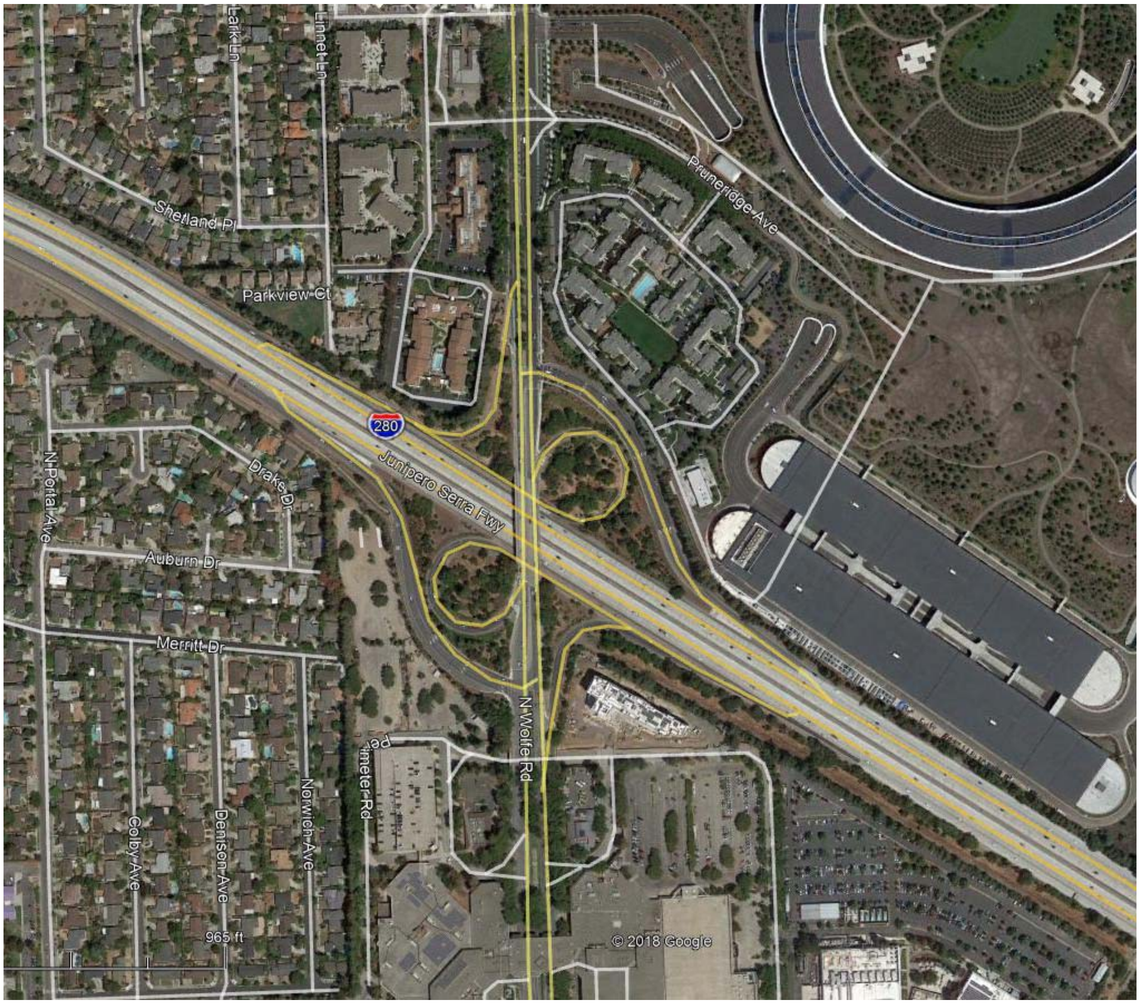
I-280/Wolfe Road Interchange Improvement Project



Noise Study Report

I-280/WOLFE ROAD INTERCHANGE IMPROVEMENT PROJECT

CUPERTINO, CALIFORNIA

04-SCL-280-PM 8.1/8.6

EA 1K300 – ID 0416000226

October 2019

Caltrans

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Summary

The California Department of Transportation (Caltrans), in cooperation with the Santa Clara Valley Transportation Authority (VTA) and the City of Cupertino, proposes to make roadway improvements to the Interstate 280 (I-280)/Wolfe Road Interchange in the City of Cupertino within Santa Clara County. The project extends from Interstate 280 Post Mile 8.1 to 8.6. The purpose of the proposed project is to improve traffic operations and facilities for multimodal forms of transportation, including bicycle, pedestrian, and high occupancy vehicle uses.

The purpose of this Noise Study Report (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." According to 23 CFR 772, 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 I-280/Wolfe Road Improvement Project (project) is a Type I Project because it would involve the construction of new roadway lanes and receive federal funding from the FHWA administered through Caltrans. Therefore, the project requires noise abatement to be considered for impacted receptors. Compliance with 23 CFR 772 provides compliance with the noise impact assessment requirements of the National Environmental Policy Act (NEPA).

The project is located in an area with relatively flat terrain. Activity Category B (residential), Category C (parks and sports areas), Category E (restaurants and hotels), and Category F (storage and industrial) land uses were identified in the vicinity of the project. Vehicles traveling along I-280 and Wolfe Road are the primary source of noise for receptors located along the project alignment. The study included noise measurements, calculations of future noise levels with the construction and operation of the project, and identification of measures to reduce construction noise levels and to abate traffic noise levels at adjacent receptors. The FHWA Traffic Noise Model, TNM 2.5, was used to calculate existing and future traffic noise levels and analyze traffic noise impacts. The model was validated based on measured noise and traffic conditions documented during the field survey. Following validation, noise levels were assessed in TNM 2.5 based on future traffic conditions provided by *Fehr and Peers*. Three Build Alternatives were assessed.

The Caltrans Traffic Noise Analysis Protocol for New Highway Construction, Reconstruction, and Retrofit Barrier Projects (Protocol) defines a noise increase as substantial when the predicted noise levels with project implementation exceed existing noise levels by 12 dBA or more. Noise levels are calculated to increase by up to 2 dBA over Existing conditions assuming 2045 No Build conditions. Build Alternatives A, B, and C would increase noise levels by up to 9 dBA over Existing and No Build conditions. These predicted noise level increases are not considered substantial.

Loudest-hour noise levels at Category B land uses are calculated to range from 50 to 69 dBA $L_{eq[h]}$ under Existing conditions, from 52 to 69 dBA $L_{eq[h]}$ under 2045 No Build conditions, from 51 to 69 dBA $L_{eq[h]}$ under 2045 Build Alternatives A and B, and from 50 to 69 dBA $L_{eq[h]}$ under 2045 Build Alternative C. The loudest-hour noise levels at Category C land uses are calculated to range from 61 to 74 dBA $L_{eq[h]}$ under Existing conditions, from 62 to 74 dBA $L_{eq[h]}$ under 2045 No Build conditions, from 63 to 74 dBA $L_{eq[h]}$ under 2045 Build Alternative A, from 63 to 70 dBA $L_{eq[h]}$ under 2045 Build Alternative B, and from 63 to 73 dBA $L_{eq[h]}$ under 2045 Build Alternative C. The loudest-hour noise levels at Category E land uses are calculated to range from 64 to 75 dBA $L_{eq[h]}$ under Existing conditions, from 64 to 76 dBA $L_{eq[h]}$ under 2045 No Build conditions, from 64 to 76 dBA $L_{eq[h]}$ under 2045 Build Alternative A, from 63 to 76 dBA $L_{eq[h]}$ under 2045 Build Alternative B, and from 64 to 76 dBA $L_{eq[h]}$ under 2045 Build Alternative C.

Under Build conditions, traffic noise levels are predicted to approach or exceed the Noise Abatement Criteria (NAC) at first row Category B and C receptors located to the north and south of I-280, west of Wolfe Road, and at second and third story balconies at the Marriott Hotel. These receptors are located behind existing noise barriers, some of which are proposed to be removed with the project under Build Alternatives A, B, and C.

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. Noise abatement, in the form of replacement and increased height noise barriers, was assessed for receptors where noise levels would approach or exceed the NAC and where an existing wall is anticipated to remain and is less than 14-feet high. A total of three potential barriers were evaluated for feasibility and acoustical reasonableness (i.e., would achieve the Caltrans noise reduction goal) under Alternatives A, B, and C. Of the three barriers evaluated, only Barrier 3 was found to be feasible and to achieve the Caltrans noise reduction design goal (minimum 7 dB reduction for at least one receptor). As shown in Table ES-1, the total reasonable allowance for Barrier 3 varies by alternative and ranges from $2,782,000 to $8,132,000.

This study does not include an analysis of noise barrier cost-effectiveness. Noise barrier cost-effectiveness will be assessed and documented in the Noise Abatement Decision Report (NADR). The final decision to include noise barriers in the proposed project design must consider reasonableness factors, such as cost-effectiveness, as well as other feasibility considerations including topography, access requirements, other noise sources, safety, and information developed during the design and public review process. Table ES-1 lists the reasonableness allowance calculated for all barriers that were calculated to be acoustically feasible and meet the Caltrans noise reduction design goal.

Construction activities would result in temporary increases to noise levels at adjacent noise-sensitive receptors. Construction activities would be conducted following applicable local regulations and would be short-term and intermittent. Measures to reduce construction noise are included in this report.

Table ES-1. Summary of Acoustically Feasible and Resonable Noise Barriers and Replacement Barriers

Barrier ID	Approximate Stationing/ Location[a]	Alternative	Noise Level w/o Barrier at Benefited Receptors ($L_{eq[h]}$)	Barrier Height (feet)	Insertion Loss (dBA)	Number of Benefited Receptors	Total Reasonable Monetary Allowance
3	NB On Ramp from SB Wolfe Road, Sta. 257 to 271 (1,320 ft)	A	63-76	8	5-8	33	$3,531,000
				10	5-10	47	$5,029,000
				12 [b]	5-11	69	$7,383,000
				14 [b]	5-11	76	$8,132,000
				16 [b]	5-12	76	$8,132,000
3	NB On Ramp from SB Wolfe Road, Sta. 257 to 271 (1,320 ft)	B	61-76	8	5-8	40	$4,280,000
				10	5-9	47	$5,029,000
				12 [b]	6-9	54	$5,778,000
				14 [b]	5-10	62	$6,634,000
				16 [b]	5-10	76	$8,132,000
3	NB On Ramp from SB Wolfe Road, Sta. 257 to 271 (1,320 ft)	C	65-76	8	5-8	26	$2,782,000
				10	6-9	26	$2,782,000
				12 [b]	5-10	41	$4,387,000
				14 [b]	6-10	41	$4,387,000
				16 [b]	6-11	41	$4,387,000

a Barrier lengths are based on linear approximations used for purposes of noise modeling in TNM 2,5. Actual lengths may differ slightly due to barrier curvature, etc.

b Barrier breaks line of sight between 11.5-foot high truck stack and 5-foot high receptor.

