over five consecutive 24-hour periods, beginning Thursday, January 19, 2006, and ending Wednesday, January 25, 2006.

Long-term monitoring location LT-1 was located at the residence at 485 Chestnut Drive on the north side of SR 26, approximately 200 feet from the SR 26 edge-of-pavement (refer to Figure 5-1). This is the same location where ST-2 measurements were taken. The average loudest-hour sound level measured was 68.9 dBA L_{eq}(h) during the 2:00 p.m. hour. Table 6-2 and Figure 6-1 summarize the results of the long-term monitoring.

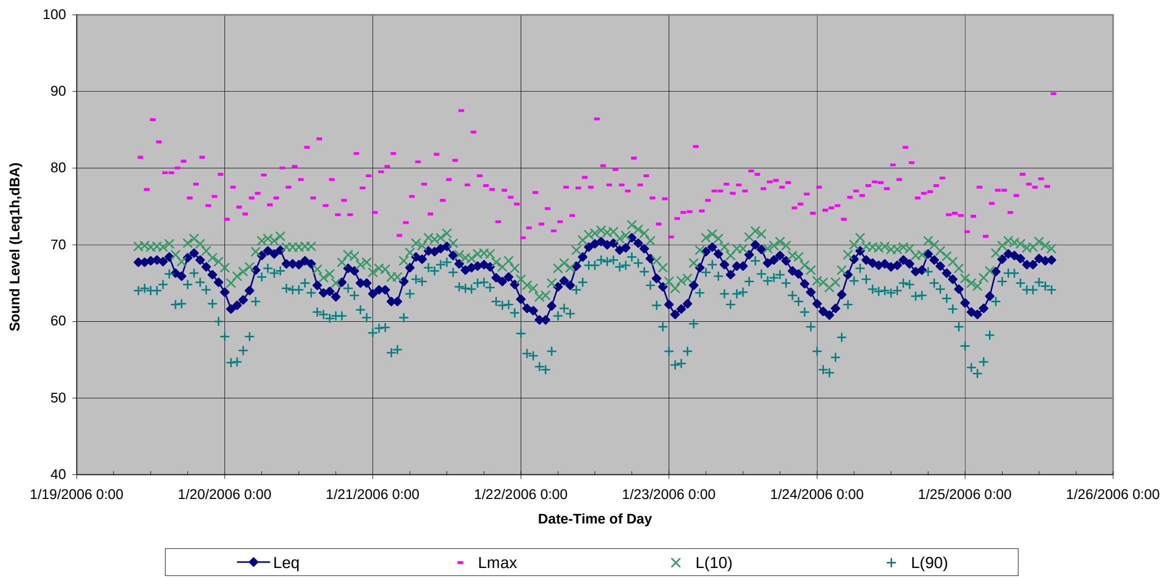
[This example includes long-term data over a 5-day period. The number of days over which long-term data is collected is determined at the discretion of the noise analyst based on actual field conditions, equipment limitations, and other factors.]

Table 6-2. Summary of Long-Term Monitoring at Location LT-1

Hour Beginning	Five-Day Average (dBA L_{eq}[h])	Difference from Loudest Hour (dB)
12:00 a.m.	62.9	-6.0
1:00 a.m.	61.8	-7.1
2:00 a.m.	61.8	-7.1
3:00 a.m.	61.9	-7.0
4:00 a.m.	63.1	-5.8
5:00 a.m.	65.6	-3.3
6:00 a.m.	67.6	-1.3
7:00 a.m.	68.4	-0.5
8:00 a.m.	67.8	-1.1
9:00 a.m.	68.2	-1.6
10:00 a.m.	67.6	-1.3
11:00 a.m.	68.1	-0.8
12:00 p.m.	68.2	-0.7
1:00 p.m.	68.1	-0.8
2:00 p.m.	**68.9**	0.0
3:00 p.m.	67.8	-1.1
4:00 p.m.	66.7	-2.2
5:00 p.m.	66.9	-2.0
6:00 p.m.	67.9	-1.0
7:00 p.m.	67.9	-1.0
8:00 p.m.	67.3	-1.6
9:00 p.m.	66.6	-2.2
10:00 p.m.	65.5	-3.4
11:00 p.m.	64.6	-4.3

Note: Worst noise hour noise level is bolded.

Figure 6-1. Long-Term Monitoring at Location LT-1, January 19–25, 2006



TNM 2.5 was used to compare measured traffic noise levels to modeled noise levels at field measurement locations. Table 6-3 compares measured and modeled noise levels at each measurement location (see Figure 5-1). The predicted sound levels are within 2 dB of the measured sound levels and are, therefore, considered to be in reasonable agreement with the measured sound levels. Therefore, no calibration of the model was made.