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List of Abbreviated Terms

23CFR772	Title 23, Part 772 of the Code of Federal Regulations
Caltrans	California Department of Transportation
CEQA	California Environmental Quality Act
CFR	Code of Federal Regulations
CNEL	Community Noise Equivalent Level
dB	Decibel
dBA	A-Weighted Decibel
FHWA	Federal Highway Administration
Hz	Hertz
I-280	Interstate 280
kHz	Kilohertz
L_{dn}	Day-Night Level
L_{eq}	Equivalent Sound Level
$L_{eq[h]}$	Equivalent Sound Level over one hour
L_{xx}	Percentile-Exceeded Sound Level
LT	Long-Term Reference Noise Measurement
L_{max}	Maximum Instantaneous Sound Level
mPa	micro-Pascals
mph	miles per hour
NAC	Noise Abatement Criteria
NADR	Nosie Abatement Decision Report
NEPA	National Environmental Policy Act
NSR	Noise Study Report
Protocol	Traffic Noise Analysis Protocol for New Highway Construction, Reconstruction, and Retrofit Barrier Projects
RCNM	FHWA Roadway Construction Noise Model v.1.0
ROW	Right of Way
SLM	Sound Level Meter
SPL	Sound Pressure Level
ST	Short-Term Noise Measurement
TeNS	Caltrans' Technical Noise Supplement
TOAR	Traffic Operations Analysis Report
TNAP	Traffic Noise Analysis Protocol for New Highway Construction, Reconstruction, and Retrofit Barrier Projects
TNM 2.5	FHWA Traffic Noise Model Version 2.5

Chapter 1. Introduction

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. Compliance with 23 CFR 772 provides compliance with the noise impact assessment requirements of the National Environmental Policy Act (NEPA).

The Caltrans Traffic Noise Analysis Protocol for New Highway Construction, Reconstruction, and Retrofit Barrier Projects (Protocol) (Caltrans 2011) provides Caltrans policy for implementing 23 CFR 772 in California. The Protocol outlines the requirements for preparing noise study reports. The primary objective of the NSR is to identify noise-sensitive receptors where noise levels would approach or exceed the Noise Abatement Criteria (NAC) with the project or receptors that would experience a substantial increase in noise levels as a result of the project. Noise impacts associated with this project under the California Environmental Quality Act (CEQA) are not evaluated in the NSR. The determination of CEQA and NEPA noise impacts are determined by the Project Development Team and will be disclosed in the project's Initial Study/Environmental Assessment (IS/EA) .

This NSR documents the assessment of existing and future traffic noise levels at noise sensitive receptors in the vicinity of the proposed project and identifies whether or not preliminary noise abatement measures are necessary for the project to comply with State and Federal noise abatement/mitigation requirements. The primary objective of this study is to identify noise sensitive receptors where noise levels would approach or exceed the NAC with the project or receptors that would experience a substantial increase in noise levels as a result of the project.

1.2. Project Purpose and Need

The purpose of the proposed project is to improve traffic operations and facilities for multimodal forms of transportation, including bicycle, pedestrian, and high occupancy vehicle (HOV) uses, at the Interstate 280 (I-280)/Wolfe Road Interchange in the City of Cupertino.

Wolfe Road is a key connector between job locations and housing, commercial, and retail developments. The existing interchange at I-280 is congested with significant delays, which are projected to worsen due to planned growth in the area. Sidewalks and bike lanes are narrow and cross high-speed, at-grade ramp connections, which discourages use by pedestrians and bicyclists. The interchange configuration is not consistent with Caltrans' Complete Streets design guidelines or the City General Plan vision for a walkable, bikeable community.

Chapter 2. Project Description

In addition to the No Build Alternative, the following three build alternatives are evaluated in this technical report:

- Alternative A: Partial Cloverleaf Interchange – Widen Overcrossing
- Alternative B: Partial Cloverleaf Interchange – Replace Overcrossing
- Alternative C: Diverging Diamond Interchange – Replace Overcrossing

2.1. No Build

Under the No Build Alternative, none of the project features described under the project would be constructed.

2.2. Build Alternative A: Partial Cloverleaf Interchange – Widen Overcrossing

Alternative A would modify the existing I-280/Wolfe Road Interchange by constructing the following improvements:

- The existing Wolfe Road bridge structure over I-280 would be widened from 63 feet to approximately 164 feet. The overcrossing would be widened from two (2) through lanes northbound and two (2) through lanes southbound, to three (3) through lanes and one (1) right-turn lane northbound and three (3) through lanes and one (1) right-turn lane southbound. The new right-turn lanes on the overcrossing would lead to loop freeway on-ramps that modify or replace the existing ones.

- The existing collector-distributor roads[1] that currently connect to the northbound and southbound loop on-ramps and merge with the northbound and southbound at-grade entrances to I-280 would be removed so that the new northbound and southbound loop on-ramps connect directly to the freeway. Retaining walls would be constructed beneath the Wolfe Road overcrossing structure at both the northbound and southbound loop on-ramps.

[1] A collector-distributor road is typically constructed on the freeway system where there is a relatively short distance between adjacent ramps. The collector-distributor road facilitates traffic operations and safety by separating merging and weaving traffic from through traffic.

- The diagonal on-ramp to northbound I-280 would be realigned, squared up[2], and widened from one (1) mixed-flow lane[3] to two (2) mixed-flow lanes and one (1) HOV lane with a new ramp meter.

- The diagonal on-ramp to southbound I-280 would be realigned, squared up, and widened from one (1) mixed-flow lane and one (1) HOV lane to two (2) mixed-flow lanes and one (1) HOV lane with a new ramp meter.

- The loop on-ramp to northbound I-280 would be realigned, squared up, and widened from one (1) mixed-flow lane and one (1) HOV lane to two (2) mixed-flow lanes and one (1) HOV lane with a new ramp meter.

- The loop on-ramp to southbound I-280 would be realigned, squared up, and widened from one (1) mixed-flow lane and one (1) HOV lane to two (2) mixed-flow lanes and one (1) HOV lane with a new ramp meter.

- The existing two-lane (2) off-ramp from northbound I-280 that widens to four (4) lanes would be realigned and squared up. A new traffic signal would be installed at the off-ramp intersection with Wolfe Road.

- The existing two-lane off-ramp from southbound I-280 that widens to four (4) lanes would be realigned, squared up, and widened to five (5) lanes. A new traffic signal would be installed at the off-ramp intersection with Wolfe Road.

- Both the north and south Wolfe Road approaches to the I-280 overcrossing would be raised by up to six (6) feet to reduce the existing six (6) percent grade to four (4) percent. This increase in profile would necessitate the construction of retaining walls along the east and west sides of Wolfe Road both north and south of the interchange.

- The height of Wolfe Road at the existing Perimeter Road undercrossing structure would be raised by placing approximately three (3) feet of fill and roadway pavement over it so that the roadway elevation would conform to the proposed raised Wolfe Road profile.

- The existing concrete box culvert that carries the Junipero Serra Channel through the interchange along the south side of I-280 would be extended or modified to accommodate the realigned on-ramp by constructing retaining walls or wingwalls within the channel east of Wolfe Road.

- Existing soundwalls along the north side of I-280, west of Wolfe Road, which would be removed to accommodate the improvements, would be replaced. In

[2] Squaring up refers to realigning the on-ramp connection to the local street to create a sharper angle of approximately 90-degrees, with the intent to slow vehicles at pedestrian crosswalks.
[3] A "mixed-flow lane" is a lane that is open to all traffic irrespective of the number of occupants in the vehicle.

addition, new soundwalls may be constructed at other locations if warranted per the requirements of Caltrans' Traffic Noise Abatement Protocol (TNAP).

- Class IV bicycle lanes[4] and 10-foot wide sidewalks would be added on both northbound and southbound Wolfe Road within the project limits. A bicycle and pedestrian connection from Wolfe Road to Perimeter Road and/or the planned Junipero Serra Trail would be provided.

- A new bicycle and pedestrian connection would be included from Wolfe Road to Perimeter Road and the planned Junipero Serra Trail.

2.3. Build Alternative B: Partial Cloverleaf Interchange – Replace Overcrossing

Similar to Alternative A, Alternative B would modify the existing I-280/Wolfe Road Interchange with the same partial cloverleaf configuration. The key difference, however, would be that Alternative B would replace the existing Wolfe Road bridge structure over I-280, whereas Alternative A would simply widen the structure. Under Alternative B, the existing Wolfe Road bridge structure over I-280 would be removed and replaced with a new overcrossing structure approximately 390 feet in length and 180 feet in width. The new structure would accommodate three (3) through lanes and one (1) right-turn lane northbound and three (3) through lanes and one (1) right-turn lane southbound. The new overcrossing would be a concrete box girder structure, which is the same type as the existing overcrossing.

All of the other improvements described above for Alternative A would be constructed under Alternative B, with the following exceptions:

- Under Alternative B, both the north and south Wolfe Road approaches to the replacement I-280 overcrossing would be raised by up to ten feet to reduce the existing six (6) percent grade to four (4) percent. Thus, when compared to Alternative A, the Wolfe Road approaches would be four (4) feet higher under Alternative B.

- Under Alternative B, approximately six (6) feet of fill and pavement would be added on the existing Perimeter Road undercrossing structure, which may require replacement of the undercrossing structure or use of lightweight fill. In contrast, under Alternative A, only three (3) feet of fill and pavement would be added on the Perimeter Road undercrossing, which may not require the replacement of the structure.

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[4] The Highway Design Manual defines a Class IV bicycle lane is an on-street bicycle lane that is physically separated from the adjacent traffic lane.

2.4. Build Alternative C: Diverging Diamond Interchange – Replace Overcrossing

This alternative would modify the existing I-280 Wolfe Road Interchange by constructing the following improvements:

- The existing Wolfe Road bridge structure over I-280 would be removed and replaced with a new overcrossing structure having a width and length of approximately 152 feet and 280 feet, respectively. The new overcrossing would be a concrete box girder structure, which is the same type as the existing overcrossing. On the west side of the structure along Wolfe Road, there would be two (2) northbound through lanes, one (1) northbound through-left lane, and one (1) northbound free flow left-turn lane. On the east side of the structure, there would be two (2) southbound through lanes, one (1) southbound through-left lane, and one (1) southbound free flow left-turn lane.

- The existing intersections at Wolfe Road and the I-280 ramps would be replaced with two (2) "cross-over intersections" where northbound and southbound traffic on Wolfe Road cross over at new traffic signals at the ramp termini.

- Both the northbound and southbound I-280 loop on-ramps and the collector-distributor roads would be removed.

- The diagonal on-ramp to northbound I-280 would be realigned, squared up, and widened from one mixed-flow lane to three (3) mixed-flow lanes and no HOV preferential bypass lane with a new ramp meter.

- The diagonal on-ramp to southbound I-280 would be realigned, squared up, and widened from one (1) mixed-flow lane and one (1) HOV lane to three (3) mixed-flow lanes and no HOV preferential bypass lane with a new ramp meter.

- The existing two-lane off-ramp from northbound I-280 would be realigned, squared up, and widened to five (5) lanes to connect to Wolfe Road at the new "cross-over intersection" with two (2) right-turn lanes and three (3) left-turn lanes. A new traffic signal would be installed at the "cross-over intersection."

- The existing two-lane off-ramp from southbound I-280 would be realigned, squared up, and widened to five (5) lanes to connect to Wolfe Road at the new "cross-over intersection" with three (3) right-turn lanes and two (2) left-turn lanes. A new traffic signal would be installed at the "cross-over intersection".

- Both the north and south Wolfe Road approaches to the I-280 overcrossing would be raised by up to ten (10) feet to reduce the existing six (6) percent grade to four (4) percent. This increase would also accommodate falsework clearances required to build the new DDI overcrossing structure. Retaining walls would be constructed along the east and west sides of Wolfe Road both north and south of the interchange.

- Approximately six (6) feet of fill and pavement would be added on top the existing Perimeter Road undercrossing structure, which may require replacement of the undercrossing structure.

- The existing concrete box culvert that carries the Junipero Serra Channel through the interchange along the south side of I-280 would be extended or modified by constructing retaining walls or wingwalls within the top of bank east of Wolfe Road.

- Existing soundwalls along the north side of I-280, west of Wolfe Road, which would be removed to accommodate the improvements, would be replaced. In addition, new soundwalls may be constructed at other locations if warranted per the requirements of Caltrans' Traffic Noise Analysis Protocol (TNAP).

- Class IV separated bikeways and 10-foot wide sidewalks would be added on both northbound and southbound Wolfe Road.

- A new bicycle and pedestrian connection would be included from Wolfe Road to Perimeter Road and the planned Junipero Serra Trail.

Chapter 3. Fundamentals of Traffic Noise

The following is a brief discussion of fundamental traffic noise concepts. For a detailed discussion, please refer to Caltrans' Technical Noise Supplement (TeNS) (Caltrans 2013), a technical supplement to the Protocol that is available on Caltrans' Web site (http://www.dot.ca.gov/hq/env/noise/pub/TeNS_Sept_2013B.pdf). Technical terms are defined in Appendix A.

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 receptor, and the propagation path between the two. The loudness of the noise source and obstructions or atmospheric factors affecting noise propagation to the receptor determines sound level and characteristics of the noise perceived by the receptor. The field of acoustics deals primarily with the propagation and control of sound.

3.1. 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.

3.2. 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.

3.3. 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.

3.4. 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 a judgment of the relative loudness or annoyance of a sound, their judgment correlates 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 hall (background)
	— 20 —	
		Broadcast/recording studio
	— 10 —	
Lowest threshold of human hearing	**— 0 —**	Lowest threshold of human hearing

Source: Caltrans 2013.

3.5. 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 mid-frequency (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.

3.6. 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.

3.7. 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.

3.7.1. 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.

3.7.2. Ground Absorption

The propagation path of noise from a highway to a receptor 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 receptor, 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 receptor, 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.

3.7.3. 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.

3.7.4. Shielding by Natural or Human-Made Features

A large object or barrier in the path between a noise source and a receptor can substantially attenuate noise levels at the receptor. 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 receptor specifically to reduce noise. A barrier that breaks the line of sight between a source and a receptor will typically result in at least 5 dB of noise reduction. Taller barriers provide increased noise reduction. Vegetation between the highway and receptor is rarely effective in reducing noise because it does not create a solid barrier.

Chapter 4. Federal Regulations and State Policies

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 projects. Under 23 CFR 772.7, projects are categorized as Type I, Type II, or Type III projects.

FHWA defines a Type I project as a proposed Federal or Federal-aid project for the construction of a highway or roadway on a new location or the physical alteration of an existing highway which significantly changes either the horizontal or vertical alignment of the highway. The following projects are also considered to be Type I projects:

- The addition of a through-traffic lane(s). This includes the addition of a through-traffic lane that functions as a high-occupancy vehicle (HOV) lane, high-occupancy toll (HOT) lane, bus lane, or truck climbing lane,
- The addition of an auxiliary lane, except for when the auxiliary lane is a turn lane,
- The addition or relocation of interchange lanes or ramps added to a quadrant to complete an existing partial interchange,
- Restriping existing pavement for the purpose of adding a through traffic lane or an auxiliary lane,
- The addition of a new or substantial alteration of a weigh station, rest stop, ride-share lot, or toll plaza.

If a project is determined to be a Type I project under this definition, the entire project area as defined in the environmental document is a Type I project.

A Type II project is a noise barrier retrofit project that involves no changes to highway capacity or alignment. A Type III project is a project that does not meet the classifications of a Type I or Type II project. Type III projects do not require a noise analysis.

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 or permitted land use in a given area.

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 D) is used as the basis for determining a noise impact. Indoor analysis is conducted at Activity Category D land uses only after all outdoor analysis options have been exhausted and after a determination has been made that exterior abatement measures will not be feasible and reasonable.

4.1.2. 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 Protocol defines a noise increase as substantial when the predicted noise levels with project implementation exceed existing noise levels by 12 dBA or more. The Protocol also states that a sound level is considered to approach a 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 Technical Noise Supplement 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.

Table 4-1. Activity Categories and Noise Abatement Criteria (23 CFR 772)

Activity Category	Activity $L_{eq}[h]$[1]	Evaluation Location	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[2]	67	Exterior	Residential.
C[2]	67	Exterior	Active sport areas, amphitheaters, auditoriums, campgrounds, cemeteries, day care centers, hospitals, libraries, medical facilities, parks, picnic areas, places of worship, playgrounds, public meeting rooms, public or nonprofit institutional structures, radio studios, recording studios, recreation areas, Section 4(f) sites, schools, television studios, trails, and trail crossings.
D	52	Interior	Auditoriums, day care centers, hospitals, libraries, medical facilities, places of worship, public meeting rooms, public or nonprofit institutional structures, radio studios, recording studios, schools, and television studios.
E	72	Exterior	Hotels, motels, offices, restaurants/bars, and other developed lands, properties, or activities not included in A–D or F.
F			Agriculture, airports, bus yards, emergency services, industrial, logging, maintenance facilities, manufacturing, mining, rail yards, retail facilities, shipyards, utilities (water resources, water treatment, electrical), and warehousing.
G			Undeveloped lands that are not permitted.

[1] The $L_{eq[h]}$ activity criteria values are for impact determination only and are not design standards for noise abatement measures. All values are A-weighted decibels (dBA).

[2] Includes undeveloped lands permitted for this activity category.

4.2. State Regulations and Policies

4.2.1. California Environmental Quality Act (CEQA)

Noise analysis under the California Environmental Quality Act (CEQA) may be required regardless of whether or not the project is a Type I project. The CEQA noise analysis is completely independent of the 23 CFR 772 analysis done for NEPA. Under CEQA, the baseline noise level is compared to the build noise level. The assessment entails looking at the setting of the noise impact and then how large or perceptible any noise increase would be in the given area. Key considerations include: the uniqueness of the setting, the sensitive nature of the noise receptors, the magnitude of the noise increase, the number of residences affected, and the absolute noise level.

The significance of noise impacts under CEQA are addressed in the environmental document rather than the NSR. Even though the NSR (or noise technical memorandum) does not specifically evaluate the significance of noise impacts under CEQA, it must contain the technical information that is needed to make that determination in the environmental document.

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 D 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 roadway 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.

There are no schools in the vicinity of the Project; therefore, this code would not apply.

Chapter 5. Study Methods and Procedures

This chapter describes the methodology used to measure and evaluate noise levels in the project area.

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

A field investigation was conducted from Tuesday, April 2, 2019 to Thursday, April 4, 2019 to identify land uses that could be subject to traffic and construction noise impacts from the proposed project. Existing land uses in the project area were categorized by land use type and Activity Category (see Table 4-1) and the extent of frequent human use. Noise receptor locations in the project area were identified through a review of project mapping, aerial photos, and field reconnaissance. Activity Category B, C, E, and F land uses border the project limits. Although all 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, which include residential backyards, common use areas at multi-family residences, hotels, and parks. There are no other noise sensitive noise receptors, such schools, libraries, churches, hospitals, etc., in the project area.

Long-term measurement sites were selected to capture the diurnal traffic noise level pattern in the project area. Short-term measurement locations were selected to serve as model validation points for representative modeling locations. Additional non-measurement locations were selected as modeling locations.

Photographs of the measurement sites are provided in Appendix B. Receptor locations selected for the project area are illustrated in Figure 5-1 and Appendix C.

5.2. Field Measurement Procedures

A field noise study was conducted in accordance with recommended procedures in the Technical Noise Supplement (TeNS) to the Traffic Noise Analysis Protocol (Protocol). Noise measurements were made with Larson Davis Model 820 Integrating Sound Level Meters (SLMs) set at “slow” response. The sound level meters were equipped with G.R.A.S. Type 40AQ ½-inch random incidence microphones fitted with windscreens. The sound level meters were calibrated prior to the noise measurements using a Larson Davis Model CAL200 or Model CA250 acoustical calibrator. The response of the system was checked after each measurement session and was always found to be within 0.2 dBA. No calibration adjustments were made to the measured sound levels. At the completion of each monitoring event, the measured interval noise level data were obtained from the SLM using the Larson Davis SLM utility software program.