Table 6-3. Comparison of Measured to Predicted Sound Levels in the TNM Model

Measurement Position	Measured Sound Level (dBA)	Predicted Sound Level (dBA)	Measured minus Predicted (dB)
ST-1	61.2	62.0	- 0.8
ST-2	68.2	67.0	+ 1.2
ST-3	68.9	70.5	- 1.6
ST-4	69.2	70.2	- 1.0

Table B-1 in Appendix B presents existing noise levels at each receiver.

Chapter 7. Future Noise Environment, Impacts, and Considered Abatement

This section discusses the predicted traffic noise level under existing and design year conditions (with and without the project), identifies traffic noise impacts, and considers noise abatement. The results of this analysis are provided in a table contained in an appendix to the NSR. This table (or tables) includes the following for each modeled receiver:

- Location identifiers that corresponds to those used in the aerial figure of modeled receiver and measurement locations;
- Description of location (physical address if possible);
- Type of land use;
- Number of dwelling units represented by each receiver;
- Noise abatement category and criterion;
- Worst-hour noise levels for existing, design year no-project, and design year with project conditions;
- Change in noise levels including:
    - Design year with project versus existing conditions, and
    - Design year with project versus design year no- project); and traffic noise impact conclusions ("approach or exceed NAC", "substantial increase", or both).

For each sub-area, predicted traffic noise levels and traffic noise impacts, if any, are discussed based on modeling results. If traffic noise impacts are identified, noise abatement is considered. A discussion of noise abatement options identified in 23 CFR 772 is provided. Typically, abatement in the form of noise barriers is evaluated and discussed in detailed.

The noise reduction (i.e. barrier insertion loss) provided by a range of barrier walls heights is evaluated for each barrier considered. Barrier heights in the range of 6 to 16 feet in 2-foot increments are typically evaluated. A table summarizing the noise reduction for each barrier height and the number of benefited receivers for each height evaluated is provided. This table also identifies the minimum wall height necessary for each barrier evaluated to break the line-of-sight between an 11.5-foot truck stack and a 5-foot-high receiver in the first row of residences. This table can be combined with the table that summarizes existing and modeled noise levels.

Reasonableness cost allowances for each height increment of each barrier are calculated using the method described in the Protocol. Cost allowance calculation sheets for each barrier are provided in an appendix. The sheets show the calculated allowance per benefited residences, the number of benefited residences, and the total allowance for each barrier height (the allowance per benefited residences multiplied by the number of benefited residences). Allowances for each barrier are summarized in a table in the body of the report.

The NSR provides information on the acoustical feasibility of barriers and reasonable cost allowances for a range of barrier heights for each barrier evaluated. It does not provide information on the construction cost of barriers considered. This construction cost information is provided in the Noise Abatement Decision Report (NADR). The NADR compares the allowances to construction cost estimates and identifies those barrier heights that are reasonable from a cost perspective.

The following is sample text for this chapter.

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7.1. Future Noise Environment and Impacts

Table B-1 in Appendix B summarizes the traffic noise modeling results for existing conditions and design-year conditions with and without the project. Predicted design-year traffic noise levels with the project are compared to existing conditions and to design-year no-project conditions. The comparison to existing conditions is included in the analysis to identify traffic noise impacts under 23 CFR 772. The comparison to no-project conditions indicates the direct effect of the project.

As stated in the TeNS, modeling results are rounded to the nearest decibel before comparisons are made. In some cases, this can result in relative changes that may not appear intuitive. An example would be a comparison between sound levels of 64.4 and 64.5 dBA. The difference between these two values is 0.1 dB. However, after rounding, the difference is reported as 1 dB.

Modeling results in Table B-1 indicate that predicted traffic noise levels for the design-year with-project conditions approach or exceed the NAC of 67 dBA L_{eq}(h) for Activity Category B land uses at residences within Area B and at the church and hotel in Area D. The results also indicate that predicted traffic noise levels for the design-year with-project conditions does not approach or exceed the NAC of 72 dBA L_{eq}(h), for Activity Category C land uses within Area C.

Therefore, traffic noise impacts are predicted to occur at Activity Category B land uses within the project area, and noise abatement must be considered.

7.2. Preliminary Noise Abatement Analysis

In accordance with 23 CFR 772, noise abatement is considered where noise impacts are predicted in areas of frequent human use that would benefit from a lowered noise level. Potential noise abatement measures identified in the Protocol include the following:

- Avoiding the impact by using design alternatives, such as altering the horizontal and vertical alignment of the project;
- Constructing noise barriers;
- Acquiring property to serve as a buffer zone;
- Using traffic management measures to regulate types of vehicles and speeds; and
- Acoustically insulating public-use or nonprofit institutional structures.