5.2.1. Long-Term Measurements

Long-term reference noise measurements were made at three locations in the project vicinity to quantify the diurnal trend in noise levels and to establish the peak traffic noise hour. These reference noise measurements included one located at the residential setback from the southbound I-280 off ramp to Wolfe Road (L1), one along the northbound I-280 off ramp to Wolfe Road (L2), and one at the setback of residences to northbound I-280 (L3). The long-term noise measurements were made over an approximate 48-hour period, from midday on Tuesday, April 2, 2019 to midday on Thursday, April 4, 2019. Long-term measurements were taken at heights of about 12 feet above ground level. Care was taken to select sites that were primarily affected by traffic noise and to avoid those sites where extraneous noise sources, such as barking dogs or mechanical equipment, could contaminate the noise data. After the data was downloaded from the sound level meter, the data was reviewed to identify any time periods possibly contaminated by local noise sources. Data points were excluded from the dataset where significant contamination was noted. The trends in ambient noise levels measured at long-term locations are summarized graphically in Appendix D.

5.2.2. Short-Term Measurements

Nine short-term noise measurements (S1 through S9) were made in the project vicinity in concurrent time intervals with the data collected at the long-term reference measurement sites. This method facilitates a direct comparison between both the short-term and long-term noise measurements and allows for the identification of the loudest-hour noise levels at land uses in the project vicinity where long-term noise measurements were not made, but where both short-term and long-term measurements are exposed to the same primary noise source. Two or more consecutive 10-minute measurements were made at each noise measurement site. At all locations, noise levels were measured 5 feet above the ground surface and at least 10 feet from structures or barriers. Noise measurement locations were used to validate the traffic noise model.

Traffic counts and speed observations were made along I-280 and Wolfe Road during the short-term noise measurements for model calibration purposes. Traffic volumes were classified into five vehicle types: (1) light-duty autos and trucks, (2) medium-duty trucks (typically trucks with two axles and more than four wheels), (3) heavy-duty trucks (typically trucks with more than two axles), (4) buses, and (5) motorcycles.

5.2.3. Meteorology

Meteorological conditions were observed during the long-term and short-term noise measurements and generally consisted of overcast skies, calm to moderate winds (1 to 5 mph), and seasonable temperatures (59 to 63°F during midday). Noise monitoring did not occur if weather conditions consisted of rain or high winds (i.e., greater than 11 mph).

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). Due to the reliability constraints of TNM 2.5 to accurately calculate noise levels at great distances from the roadway, Caltrans limits noise assessments to approximately 500 feet of the roadway source.

TNM 2.5 calculates traffic noise levels based on the geometry of the sites, which includes the positioning of travel lanes, receptors, barriers, terrain, ground type, buildings, etc. The noise source is the traffic flow, as defined by the user, in terms of hourly volumes of automobiles, medium-duty trucks, heavy-duty trucks, buses, and motorcycles. Existing traffic and Design Year (2045) peak hour traffic volume data and speed estimates provided by *Fehr and Peers* were used as model inputs for local roads and ramps. *HMH* provided the geometric plans used to create the base traffic noise model. The proposed roadway, existing and future receptors, terrain lines, ground zones, and noise barriers were digitized and input into the traffic noise model.

5.3.1. Validation of the Traffic Noise Model

TNM 2.5 cannot accurately account for pavement types and conditions, atypical vehicle noise populations, transparent shielding (such as wood fences with shrinkage gaps), reflections from nearby buildings and structures, or meteorological conditions. For these reasons, noise measurements are conducted, and traffic noise model adjustments and validation factors are developed. For each measured condition, the corresponding observed traffic conditions are used in the model to calculate the noise level. The calculated and measured noise levels are compared to assess differences and validate the traffic noise model.

Traffic counts made during the noise monitoring survey were adjusted to reflect one-hour conditions, assuming the traffic volumes during the noise measurement interval (10 minutes) were equal during the six 10-minute intervals of an hour. These adjusted one-hour volumes were input into the model for validation.

Calibration factors or model adjustments developed from this process are used to modify the model to more closely represent measured conditions. Modeled results that vary from measurements by more than 2 dB are adjusted after a careful review of all measurement and modeled data. The adjustments are calculated as follows:

- Where modeled levels are more than 2 dB lower than measured levels, the modeled results are adjusted to measured conditions: Adjustment = Measured – Modeled.

- Where the modeled result is 0 to +2 dB lower than the measured level, no adjustment is made: Adjustment = 0.

- Where the modeled result is 0 to +2 dB higher than the measured level, no adjustment is made: Adjustment = 0.

- Where the modeled result is more than +2 dB higher than the measured level, an adjustment is made to bring the modeled result to within 2 dB of measured conditions: Adjustment = (Measured + 2) – Modeled.

5.3.2. Traffic Inputs used for Noise Modeling

Once the TNM 2.5 was validated, the loudest hour traffic noise levels were calculated for Existing, 2045 No Build, and 2045 Build cases for Alternatives A, B, and C. The loudest hour is not necessarily the hour with peak traffic volumes. Congestion results in slower speeds, which substantially reduces traffic noise levels. The loudest hour is generally characterized by free-flowing traffic at the roadway design speed (i.e., Level of Service [LOS] C/D or better).

Traffic volume and mix inputs for the traffic noise model were taken from the traffic projections provided by *Fehr and Peers*. Peak hour traffic volumes were calculated by dividing the provided two-hour peak traffic volumes in half. Arterial roadways were modeled at the posted speed limits for the roadway.

Traffic mix information reported by Caltrans was used for both existing and future scenarios for I-280. The average traffic mix for the I-280 mainline within the project study limits was 96.7% autos, 1.9% medium trucks (MT) and 1.4% heavy trucks (HT).

Traffic volumes, speeds, and mix information used in the TNM 2.5 model are given in Appendix E.

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

Traffic noise impacts are considered to occur at receptor locations where predicted design-year noise levels are 12 dB or greater than existing noise levels, or where predicted design-year noise levels approach or exceed the NAC for the applicable activity category, as shown in Table 4-1. Caltrans has defined the meaning of approaching the NAC to be 1 dBA below the NAC (e.g., 66 dBA is considered approaching the NAC for Activity Category B activity areas). Where traffic noise impacts are identified, noise abatement must be considered for reasonableness and feasibility as required by 23 CFR 772 and the Protocol.

Noise abatement is only considered where frequent human usage occurs and where a lowered noise level would be of benefit. Areas of frequent human usage are considered to occur at exterior locations where people are exposed to traffic noise for an extended period of time on a regular basis. Therefore, impacts are typically assessed at locations with defined outdoor activity areas, such as residential backyards, common exterior use areas, trails, pools, patios, and parks (e.g., playfields, playgrounds, or picnic tables). Other examples are outdoor seating areas at restaurants or outdoor use areas at hotels.

Caltrans policies and procedures for traffic noise analysis are contained in the Protocol and TeNS. The feasibility of noise abatement is an engineering consideration. According to the Protocol, abatement measures are considered acoustically feasible if a minimum noise reduction of 5 dB at impacted receptor locations is predicted with implementation of the abatement measures. Other factors that affect feasibility include topography, utility conflicts, and safety considerations.

Once all feasible noise abatement is identified, a procedure is conducted to assess the reasonableness of noise abatement. The determination of the reasonableness of noise abatement is more subjective than the determination of its feasibility. As defined in Section 772.5 of the regulation, reasonableness is the combination of social, economic, and environmental factors considered in the evaluation of a noise abatement measure. NSRs calculate the reasonable cost allowance for feasible noise barriers, but do not determine whether a feasible barrier would be reasonable.

The overall reasonableness of noise abatement is determined by the following three factors:

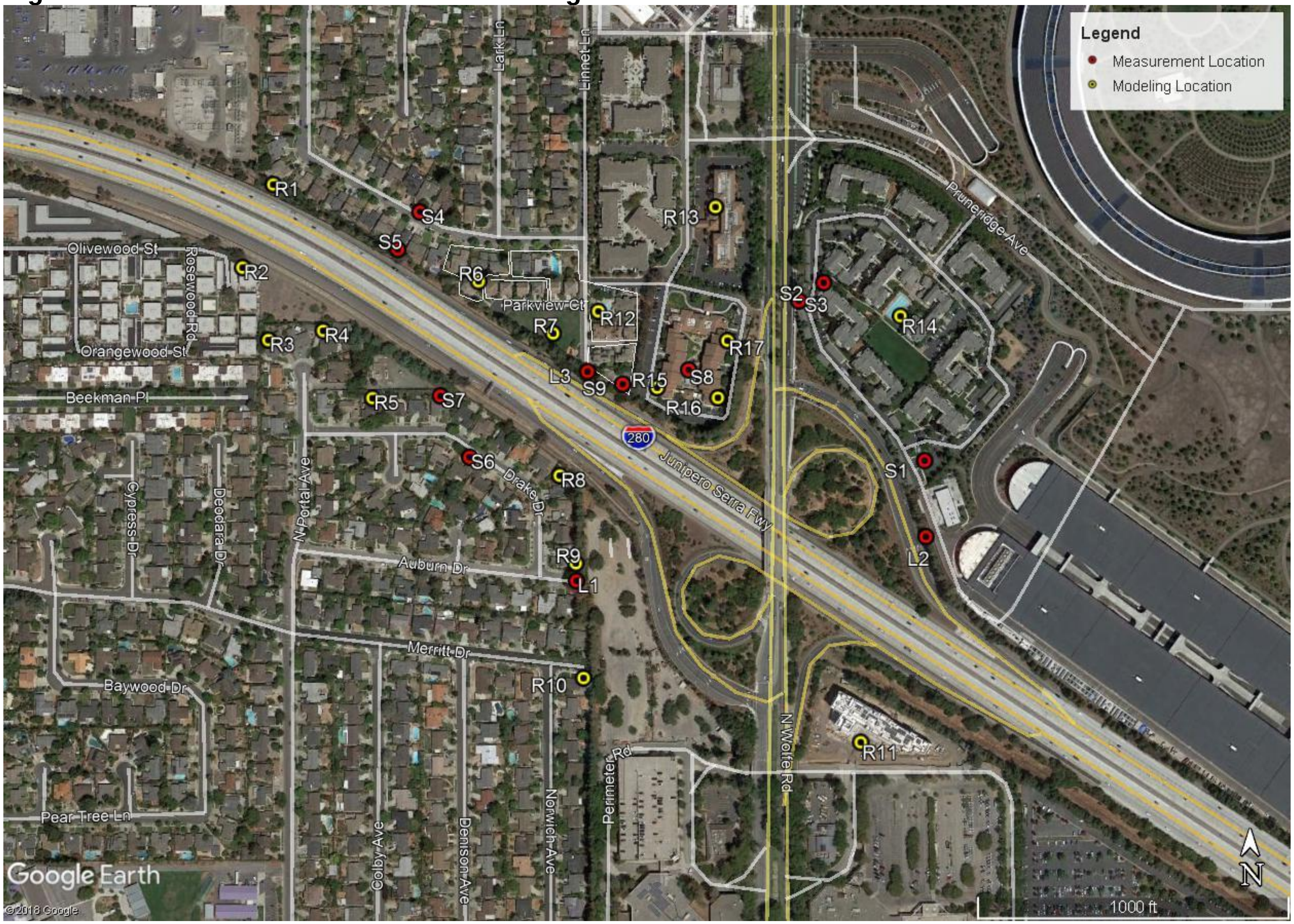
- The noise reduction design goal (a barrier must be predicted to provide at least 7 dB of noise reduction at one or more benefited receptors).
- The cost of noise abatement (2019 allowance of $107,000 per benefited receptor).
- The viewpoints of benefited receptors (including property owners and residents of the benefited receptors).

The Caltrans’ acoustical design goal is that a barrier must be predicted to provide at least 7 dB of noise reduction at one benefited receptor. This design goal applies to any receptor and is not limited to impacted receptors.

The Protocol defines the procedure for assessing reasonableness of noise barriers from a cost perspective. Cost considerations for determining noise abatement reasonableness are based on an allowance per benefitted receptor. This reasonable allowance maybe adjusted based on the most recent annual Construction Price Index. The annual price index for the fourth quarter of any year is usually posted by February of the following year. The base cost allowance for any 2019 reasonable/feasible analysis is $107,000 for each benefited receptor (i.e., receptors that receive at least 5 dB of noise reduction from a noise barrier). The total allowance for each barrier is calculated by multiplying the number of benefited receptors by $107,000.

The noise study report identifies traffic noise impacts and evaluates noise abatement for acoustical feasibility. It also reports information that will be used in the reasonableness analysis, including if the 7 dB design goal reduction in noise can be achieved and the abatement allowances. The noise study report does not make any conclusions regarding reasonableness. The feasibility and reasonableness of noise abatement is reported in the Noise Abatement Decision Report (NADR).

Figure 5-1. Noise Measurement and Modeling Positions



Chapter 6. Existing Noise Environment

The following is a discussion of existing noise levels in the project area.

6.1. Existing Land Uses

Existing land uses in the project area were categorized by Activity Category, as outlined in Section 4.1 (see Table 4-1 for land use descriptions). A field investigation was conducted to identify land uses that could be subject to traffic and construction noise impacts from the proposed project. Activity Category A land uses (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) were not identified in the project area. The following noise-sensitive land uses were identified in the project area:

- Activity Category B - Residential;
- Activity Category C – Sports Areas, Parks;
- Activity Category E – Restaurants, Hotels, Offices;

Activity Category F land uses located in the project area are not noise-sensitive. 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, common exterior use areas for multi-family development, sports areas, and outdoor hotel use areas. The noise-sensitive uses identified in the project area are described in further detail in Chapter 7.

6.2. Noise Measurement Results

The existing noise environment throughout the project area varies by location, depending on site characteristics such as proximity of receptors to I-280, local roadways, or other significant sources of noise in the area, the relative base elevations of roadways and receptors, and the presence of any intervening structures or barriers.

Three long-term noise measurements (L1 through L3) were made to quantify the diurnal trend in noise levels and establish the peak traffic noise hour. Nine short-term noise measurements (S1 through S9) were made at land uses in the project vicinity. All short-term noise measurements were made at heights of 5 feet above ground level. Short-term noise measurement locations were used to validate the traffic noise model. Appendix G contains the traffic counts used to validate the model.

The results of the long- and short-term field measurements are summarized in Table 6-1 and Table 6-2. The calculated existing loudest-hour noise levels at short-term noise measurement locations are based on validated noise modeling results. As indicated in Tables 6-1 and 6-2, existing loudest hour noise levels ranged from 64 to 73 dBA $L_{eq[h]}$ at long-term locations and from 61 to 74 dBA $L_{eq[h]}$ at short-term measurement locations.

Table 6-1. Summary of Long-Term Noise Measurements

Receptor ID	Location (See Photos in Appendix B)	Date	Loudest Hour(s)	Loudest Hour $L_{eq[h]}$, dBA
L1	19640 Auburn Drive, Cupertino	4/3/2019	9:00 a.m.	64
L2	19500 Pruneridge Avenue, Cupertino	4/3/2019	6:00 a.m., 10:00 a.m., 11:00 a.m., and 5:00 p.m.	73
L3	10631 Becker Lane, Cupertino	4/3/2019	10:00 a.m., 11:00 a.m., and 12:00 p.m.	71

Table 6-2. Summary of Short-Term Noise Measurements

Receptor ID	Location (See Appendix B)	Date	Start Time	10- minute L_{eq}, dBA	Calculated Loudest-Hour $L_{eq[h]}$, dBA
S1	19500 Pruneridge Avenue Cupertino	4/4/2019	10:40 a.m.	61	61
			10:50 a.m.	62	
S2	10750 N Wolfe Road Cupertino	4/4/2019	10:50 a.m.	71	68
S3	10750 N Wolfe Road Cupertino	4/4/2019	11:00 a.m.	60	61
			11:10 a.m.	60	
S4	831 Shetland Place Sunnyvale	4/4/2019	11:50 a.m.	61	64
			12:00 a.m.	62	
S5	826 Shetland Place Sunnyvale	4/4/2019	11:50 p.m.	66	66
			12:00 p.m.	66	
S6	19700 Drake Drive Cupertino	4/4/2019	12:40 p.m.	61	62
			12:50 p.m.	61	
S7	19711 Drake Drive Cupertino	4/4/2019	12:40 p.m.	66	68
			12:50 p.m.	66	
S8		4/4/2019	1:30 p.m.	63	

Receptor ID	Location (See Appendix B)	Date	Start Time	10- minute L_{eq}, dBA	Calculated Loudest-Hour $L_{eq[h]}$, dBA
	10605 N Wolfe Road Cupertino		1:40 p.m.	62	64
S9	10631 Becker Lane Cupertino	4/4/2019	1:30 p.m.	72	74
			1:40 p.m.	72	

6.3. Model Validation to Existing Conditions

TNM 2.5 was used to calculate existing noise levels at field measurement locations during periods when the measurements were made and traffic was counted. Adjustments or "K factors" were then developed where the traffic noise model and the measured levels varied by 2 dBA or greater. The development of each K factor followed the methodology detailed in Section 5.3. The adjustment is added to modeled results for existing and future loudest-hour traffic conditions. The K factor for each receptor can be found in Table 6-3. As a conservative measure, when modeled traffic noise levels exceeded corresponding measured levels by 2 dBA or more, a K factor was developed to bring modeled noise level predictions 2 dBA higher (e.g., if measured noise level was 60 dBA and modeled noise level was 64 dBA, K factor = -2 dBA; whereas, if measured noise level was 60 dBA and modeled noise level was 56 dBA, K factor = 4 dBA).

Table 6-3. TNM 2.5 Adjustment Factors

Receptor ID	10-min L_{eq} Noise Level, dBA						K Factor, dBA
	Measured Level	TNM 2.5 Validation	Difference	Measured Level	TNM 2.5 Validation	Difference	
S1	60.9	59.9	1	61.7	59.7	2	0
S2	70.5	68.6	1.9	-	-	-	0
S3	60	60.7	-0.7	60.2	60.7	-0.5	0
S4	61.4	59.2	2.2	62	59.2	2.8	2.5
S5	65.6	63.7	1.9	65.6	63.8	1.8	0
S6	61.2	59.8	1.4	61.3	60.2	1.1	0
S7	66	63.5	2.5	65.9	63.8	2.1	2.3
S8	61.9	56.9	5.0	61.9	57.1	4.8	4.9[1]
S9	71.8	72.2	-0.4	71.6	72.4	-0.8	0

[1] S8 is shielded behind a large 3-story hotel building. TNM 2.5 does not accurately account for multiple barriers or shielding by large structures. Therefore, a K-factor is applied to account for additional noise reduction in real-life conditions that is not accounted for in the model.

6.4. Future Undeveloped Land Uses

The Protocol requires that the NSR discuss the development of future land uses in the vicinity of the project. Much of the land in the project area is developed. Lists of planned and approved projects in the City of Cupertino were reviewed to identify undeveloped lands for which development is planned, designed, and programmed so that those proposed developments may be considered approved (or, a part of the existing conditions). According to the Protocol, future development would be considered planned, designed, and programmed once it receives final development approval. The review focused on projects within approximately 500 feet of the project limits, where traffic noise levels from the improved project roadways could dominate the noise environment. Projects located beyond this distance were excluded from further analysis.

6.4.1. Cupertino

The City of Cupertino currently has several projects that are in progress in the areas surrounding the project site. These include:

- Hyatt House Hotel: currently under construction with a 148-room hotel and conference facilities to the southeast of the I-280/Wolfe Road Interchange;

- Cupertino Village retail building: currently under construction west of Wolfe Road at Apple Park Way;

- Vallco Specific Plan: approved for a mixed-use town center in the area directly south of the I-280/Wolfe Road Interchange;

- The Hamptons residential project: approved to replace 342 units with 942 apartment units to the northeast of the I-280/Wolfe Road Interchange;

- Cupertino Village Boutique Hotel: applied (not yet approved) for a full service 185 room hotel west of Wolfe Road at Pruneridge Avenue.

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

This chapters discusses potential noise impacts and presents a preliminary analysis of noise abatement measures.