All of these abatement options have been considered. However, because of the configuration and location of the project, abatement in the form of noise barriers is the only abatement that is considered to be feasible.

Each noise barrier evaluated has been evaluated for feasibility based on achievable noise reduction. For each noise barrier found to be acoustically feasible, reasonable cost allowances were calculated. Worksheets provided in Appendix C summarize the reasonable cost allowance calculations at the critical design receiver based on the allowance calculation procedure identified in the Protocol. Refer to the Protocol for the definition of the critical design receiver. Table B-1 in Appendix B summarizes results at receiver locations for the single noise barrier (Barrier NB-1) that has been evaluated in detail for this project.

For any noise barrier to be considered reasonable from a cost perspective, the estimated cost of the noise barrier should be equal to or less than the total cost allowance calculated for the barrier. The cost calculations of the noise barrier should include all items appropriate and necessary for construction of the barrier, such as traffic control, drainage modification, and retaining walls. Construction cost estimates are not provided in this NSR, but are presented in the NADR. The NADR is a design responsibility and is prepared to compile information from the NSR, other relevant environmental studies, and design considerations into a single, comprehensive document before public review of the project. The NADR is prepared by the project engineer after completion of the NSR and prior to publication of the draft environmental document. The NADR includes noise abatement construction cost estimates that have been prepared and signed by the project engineer based on site-specific conditions. Construction cost estimates are compared to reasonableness allowances in the NADR to identify which wall configurations are reasonable from a cost perspective.

The design of noise barriers presented in this report is preliminary and has been conducted at a level appropriate for environmental review and not for final design of the project. Preliminary information on the physical location, length, and height of noise barriers is provided in this report. If pertinent parameters change substantially during the final project design, preliminary noise barrier designs may be modified or eliminated from the final project. A final decision on the construction of the noise abatement will be made upon completion of the project design.

The following is a discussion of noise abatement considered for each evaluation area where traffic noise impacts are predicted.

7.2.1. Area A

The traffic noise modeling results in Table B-1 indicate that traffic noise levels at residences in Area A are predicted to be in the range of 64 to 65 dBA L_{eq}(h) in the design year. The results also indicate that the increase in noise between existing conditions and the design year is predicted to be 3 dB. Because the predicted noise level in the design year is not predicted to approach or exceed the noise abatement criterion (67 dBA L_{eq}[h]) or result in a substantial increase in noise, noise abatement does not need to be considered in this area.

7.2.2. Area B

The traffic noise modeling results in Table B-1 indicate traffic noise levels at residences in Area B are predicted to be in the range of 64 to 70 dBA L_{eq}(h) in the design year, and that the increase in noise will be 3 dB in the design year. Because the predicted noise level in the design year exceeds 67 dBA L_{eq}(h), traffic noise impacts are predicted at residences in this area, and noise abatement must be considered. Receivers ST-2, ST-3, R-3, and R-4 represent a total of 63 residences in Area B. Detailed modeling analysis was conducted for a barrier located at the edge of the shoulder. The barrier evaluated is identified as Barrier NB-1 in Figure 5-1. Barrier heights in the range of 6 to 16 feet were evaluated in 2-foot increments. Table D-1 in Appendix D summarizes the results of the barrier analysis for each receiver location in Area B. Reasonable allowance calculation sheets for this barrier are provided in Worksheets C1 through C5 in Appendix C. Table 7-1 summarizes the calculated noise reductions and reasonable allowances for each barrier height.

Table 7-1. Summary of Reasonableness Determination Data—Barrier NB-1[a]

Barrier I.D.: NB-1 in Area B						
Predicted Sound Level without Barrier						
Critical Design Receiver: NB-1						
Design Year Noise Level, dBA L_{eq}(h): 70						
Design Year Noise Level Minus Existing Noise Level: 3						
Design Year with Barrier	**6-Foot Barrier**	**8-Foot Barrier**	**10-Foot Barrier**	**12-Foot Barrier**	**14-Foot Barrier**	**16-Foot Barrier**
Barrier Noise Reduction, dB	NA	5	6	7	8	9
Number of Benefited Residences	NA	14	30	63	63	63
New Highway or More than 50% of Residences Predate 1978[b]	NA	Yes	Yes	Yes	Yes	Yes
Reasonable Allowance Per Benefited Residence	NA	$52,000	$54,000	$54,000	$54,000	$56,000
Total Reasonable Allowance	NA	$728,000	$1.620M	$3.150M	$3.40M	$3.530M

Note: NA-Not applicable. Barrier does not provide 5 dB of noise reduction.

[a] An NADR will be prepared that will identify noise barrier construction cost information and the noise barriers that are reasonable from a cost perspective.

[b] This adjustment increases the abatement allowance by $10,000 if the project is new highway construction or if most of the benefited residences (more than 50%) existed before January 1, 1978.

7.2.3. Area C

The traffic noise modeling results in Table B-1 indicate traffic noise levels at commercial uses in Area C will be 70 dBA L_{eq}(h) in the design year. The results also indicate that the increase in noise between existing conditions and the design year is 3 dB. Because the predicted noise level in the design year is not predicted to approach or exceed the noise abatement criterion (72 dBA L_{eq}[h]) or result in a substantial increase in noise, noise abatement does not need to be considered in this area.

7.2.4. Area D

The traffic noise modeling results in Table B-1 indicate traffic noise levels at the hotel and church will be 70 dBA L_{eq}(h) in the design year and that the increase in noise will be 3 dB. Because the predicted noise level in the design year is predicted to approach or exceed the noise abatement criterion (67 dBA L_{eq}[h]), noise abatement must be considered in this area.

All of the outdoor use areas at the church and hotel that are directly exposed to noise from traffic on SR 26 are parking areas. Parking areas are not considered to be areas of frequent human use that would benefit from a lowered noise level. Therefore, noise abatement is not considered further in this area.

Chapter 8. Construction Noise

23 CFR 772 requires that construction noise impacts be identified, but does not specify specific methods or abatement criteria for evaluating construction noise. However, the FHWA Roadway Construction Noise Model (Federal Highway Administration 2006) can be used to determine if construction would result in adverse construction noise impacts on land uses or activities in the project area. The discussion of construction noise impacts includes:

- A description of the type of equipment anticipated to be used and when and where it will be used;
- Predicted construction noise levels in the project area;
- Conclusions regarding the severity of construction noise impacts; and
- Identification of construction noise abatement, if any.

If adverse construction noise impacts are anticipated (e.g. nighttime pile driving near residences), project plans and specifications should identify abatement measures that would minimize or eliminate adverse construction noise impacts to the community. In determining the feasibility of construction noise abatement, Caltrans will consider the benefits achieved and the overall adverse social, economic, and environmental effects and the costs of the construction noise abatement measures.

The following is sample text for this chapter.

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During construction of the project, noise from construction activities may intermittently dominate the noise environment in the immediate area of construction. Construction noise is regulated by Caltrans Standard Specifications Section 7-1.01I, "Sound Control Requirements," which states that noise levels generated during construction shall comply with applicable local, state, and federal regulations, and that all equipment shall be fitted with adequate mufflers according to the manufacturers' specifications.

Table 8-1 summarizes noise levels produced by construction equipment that is commonly used on roadway construction projects. Construction equipment is expected to generate noise levels ranging from 70 to 90 dB at a distance of 50 feet, and noise produced by construction equipment would be reduced over distance at a rate of about 6 dB per doubling of distance.

Table 8-1. Construction Equipment Noise

Equipment	Maximum Noise Level (dBA at 50 feet)
Scrapers	89
Bulldozers	85
Heavy Trucks	88
Backhoe	80
Pneumatic Tools	85
Concrete Pump	82

Source: Federal Transit Administration 1995.

No adverse noise impacts from construction are anticipated because construction would be conducted in accordance with Caltrans Standard Specifications Section 7-1.01I and applicable local noise standards. Construction noise would be short-term, intermittent, and overshadowed by local traffic noise. Further, implementing the following measures would minimize the temporary noise impacts from construction:

- All equipment will have sound-control devices that are no less effective than those provided on the original equipment. No equipment will have an unmuffled exhaust.

- As directed by Caltrans, the contractor will implement appropriate additional noise mitigation measures, including changing the location of stationary construction equipment, turning off idling equipment, rescheduling construction activity, notifying adjacent residents in advance of construction work, and installing acoustic barriers around stationary construction noise sources.

Chapter 9. References

This chapter contains references cited in the NSR. The format for cited references is provided below. References cited in the boiler plate and example text are also provided below.

Books, Journal Articles, Reports: [Author(s). YEAR Title. Publisher/Source. Volume: Page begin-Page end].

Correspondence: [Author(s). Date. Subject. Agency/Company. Pp. (pages)].

Phone: [Contact Name. Date. Subject. Agency/Company. Phone Number. Result/Action].

E-mail: [Contact Name. Date. Subject. Agency/Company. E-mail address. Result/Action].

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Appendix A Traffic Data

This appendix contains tables presenting the traffic data for existing conditions, design year conditions without the project, and design year conditions with the project for each alternative.

Tables A-1 through A-3 are sample tables containing traffic data.

[Begin typing here].