7.1. Future Noise Environment and Impacts

Traffic noise modeling results and predicted traffic noise impacts for existing and design year conditions are shown in Table 7-1. The modeling results are discussed in detail following Table 7-1. In this table, 2045 Build Alternatives A, B, and C traffic noise levels are compared to Existing conditions and to 2045 No Build conditions. The comparison to Existing conditions is included in the analysis to identify traffic noise impacts as defined under 23 CFR 772. The comparison between 2045 Build and 2045 No Build 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 calculated 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.

Impacted receptors were identified by Activity Category and the number of impacted receptors is summarized to calculate reasonableness monetary allowances for feasible noise barriers that also meet the 7 dB noise reduction design goal. Noise levels discussed in this section are based on the adjusted model results, using loudest-case traffic conditions (in terms of noise generation) for the Existing, 2045 No Build, and 2045 Build scenarios.

Nine short-term measurement positions (S1 through S9) were used as modeling receptors in the vicinity of the project alignment. In addition, there are thirteen modeled receptor locations (R1 through R13). Noise barriers currently shield receptors to the north and south of I-280, west of Wolfe Road. The segment of noise barrier to the north of I-280 east of Parkview Court would be removed and replaced with construction of any of the Build Alternatives. Noise levels indicated in Table 7-1 do not include the insertion loss from the replacement sound walls proposed under Alternatives A, B, and C.

Table 7-1. Calculated Noise Levels

Receptor ID	Loudest-Hour Noise Levels, $L_{eq[h]}$ dBA					Increase Over Existing, dBA				Increase Over No Build, dBA			Activity Category (NAC)	Impact[1]		
	Exist	2045 No Build	2045 Alt A	2045 Alt B	2045 Alt C	2045 No Build	2045 Alt A	2045 Alt B	2045 Alt C	2045 Alt A	2045 Alt B	2045 Alt C		2045 Alt A	2045 Alt B	2045 Alt C
S1	61	62	63	63	63	1	2	2	2	1	1	1	C(67)	None	None	None
S2	68	71	71	71	71	3	3	3	2	0	0	-1	Validation	None	None	None
S3	61	63	64	64	63	3	3	3	3	0	0	0	B(67)	None	None	None
S4	64	64	64	64	64	0	0	0	0	0	0	0	B(67)	None	None	None
S5	66	66	67	67	67	0	1	1	1	1	1	1	B(67)	A/E	A/E	A/E
S6	62	62	62	62	62	0	0	0	0	0	0	0	B(67)	None	None	None
S7	68	68	68	68	68	0	0	0	0	0	0	0	B(67)	A/E	A/E	A/E
S8	64	64	64	63	64	0	0	-1	0	0	-1	0	E(72)	None	None	None
S9	74	74	74	70	73	0	0	-4	-1	0	-4	-1	C(67)	A/E	A/E	A/E
R1	66	66	66	66	66	0	0	0	0	0	0	0	B(67)	A/E	A/E	A/E
R2	68	68	68	68	68	0	0	0	0	0	0	0	B(67)	A/E	A/E	A/E
R3	63	63	63	63	63	0	0	0	0	0	0	0	B(67)	None	None	None
R4	69	69	69	69	69	0	0	0	0	0	0	0	B(67)	A/E	A/E	A/E
R5	63	63	63	63	63	0	0	0	0	0	0	0	B(67)	None	None	None
R6	60	60	68	67	68	0	8	7	8	8	7	8	B(67)	A/E	A/E	A/E
R7	67	67	75	75	75	0	9	8	9	9	8	9	C(67)	A/E	A/E	A/E
R8	65	65	65	65	65	0	0	0	0	0	0	0	B(67)	None	None	None
R9	61	61	61	61	61	0	0	0	0	0	0	0	B(67)	None	None	None
R10	59	60	60	60	60	1	1	1	1	0	1	0	B(67)	None	None	None
R11	62	63	63	63	63	0	1	0	0	0	0	0	E(72)	None	None	None
R12	61	61	66	66	66	0	5	5	6	5	5	5	B(67)	A/E	A/E	A/E
R13	55	55	55	55	56	0	0	0	1	0	0	1	B(67)	None	None	None
R14	50	52	51	51	50	1	1	0	0	-1	-1	-1	B(67)	None	None	None
R15a[3]	72	72	68	64	67	0	-4	-8	-5	-4	-8	-5	E(72)	None	None	None

Receptor ID	Loudest-Hour Noise Levels, $L_{eq[h]}$ dBA					Increase Over Existing, dBA				Increase Over No Build, dBA			Activity Category (NAC)	Impact[1]		
	Exist	2045 No Build	2045 Alt A	2045 Alt B	2045 Alt C	2045 No Build	2045 Alt A	2045 Alt B	2045 Alt C	2045 Alt A	2045 Alt B	2045 Alt C		2045 Alt A	2045 Alt B	2045 Alt C
R15b[3]	74	74	74	72	73	0	1	-2	0	0	-2	-1	E(72)	A/E	A/E	A/E
R15c[3]	75	76	76	76	76	0	0	0	1	0	0	1	E(72)	A/E	A/E	A/E
R16a[3]	68	68	63	61	65	1	-5	-7	-2	-6	-7	-3	E(72)	None	None	None
R16b[3]	70	71	67	66	69	1	-3	-5	-1	-4	-6	-2	E(72)	None	None	None
R16c[3]	71	72	70	70	71	1	-1	-1	-1	-2	-2	-2	E(72)	None	None	A/E
R17a[3]	64	66	65	63	66	2	1	0	2	-1	-2	1	E(72)	None	None	None
R17b[3]	68	69	68	68	69	2	1	0	1	-1	-1	0	E(72)	None	None	None
R17c[3]	68	70	69	70	70	1	1	1	1	0	0	0	E(72)	None	None	None

1 Impact Type: S = Substantial Increase (12 dBA or more), A/E = Approach or Exceed NAC, None = Increase is less than 12 decibels and noise levels do not approach or exceed the NAC.

2 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.

3 These receptors are representative of Marriott Hotel balconies. The hotel has three levels of balconies; ‘a’ designates first floor balconies, ‘b’ the second floor balconies, and ‘c’ the third floor balconies.

As shown in Table 7-1, the loudest-hour noise levels at Category B land uses are calculated to range from 50 to 69 dBA $L_{eq[h]}$ under Existing conditions, from 52 to 69 dBA $L_{eq[h]}$ under 2045 No Build conditions, from 51 to 69 dBA $L_{eq[h]}$ under 2045 Build Alternatives A and B, and from 50 to 69 dBA $L_{eq[h]}$ under 2045 Build Alternative C. The loudest-hour noise levels at Category C land uses are calculated to range from 61 to 74 dBA $L_{eq[h]}$ under Existing conditions, from 62 to 74 dBA $L_{eq[h]}$ under 2045 No Build conditions, from 63 to 76 dBA $L_{eq[h]}$ under 2045 Build Alternative A, from 63 to 77 dBA $L_{eq[h]}$ under 2045 Build Alternative B, and from 63 to 75 dBA $L_{eq[h]}$ under 2045 Build Alternative C. 2045 Build traffic noise levels are predicted to approach or exceed the Noise Abatement Criteria (NAC) at first row Category B and C receptors located to the north and south of I-280, west of Wolfe Road (S5, S7, S9, R1, R2, R4, R6, R7, and R12). Category B receptors are located behind existing walls, some of which are proposed to be removed with the project under Build Alternatives A, B, and C. Category C land uses (S9 and R7) are partially shielded by an existing sound wall, which is planned to be removed under all Build Alternatives. Noise abatement in the form of replacement sound walls and barrier height increases were considered for impacted receptors.

The loudest-hour noise levels at Category E land uses are calculated to range from 64 to 75 dBA $L_{eq[h]}$ under Existing conditions, from 64 to 76 dBA $L_{eq[h]}$ under 2045 No Build conditions, from 64 to 76 dBA $L_{eq[h]}$ under 2045 Build Alternative A, from 63 to 76 dBA $L_{eq[h]}$ under 2045 Build Alternative B, and from 64 to 76 dBA $L_{eq[h]}$ under 2045 Build Alternative C. 2045 Build traffic noise levels are predicted to approach or exceed the Noise Abatement Criteria (NAC) at second and third floor patios of the Mariott Hotel (15b, 15c, and, under Alternative C, 16c).

Noise levels would increase by up to 3 dBA over Existing conditions under 2045 No Build conditions and by up to 9 dBA under 2045 Build Alternatives A, B, and C, due to the removal of the existing sound wall. This noise level increase is not considered substantial.

7.2. Preliminary Noise Abatement Analysis

Noise abatement is considered where noise impacts are predicted in areas of frequent human use that would benefit from a lowered noise level. Noise abatement must be predicted to provide at least a 5 dB minimum reduction at an impacted receptor to be considered feasible by Caltrans (i.e., the barrier would provide a noticeable noise reduction). Additionally, the Protocol’s acoustical design goal states that the noise barrier must provide at least 7 dB of noise reduction at one or more benefited receptors. Noise abatement measures that provide noise reduction of more than 5 dB are encouraged, as long as they meet the reasonableness guidelines. According to 23 CFR 772(13)(c) and 772(15)(c), federal funding may be used for the following abatement measures:

- Construction of noise barriers, including acquisition of property rights, either within or outside the highway right-of-way.
- Traffic management measures including, but not limited to, traffic control devices and signing for prohibition of certain vehicle types, time-use restrictions for certain vehicle types, modified speed limits, and exclusive lane designations.
- Alteration of horizontal and vertical alignments.
- Acquisition of real property or interests therein (predominantly unimproved property) to serve as a buffer zone to preempt development, which would be adversely impacted by traffic noise.
- Noise insulation of Activity Category D land use facilities listed in Table 4-1. Post-installation maintenance and operational costs for noise insulation are not eligible for Federal-aid funding.

Noise barriers are the only form of noise abatement considered for this project. Each noise barrier evaluated has been evaluated for feasibility based on achievable noise reduction. The noise barriers within the State right-of-way are typically constructed to meet the criteria in Chapter 1100 of the Highway Design Manual. The manual states that noise barriers should not be higher than 14 feet above the pavement when located within 15 feet of the edge of traveled way and 16 feet above ground when located more than 15 feet from the edge of traveled way.