Table A-1. Traffic Data for Existing Conditions

	Segment	Number of Lanes	Total Volume PM Peak Hour Volume	Auto		Medium Trucks		Heavy Trucks		Speed (A/MT/HT)
				%	Volume	%	Volume	%	Volume	
Mainline										
SR 26 eastbound	West of Main Street	2	3,760	90.0%	3,389	3.0%	113	7.0%	264	65/65/55
SR 26 eastbound[a]	Main Street to Maple Avenue	2	4,000	90.0%	3,600	3.0%	120	7.0%	280	65/65/55
SR 26 eastbound	East of Maple Avenue	2	3,860	90.0%	3,476	3.0%	116	7.0%	270	65/65/55
SR 26 westbound	West of Main Street	2	3,620	89.0%	3,224	4.0%	145	7.0%	254	65/65/55
SR 26 westbound[a]	Main Street to Maple Avenue	2	4,000	89.0%	3,560	4.0%	160	7.0%	280	65/65/55
SR 26 westbound	East of Maple Avenue	2	3,740	89.0%	3,333	4.0%	150	7.0%	262	65/65/55
Surface Streets										
Main Street	North of SR 26	2	640	97.0%	626	2.0%	13	1.0%	6	35
Main Street	South of SR 26	2	720	97.0%	700	2.0%	14	1.0%	7	35
Maple Avenue	North of SR 26	2	710	97.0%	684	2.0%	14	1.0%	7	35
Maple Avenue	South of SR 26	2	640	97.0%	625	2.0%	13	1.0%	6	35

[a] Forecast peak hour volume exceeds 2,000 vehicles per lane per hour (vplph). Volume has been limited to 2,000 vplph to model the maximum noise condition.

Table A-2. Traffic Data for Design Year No-Project Conditions

	Segment	Number of Lanes	Total Volume PM Peak Hour Volume	Auto		Medium Trucks		Heavy Trucks		Speed
				%	Volume	%	Volume	%	Volume	
Mainline										
SR 26 eastbound[a]	West of Main Street	2	4,000	90.0%	3,600	3.0%	120	7.0%	280	65/65/55
SR 26 eastbound[a]	Main Street to Maple Avenue	2	4,000	90.0%	3,600	3.0%	120	7.0%	280	65/65/55
SR 26 eastbound[a]	East of Maple Avenue	2	4,000	90.0%	3,600	3.0%	120	7.0%	280	65/65/55
SR 26 westbound[a]	West of Main Street	2	4,000	89.0%	3,560	4.0%	160	7.0%	280	65/65/55
SR 26 westbound[a]	Main Street to Maple Avenue	2	4,000	89.0%	3,560	4.0%	160	7.0%	280	65/65/55
SR 26 westbound[a]	East of Maple Avenue	2	4,000	89.0%	3,560	4.0%	160	7.0%	280	65/65/55
Surface Streets										
Main Street	North of SR 26	2	760	97.0%	722	2.0%	15	1.0%	7	35
Main Street	South of SR 26	2	840	97.0%	810	2.0%	17	1.0%	8	35
Maple Avenue	North of SR 26	2	820	97.0%	797	2.0%	16	1.0%	8	35
Maple Avenue	South of SR 26	2	700	97.0%	685	2.0%	14	1.0%	7	35

[a] Forecast peak hour volume exceeds 2,000 vehicles per lane per hour (vplph). Volume has been limited to 2,000 vplph to model the maximum noise condition.

Table A-3. Traffic Data for Design Year With Project Conditions

	Segment	Number of Lanes	Total Volume PM Peak Hour Volume	Auto		Medium Trucks		Heavy Trucks		Speed
				%	Volume	%	Volume	%	Volume	
Mainline										
SR 26 eastbound	West of Main Street	3	5,120	90.0%	4,608	3.0%	154	7.0%	358	65/65/55
SR 26 eastbound	Main Street to Maple Avenue	3	4,960	90.0%	4,464	3.0%	149	7.0%	347	65/65/55
SR 26 eastbound	East of Maple Avenue	3	5,440	90.0%	4,896	3.0%	163	7.0%	381	65/65/55
SR 26 westbound	West of Main Street	3	5,890	89.0%	5,242	4.0%	236	7.0%	412	65/65/55
SR 26 westbound	Main Street to Maple Avenue	3	4,840	89.0%	4,308	4.0%	194	7.0%	339	65/65/55
SR 26 westbound	East of Maple Avenue	3	4,760	89.0%	4,236	4.0%	190	7.0%	333	65/65/55
Surface Streets										
Main Street	North of SR 26	2	840	97.0%	817	2.0%	17	1.0%	8	35
Main Street	South of SR 26	2	890	97.0%	863	2.0%	18	1.0%	9	35
Maple Avenue	North of SR 26	2	906	97.0%	879	2.0%	18	1.0%	9	35
Maple Avenue	South of SR 26	2	840	97.0%	819	2.0%	17	1.0%	8	35

Appendix B Predicted Future Noise Levels and Noise Barrier Analysis

This appendix contains a table (or tables) that summarizes the traffic noise modeling results for existing and design-year conditions with and without the project. This table also compares the predicted noise reductions by barrier height for each noise barrier analyzed.

Table B-1 is a sample table.

[Begin typing here]

Table B-1. Predicted Future Noise and Barrier Analysis

Receiver I.D.	Area	Barrier I.D.	Land Use	Number of Dwelling Units	Address	Existing Noise Level $L_{eq}(h)$, dBA	SR-26 Future Worst Hour Noise Levels - $L_{eq}(h)$, dBA																							
							Design Year Noise Level without Project $L_{eq}(h)$, dBA	Design Year Noise Level with Project $L_{eq}(h)$, dBA	Design Year Noise Level without Project minus Existing Conditions $L_{eq}(h)$, dBA	Design Year Noise Level with Project Minus No Project Conditions $L_{eq}(h)$, dBA	Activity Category (NAC)	Impact Type	Noise Prediction with Barrier, Barrier Insertion Loss (I.L.), and Number of Benefited Receivers (NBR)																	
													6 feet			8 feet			10 feet			12 feet			14 feet			16 feet		
													$L_{eq}(h)$	I.L.	NBR	$L_{eq}(h)$	I.L.	NBR	$L_{eq}(h)$	I.L.	NBR	$L_{eq}(h)$	I.L.	NBR	$L_{eq}(h)$	I.L.	NBR	$L_{eq}(h)$	I.L.	NBR
ST-1	A	-	Residential	14	123 Chestnut Drive	61	63	64	3	1	B (67)	None	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
R-1	A	-	Residential	10	345 Chestnut Drive	62	64	65	3	1	B (67)	None	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
ST-2 (LT-1)	B	NB-1	Residential	14	485 Chestnut Drive	66	68	69	3	1	B (67)	A/E	65	4	0	64	5	14	63[a]	6	14	62	7	14	61	8	14	60	9	14
ST-3	B	NB-1	Residential	16	685 Chestnut Drive	67	69	70	3	1	B (67)	A/E	67	3	0	66	4	0	65[a]	5	16	64	6	16	63	7	16	61	9	16
R-3	B	NB-1	Residential	15	480 Chestnut Drive	61	63	64	3	1	B (67)	A/E	62	2	0	61	3	0	60[a]	4	0	59	5	15	58	6	15	58	6	15
R-4	B	NB-1	Residential	18	680 Chestnut Drive	62	64	65	3	1	B (67)	A/E	64	1	0	63	2	0	61[a]	4	0	60	5	18	60	5	18	59	6	18
R-2	C	-	Commercial	None	120 Pecan Drive	67	69	70	3	1	C (72)	None	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
ST-4	D	-	Hotel, Church	None	159 Pecan Drive	67	69	70	3	1	B (67)	A/E	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–

Note: A/E= Future noise conditions approach or exceed the Noise Abatement Criteria.

[a] Minimum height needed to break the line of sight between 11.5 foot truck stack and first row receivers.

Appendix C Noise Barrier Reasonableness Analysis Worksheet

This appendix includes the worksheets for the calculation of reasonableness allowances for each analyzed noise barrier.

Worksheets C1 through C5 are sample worksheets.

[Begin typing here].

Worksheet C-1

CALCULATION OF REASONABLE ALLOWANCE

PROJECT: SR 26 Widening Project	PROJECT LOCATION: Clark County		Date: 9-12-2007
NOISE BARRIER I.D. & LOCATION:	NB1, Area B, 8 feet high		
NOISE ANALYST: Buehler			
Base Allowance (2006 Dollars)			$36,000
1) Absolute Noise Levels (Choose One)	70 dBA*	Check	
69 dBA or less:	Add $ 2,000		
70-74 dBA:	Add $ 4,000	√	$4,000
75-78 dBA:	Add $ 6,000		
More than 78 dBA:	Add $ 8,000		
2) "Build" VS Existing Noise Levels (Choose One)	3 dBA*	Check	
Less than 3 dBA:	Add $ 0		
3-7 dBA:	Add $ 2,000	√	$2,000
8-11 dBA:	Add $ 4,000		
12 dBA or more:	Add $ 6,000		
3) Achievable Noise Reduction (Choose One)	5 dBA*	Check	
Less than 6 dBA:	Add $ 0	√	$0
6-8 dBA:	Add $ 2,000		
9-11 dBA:	Add $ 4,000		
12 dBA or more:	Add $ 6,000		
4) Either New Construction Or Pre-date 1978? (Choose Yes or No)			
YES on either one:	Add $10,000	√	$10,000
NO on both:	Add $ 0		
Unmodified Reasonable Allowance Per Residence			$52,000
Number of Benefited Residences			14
Total Unmodified Reasonable Allowance			$728,000