A height consideration in the acoustical design of noise barriers is Caltrans guidance to break the line-of-sight between an 11.5-foot-high truck exhaust stack and a 5-foot-high receiver in the first row of houses. This guideline, detailed in Highway Design Manual Chapter 1100, is intended to reduce the visual and noise intrusiveness of truck exhaust stacks at the first-line receivers. Barrier heights determined by TNM 2.5 often satisfy the acoustical requirements without shielding high truck exhaust stacks. Although such barriers may reduce noise levels sufficiently to meet feasibility and design goal requirements, they have generated complaints from the public in the past when truck stacks were visible. As such, the barrier height at which the line-of-sight to a truck stack is broken is indicated for each evaluated barrier.

The design of noise barriers presented in this report is preliminary and has been conducted at a level appropriate for environmental review but 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 noise barriers will be made upon completion of the project design.

Preliminary noise barriers were evaluated at the most acoustically effective locations within the State right-of-way. Where the roadway is at grade, or elevated above receptors, the most acoustically effective location for a barrier is near the edge of the shoulder, either on the structure or at the top of the slope. Where the roadway is located in a cut-section, the most acoustically effective location for a barrier is typically at the right-of-way. For receptors located behind an existing noise barrier that experience loudest-hour noise levels that approach or exceed the NAC, increasing the height of the existing barrier (or replacing it with a taller noise barrier) was assessed when the existing barrier was observed to be at a height of less than 14 feet. Because the existing walls in the vicinity of the project were observed to generally be in good condition, replacement walls of equal height to existing walls would not be anticipated to change the noise environment behind the wall. Therefore, the insertion loss for replacement sound walls was calculated based on wall height increases over the existing wall height. Existing barriers that are removed due to alignment shifts will be replaced in kind with respect to matching the height and length of each affected wall. For receptors located behind existing barriers that are proposed to be removed and replaced with the project, the insertion loss for the replacement sound wall was calculated based on wall height increases over the no barrier condition.

Degradation of noise barrier performance is a possibility when the ratio of the spacing between parallel barriers or retaining walls constructed with noise-reflecting materials and the average height of the barriers or walls is 15:1 or less. For these barriers, reflective noise and the use of acoustically absorptive surfaces should be considered. The cost of implementing an absorptive surface would not be included in the construction cost for comparison to the reasonable allowance.

Three noise barriers were studied as potential noise abatement. This includes two barriers where noise levels behind existing walls would approach or exceed the NAC under Build conditions and the existing barrier is below 14 feet high (Barriers 1 and 2), and the replacement of one existing noise barrier that would be removed with the project (Barrier

3). Noise levels at receptors behind Existing Barrier 4 would not approach or exceed the NAC under Build conditions; therefore, this barrier is not addressed further in this analysis.

Potential noise barriers are discussed in detail below. Once a noise barrier achieved the minimum of a 5 dB reduction at a given receptor and achieved the 7 dB noise reduction design goal for at least one receptor, the reasonable allowance was determined. Tables 7-2 through 7-10 show the predicted 2045 loudest-hour noise levels and insertion loss for each barrier at various design heights under each Build Alternative. Table 7-11 summarizes the insertion loss, benefited receptors, and reasonable allowances for each feasible barrier that also met the 7 dB noise reduction design goal. Evaluated barrier locations, as well as measured and modeled receptor locations, are depicted in Appendix C.

7.2.1. South of I-280

Outdoor areas of first row residences (S7, R2, and R4) have been identified for noise abatement because 2045 Build noise levels would approach or exceed the NAC and the existing barrier is below 14 feet high. Barrier 1 is an existing sound wall with a height of 10 feet. This barrier was assessed at increased barrier heights of 12, 14, and 16 feet. Tables 7-2 through 7-4 show the predicted 2045 loudest-hour noise levels and insertion loss for Barrier 1 at various design heights under each Build Alternative. Noise levels at receptors behind Existing Barrier 4 would not approach or exceed the NAC under Build conditions; therefore, this barrier is not addressed further in this analysis.

7.2.1.1. Barrier 1: Height Increase

With the implementation of Alternatives A, B, or C, increasing the height of Barrier 1 would not feasibly abate traffic noise or meet the 7 dB noise reduction goal. Therefore, a reasonable allowance was not calculated for Barrier 1.

Table 7-2. Height Increase Barrier 1 – Alternative A

Receptor ID	Units Represented	Noise Level w/ Existing 10 ft Wall	With Wall H=12 feet		With Wall H=14 feet		With Wall H=16 feet	
			$L_{eq[h]}$	I.L.	$L_{eq[h]}$	I.L.	$L_{eq[h]}$	I.L.
S7	3	68	67	1	66	2	66	2
R2	6	68	66	2	65	3	65	3
R3	4	63	62	1	61	2	61	2
R4	4	69	67	2	66	3	64	5
R5	3	63	63	0	62	1	61	2

Table 7-3. Height Increase Barrier 1 – Alternative B

Receptor ID	Units Represented	Noise Level w/ Existing 10 ft Wall	With Wall H=12 feet		With Wall H=14 feet		With Wall H=16 feet	
			$L_{eq[h]}$	I.L.	$L_{eq[h]}$	I.L.	$L_{eq[h]}$	I.L.

S7	3	68	67	1	67	1	66	2
R2	6	68	66	2	65	3	65	3
R3	4	63	62	1	61	2	61	2
R4	4	69	67	2	66	3	64	5
R5	3	63	63	0	62	1	61	2

Table 7-4. Height Increase Barrier 1 – Alternative C

Receptor ID	Units Represented	Noise Level w/ Existing 10 ft Wall	With Wall H=12 feet		With Wall H=14 feet		With Wall H=16 feet	
			$L_{eq[h]}$	I.L.	$L_{eq[h]}$	I.L.	$L_{eq[h]}$	I.L.
S7	3	68	67	1	67	1	67	1
R2	6	68	66	2	65	3	65	3
R3	4	63	62	1	61	2	61	2
R4	4	69	67	2	66	3	64	5
R5	3	63	63	0	62	1	61	2

7.2.2. North of I-280

Outdoor areas of first row residences (S5, R1, R6, and R12), recreation areas (S9 and R7), and upper level hotel patios (R15b, R156c, and, Under Alternative C, 16c) have been identified for noise abatement because 2045 Build noise levels would approach or exceed the NAC, and existing barriers are of heights below 14 feet or would be removed with the project. Barrier 2 is an existing sound wall with a height of 10 feet. This barrier was assessed at increased barrier heights of 12, 14, and 16 feet. Barrier 3 replaces the existing portion of the sound wall located east of Parkview Court, which would be removed under all Build Alternatives. Tables 7-5 through 7-10 show the predicted 2045 loudest-hour noise levels and insertion loss for each proposed barrier at various design heights under each Build Alternative.

7.2.2.1. Barrier 2: Height Increase

With the implementation of Alternatives A, B, or C, increasing the height of Barrier 2 would not feasibly abate traffic noise or meet the 7 dB noise reduction goal. Therefore, a reasonable allowance was not calculated for Barrier 2.

Table 7-5. Height Increase Barrier 2 – Alternative A

Receptor ID	Units Represented	Noise Level w/ Existing 10 ft Wall	With Wall H=12 feet		With Wall H=14 feet		With Wall H=16 feet	
			$L_{eq[h]}$	I.L.	$L_{eq[h]}$	I.L.	$L_{eq[h]}$	I.L.
S4	9	64	63	1	62	2	62	2
S5	5	67	66	1	65	2	65	2
R1	6	66	65	1	64	2	63	3
R6	4	68	68	0	68	0	68	0

Table 7-6. Height Increase Barrier 2 – Alternative B

Receptor ID	Units Represented	Noise Level w/ Existing 10 ft Wall	With Wall H=12 feet		With Wall H=14 feet		With Wall H=16 feet	
			$L_{eq[h]}$	I.L.	$L_{eq[h]}$	I.L.	$L_{eq[h]}$	I.L.
S4	9	64	63	1	62	2	62	2
S5	5	67	66	1	65	2	65	2
R1	6	66	65	1	64	2	63	3
R6	4	67	67	0	67	0	67	0

Table 7-7. Height Increase Barrier 2 – Alternative C

Receptor ID	Units Represented	Noise Level w/ Existing 10 ft Wall	With Wall H=12 feet		With Wall H=14 feet		With Wall H=16 feet	
			$L_{eq[h]}$	I.L.	$L_{eq[h]}$	I.L.	$L_{eq[h]}$	I.L.
S4	9	64	63	1	62	2	62	2
S5	5	67	66	1	65	2	65	2
R1	6	66	65	1	64	2	63	3
R6	4	68	68	0	68	0	68	0

7.2.2.2. Barrier 3: Replacement Barrier

With the implementation of Alternative A, B, or C, Barrier 3 would feasibly abate traffic noise, meet the 7 dB noise reduction goal at a minimum height of 8 feet, and break the line-of-sight between truck stacks and receptors at a minimum height of 12 feet. The reasonable allowance calculated for barrier heights of 8 to 16 feet ranges from $2,782,000 to $8,132,000.

Barrier 3 would be directly across I-280 from Existing Barriers 1 and 4 (see Appendix C). Both existing barriers are 10-feet in height. The ratio of the spacing between Barriers 1 and 3 to the average height of the barriers would be less than 15:1 if Barrier 3 were to be constructed at a height of 17 feet or greater. The ratio of the spacing between Barriers 3 and 4 to the average height of the barriers would be less than 15:1 if Barrier 3 were to be constructed at a height of 25 feet or greater. Heights greater than 16-feet are not proposed for Barrier 3; therefore, reflective noise is not anticipated to be a concern for Barrier 3.