* at Critical Design Receiver

Worksheet C-2

CALCULATION OF REASONABLE ALLOWANCE

PROJECT: SR 26 Widening Project	PROJECT LOCATION: Clark County		Date: 9-12-2007
NOISE BARRIER I.D. & LOCATION:	NB1, Area B, 10 feet high		
NOISE ANALYST: Buehler			
Base Allowance (2006 Dollars)			$36,000
1) Absolute Noise Levels (Choose One)	70 dBA*	Check	
69 dBA or less: 70-74 dBA: 75-78 dBA: More than 78 dBA:	Add $ 2,000 Add $ 4,000 Add $ 6,000 Add $ 8,000	√	$4,000
2) "Build" VS Existing Noise Levels (Choose One)	3 dBA*	Check	
Less than 3 dBA: 3-7 dBA: 8-11 dBA: 12 dBA or more:	Add $ 0 Add $ 2,000 Add $ 4,000 Add $ 6,000	√	$2,000
3) Achievable Noise Reduction (Choose One)	6 dBA*	Check	
Less than 6 dBA: 6-8 dBA: 9-11 dBA: 12 dBA or more:	Add $ 0 Add $ 2,000 Add $ 4,000 Add $ 6,000	√	$2,000
4) Either New Construction Or Pre-date 1978? (Choose Yes or No)			
YES on either one: NO on both:	Add $10,000 Add $ 0	√	$10,000
Unmodified Reasonable Allowance Per Residence			$54,000
Number of Benefited Residences			30
Total Unmodified Reasonable Allowance			$1,620,000

* at Critical Design Receiver

Worksheet C-3

CALCULATION OF REASONABLE ALLOWANCE

PROJECT: SR 26 Widening Project	PROJECT LOCATION: Clark County		Date: 9-12-2007
NOISE BARRIER I.D. & LOCATION:	NB1, Area B, 12 feet high		
NOISE ANALYST: Buehler			
Base Allowance (2006 Dollars)			$36,000
1) Absolute Noise Levels (Choose One)	70 dBA*	Check	
69 dBA or less: 70-74 dBA: 75-78 dBA: More than 78 dBA:	Add $ 2,000 Add $ 4,000 Add $ 6,000 Add $ 8,000	√	$4,000
2) "Build" VS Existing Noise Levels (Choose One)	3 dBA*	Check	
Less than 3 dBA: 3-7 dBA: 8-11 dBA: 12 dBA or more:	Add $ 0 Add $ 2,000 Add $ 4,000 Add $ 6,000	√	$2,000
3) Achievable Noise Reduction (Choose One)	7 dBA*	Check	
Less than 6 dBA: 6-8 dBA: 9-11 dBA: 12 dBA or more:	Add $ 0 Add $ 2,000 Add $ 4,000 Add $ 6,000	√	$2,000
4) Either New Construction Or Pre-date 1978? (Choose Yes or No)			
YES on either one: NO on both:	Add $10,000 Add $ 0	√	$10,000
Unmodified Reasonable Allowance Per Residence			$54,000
Number of Benefited Residences			63
Total Unmodified Reasonable Allowance			$3,402,000

* at Critical Design Receiver

Worksheet C-4

CALCULATION OF REASONABLE ALLOWANCE

PROJECT: SR-26 Widening Project	PROJECT LOCATION: Clark County		Date: 9-12-2007
NOISE BARRIER I.D. & LOCATION:	NB1, Area B, 14 feet high		
NOISE ANALYST: Buehler			
Base Allowance (2006 Dollars)			$36,000
1) Absolute Noise Levels (Choose One)	70 dBA*	Check	
69 dBA or less:	Add $ 2,000		
70-74 dBA:	Add $ 4,000	√	$4,000
75-78 dBA:	Add $ 6,000		
More than 78 dBA:	Add $ 8,000		
2) "Build" VS Existing Noise Levels (Choose One)	3 dBA*	Check	
Less than 3 dBA:	Add $ 0		
3-7 dBA:	Add $ 2,000	√	$2,000
8-11 dBA:	Add $ 4,000		
12 dBA or more:	Add $ 6,000		
3) Achievable Noise Reduction (Choose One)	8 dBA*	Check	
Less than 6 dBA:	Add $ 0		
6-8 dBA:	Add $ 2,000	√	$2,000
9-11 dBA:	Add $ 4,000		
12 dBA or more:	Add $ 6,000		
4) Either New Construction Or Pre-date 1978? (Choose Yes or No)			
YES on either one:	Add $10,000	√	$10,000
NO on both:	Add $ 0		
Unmodified Reasonable Allowance Per Residence			$54,000
Number of Benefited Residences			63
Total Unmodified Reasonable Allowance			$3,402,000

* at Critical Design Receiver

Worksheet C-5

CALCULATION OF REASONABLE ALLOWANCE

PROJECT: SR-26 Widening Project	PROJECT LOCATION: Clark County		Date: 9-12-2007
NOISE BARRIER I.D. & LOCATION:	NB1, Area B, 16 feet high		
NOISE ANALYST: Buehler			
Base Allowance (2006 Dollars)			$36,000
1) Absolute Noise Levels (Choose One)	70 dBA*	Check	
69 dBA or less: 70-74 dBA: 75-78 dBA: More than 78 dBA:	Add $ 2,000 Add $ 4,000 Add $ 6,000 Add $ 8,000	√	$4,000
2) "Build" VS Existing Noise Levels (Choose One)	3 dBA*	Check	
Less than 3 dBA: 3-7 dBA: 8-11 dBA: 12 dBA or more:	Add $ 0 Add $ 2,000 Add $ 4,000 Add $ 6,000	√	$2,000
3) Achievable Noise Reduction (Choose One)	9 dBA*	Check	
Less than 6 dBA: 6-8 dBA: 9-11 dBA: 12 dBA or more:	Add $ 0 Add $ 2,000 Add $ 4,000 Add $ 6,000	√	$4,000
4) Either New Construction Or Pre-date 1978? (Choose Yes or No)			
YES on either one: NO on both:	Add $10,000 Add $ 0	√	$10,000
Unmodified Reasonable Allowance Per Residence			$56,000
Number of Benefited Residences			63
Total Unmodified Reasonable Allowance			$3,528,000

* at Critical Design Receiver

Appendix D Noise Barrier Analysis

This appendix contains a table that compares the predicted noise reductions by barrier height for each noise barrier analyzed.

Table D-1 is a sample table for a noise barrier analysis.

[Begin typing here]

Table D-1. Analysis of Barrier NB-1

	Position				Total Number of Benefited Receivers
	ST-2	St-3	R-3	R-4	
Number of Units Represented	14	16	15	18	
Existing Traffic Noise Level (dBA L_{eq}[h])	66	67	61	62	
Design Year with Project Traffic Noise Level (dBA L_{eq}[h])	**69**	**70**	**64**	**65**	
Design Year with Project minus Existing Traffic Noise Level (dBA L_{eq}[h])	+3	+3	+3	+3	
6-Foot Barrier					
Design Year with Project Traffic Noise Level (dBA L_{eq}[h])	65	**67**	**62**	**64**	
Predicted Noise Reduction (dB)	-4	-3	2	1	
Number of Benefited Receivers	0	0	0	0	0
8-Foot Barrier					
Design Year with Project Traffic Noise Level (dBA L_{eq}[h])	64	**66**	**61**	**63**	
Predicted Noise Reduction (dB)	-5	-4	-3	-2	
Number of Benefited Receivers	14	0	0	0	14
10-Foot Barrier					
Design Year with Project Traffic Noise Level (dBA L_{eq}[h])	63	65[a]	60	61	
Predicted Noise Reduction (dB)	-6	-5	4	4	
Number of Benefited Receivers	14	16	0	0	30
12-Foot Barrier[b]					
Design Year with Project Traffic Noise Level (dBA L_{eq}[h])	62	64	59	60	
Predicted Noise Reduction (dB)	-7	-6	-5	-5	
Number of Benefited Receivers	14	16	15	18	63
14-Foot Barrier					
Design Year with Project Traffic Noise Level (dBA L_{eq}[h])	61	63	58	60	
Predicted Noise Reduction (dB)	-8	-7	-6	-5	
Number of Benefited Receivers	14	16	15	18	63
16-Foot Barrier					
Design Year with Project Traffic Noise Level (dBA L_{eq}[h])	60	61	58	59	
Predicted Noise Reduction (dB)	-9	-9	-6	-6	
Number of Benefited Receivers	14	16	15	18	63

[a] Traffic noise levels that approach or exceed 67 dBA L_{eq}(h) are shown in bold.
[b] 12-foot-high barrier breaks the line of sight to an 11.5-foot truck stack.

Appendix E Supplemental Data

Supplemental data such as field notes, photographs, and other data from the field investigation should be provided here.