Table 7-8. Replacement Barrier 3 – Alternative A

Receptor ID	Units Represented	Noise Level w/o Wall	With Wall H=8 feet		With Wall H=10 feet		With Wall H=12 feet		With Wall H=14 feet		With Wall H=16 feet	
			$L_{eq[h]}$	I.L.	$L_{eq[h]}$	I.L.	$L_{eq[h]}$	I.L.	$L_{eq[h]}$	I.L.	$L_{eq[h]}$	I.L.
S9	3	74	66	8	64	10	63	11	63	11	62	12
R6	4	68	62	6	61	7	61	7	61	7	60	8
R7	5	75	68	7	67	8	66	9	66	9	65	10
R12	8	66	63	3	62	4	61	5	61	5	61	5
R15a	7	68	63	5	62	6	61	7	61	7	60	8
R15b	7	74	68	6	66	8	65	9	64	10	63	11
R15c	7	76	76	0	75	1	73	3	71	5	68	8
R16a	7	63	60	3	59	4	58	5	58	5	57	6

R16b	7	67	62	5	61	6	60	7	60	7	59	8
R16c	7	70	68	2	66	4	65	5	62	8	61	9
R17a	7	65	61	4	60	5	59	6	59	6	58	7
R17b	7	68	65	3	63	5	62	6	61	7	61	7
R17c	7	69	68	1	68	1	67	2	66	3	65	4

Table 7-9. Replacement Barrier 3 – Alternative B

Receptor ID	Units Represented	Noise Level w/o Wall	With Wall H=8 feet		With Wall H=10 feet		With Wall H=12 feet		With Wall H=14 feet		With Wall H=16 feet	
			$L_{eq[h]}$	I.L.	$L_{eq[h]}$	I.L.	$L_{eq[h]}$	I.L.	$L_{eq[h]}$	I.L.	$L_{eq[h]}$	I.L.
S9	3	70	64	6	63	7	62	8	62	8	61	9
R6	4	67	62	5	61	6	61	6	61	6	60	7
R7	5	75	67	8	66	9	66	9	65	10	65	10
R12	8	66	63	3	62	4	62	4	61	5	61	5
R15a	7	64	61	3	61	3	60	4	60	4	59	5
R15b	7	72	66	6	65	7	64	8	63	9	62	10
R15c	7	76	73	3	71	5	69	7	67	9	66	10
R16a	7	61	58	3	58	3	57	4	57	4	56	5
R16b	7	66	61	5	60	6	59	7	59	7	58	8
R16c	7	70	64	6	62	8	61	9	60	10	60	10
R17a	7	63	60	3	60	3	59	4	59	4	59	4
R17b	7	68	63	5	63	5	62	6	62	6	62	6
R17c	7	70	67	3	66	4	64	6	63	7	63	7

Table 7-10. Replacement Barrier 3 – Alternative C

Receptor ID	Units Represented	Noise Level w/o Wall	With Wall H=8 feet		With Wall H=10 feet		With Wall H=12 feet		With Wall H=14 feet		With Wall H=16 feet	
			$L_{eq[h]}$	I.L.	$L_{eq[h]}$	I.L.	$L_{eq[h]}$	I.L.	$L_{eq[h]}$	I.L.	$L_{eq[h]}$	I.L.
S9	3	73	65	8	64	9	63	10	63	10	62	11
R6	4	68	62	6	61	7	61	7	61	7	61	7
R7	5	75	68	7	67	8	66	9	66	9	65	10
R12	8	66	62	4	62	4	61	5	60	6	60	6
R15a	7	67	62	5	61	6	61	6	60	7	60	7
R15b	7	73	67	6	66	7	64	9	63	10	63	10
R15c	7	76	75	1	73	3	71	5	68	8	66	10
R16a	7	65	64	1	63	2	63	2	62	3	62	3
R16b	7	69	68	1	67	2	66	3	66	3	65	4
R16c	7	71	69	2	69	2	69	2	68	3	68	3
R17a	7	66	64	2	63	3	63	3	62	4	62	4
R17b	7	69	68	1	67	2	66	3	66	3	65	4
R17c	7	70	69	1	69	1	69	1	68	2	68	2

7.3. Preliminary Reasonableness Analysis

The determination of the reasonableness of noise abatement is more subjective than the determination of its feasibility. As defined in Section 772.5 of the regulation, reasonableness is the combination of social, economic, and environmental factors considered in the evaluation of a noise abatement measure.

The overall reasonableness of noise abatement is determined by the following three factors:

- The noise reduction design goal (a barrier must be predicted to provide at least 7 dB of noise reduction at one or more benefited receptors).
- The cost of noise abatement (reasonable allowance of $107,000 per benefited receptor).
- The viewpoints of benefited receptors (including property owners and residents of the benefited receptors).

For any noise barrier to be considered reasonable from a cost perspective, the estimated cost of the barrier should be equal to or less than the total cost allowance calculated for the barrier. The cost calculations of the noise barrier must include all items appropriate and necessary for construction of the barrier, such as traffic control, drainage modification, retaining walls, landscaping for graffiti abatement, and right-of-way costs. Construction cost estimates are not provided in this NSR but are presented in the NADR. The NADR 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 Development Team 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 Development Team based on site-specific conditions. Construction cost estimates are compared to reasonable allowances in the NADR to identify which wall configurations are reasonable from a cost perspective.

Table 7-11 lists the reasonableness allowance calculated for all barriers that were calculated to be acoustically feasible and to meet the Caltrans noise reduction design goal. For each noise barrier found to be acoustically feasible, reasonable cost allowances were calculated by multiplying the number of benefited receptors by $107,000

Table 7-11. Summary of Acoustically Feasible and Resonable Noise Barriers and Replacement Barriers

Barrier ID	Approximate Stationing/ Location[a]	Alternative	Noise Level w/o Barrier at Benefited Receptors ($L_{eq[h]}$)	Barrier Height (feet)	Insertion Loss (dBA)	Number of Benefited Receptors	Total Reasonable Monetary Allowance
3	NB On Ramp from SB Wolfe Road, Sta. 257 to 271 (1,320 ft)	A	63-76	8	5-8	33	$3,531,000
				10	5-10	47	$5,029,000
				12 [b]	5-11	69	$7,383,000
				14 [b]	5-11	76	$8,132,000
				16 [b]	5-12	76	$8,132,000
3	NB On Ramp from SB Wolfe Road, Sta. 257 to 271 (1,320 ft)	B	61-76	8	5-8	40	$4,280,000
				10	5-9	47	$5,029,000
				12 [b]	6-9	54	$5,778,000
				14 [b]	5-10	62	$6,634,000
				16 [b]	5-10	76	$8,132,000
3	NB On Ramp from SB Wolfe Road, Sta. 257 to 271 (1,320 ft)	C	65-76	8	5-8	26	$2,782,000
				10	6-9	26	$2,782,000
				12 [b]	5-10	41	$4,387,000
				14 [b]	6-10	41	$4,387,000
				16 [b]	6-11	41	$4,387,000

a Barrier lengths are based on linear approximations used for purposes of noise modeling in TNM 2.5. Actual lengths may differ slightly due to barrier curvature, etc.

b Barrier breaks line of sight between 11.5-foot high truck stack and 5-foot high receptor.

Chapter 8. Construction Noise

Components of the project are described in detail in Chapter 2. Noise generated by project-related construction activities would be a function of the noise levels generated by individual pieces of construction equipment, the type and amount of equipment operating at any given time, the timing and duration of construction activities, the proximity of nearby sensitive land uses, and the presence or lack of shielding at these sensitive land uses. Construction noise levels would vary on a day-to-day basis during each phase of construction depending on the specific task being completed.

8.1. Regulatory Criteria

8.1.1. State Policy

Noise associated with construction is controlled by Caltrans Standard Specification Section 14-8.02, "Noise Control," which states the following:

- Control and monitor noise resulting from work activities.
- Do not exceed 86 dBA L_{max} at 50 feet from the job site activities from 9:00 p.m. to 6:00 a.m.

8.1.2. Local Regulations

The City of Cupertino's Noise Ordinance exempts grading, construction, and demolition activities occurring during daytime hours (7:00 am to 8:00 pm) from the municipal code noise limits, provided that the equipment utilized has high-quality noise muffler and abatement devices installed and in good condition, and the activity meets one of the following two criteria:

1. No individual device produces a noise level more than 87 dBA at a distance of 25 feet (7.5 meters); or
2. The noise level on any nearby property does not exceed 80 dBA.

It is a violation of the Municipal Code to engage in any grading, street construction, demolition, or underground utility work within 750 feet of a residential area on Saturdays, Sundays, and holidays, and during the nighttime period (defined as 8:00 pm to 7:00 am).

8.2. Construction Phasing and Noise Levels

Project construction is anticipated to occur over a period of 2 years and would include demolition, site preparation, grading, and structures. Pile driving could be used as a method of construction for structure foundation. Construction noise would primarily result from the operation of heavy construction equipment and arrival and departure of heavy-duty trucks.

Table 8-1 presents construction noise levels calculated for each major phase of the project at a distance of 50 feet, based on calculations conducted in FHWA's Roadway Construction Noise Model (RCNM) using project specific construction information. This construction noise model includes representative sound levels for the most common types of construction equipment and the approximate usage factors of such equipment that were developed based on an extensive database of information gathered during the construction of the Central Artery/Tunnel Project in Boston, Massachusetts (CA/T Project or "Big Dig"). In some instances, maximum instantaneous noise levels are calculated to be slightly lower than hourly average noise levels. This occurs because the model reports the maximum instantaneous noise level generated by the loudest single piece of construction equipment, while reporting the hourly average noise levels resulting from the additive effect of multiple pieces of construction equipment operating simultaneously. Noise generated by construction equipment drops off at a rate of 6 dB per doubling of distance.

Table 8-1. Noise Levels by Construction Phase at 50 feet

Construction Phase	Maximum Noise Level (L_{max}, dBA)	Hourly Average Noise Level ($L_{eq[h]}$, dBA)
Site Preparation	90	85
Grading Phase 1	85	87
Structure Phase 1	81	80
Structure Demolition	90	85
Structures (with Pile Driving)	95	88
Grading Phase 2	85	87
Structure Phase 2	81	80
Final Grading	81	81

8.3. Construction Noise Impacts

Although the overall construction schedule is anticipated to occur over a period of 2 years, roadway construction activities typically occur for relatively short periods of time in any specific location as construction proceeds along the project's alignment. Construction noise would mostly be of concern in areas where heavy construction would be concentrated for extended periods of time in areas adjacent to noise sensitive receptors, where noise levels from individual pieces of equipment are substantially higher than ambient conditions, or when construction activities would occur during noise-sensitive early morning, evening, or nighttime hours.

As indicated through comparison of Table 8-1, most construction phases would generate average noise levels that would exceed ambient daytime noise levels at adjacent land uses by 15 to 20 dBA $L_{eq[h]}$. Receptors shielded by noise barriers would be exposed to a similar increase in noise, albeit at lower overall noise levels because the shielding provided by the existing noise barriers would attenuate construction noise at a similar rate to traffic noise.

With the exception of short periods of pile driving (if used as a method of construction), heavy demolition, and site preparation, construction noise levels would not be expected to exceed the quantitative noise limits established by Caltrans. Construction noise levels are anticipated to exceed the City of Cupertino's noise criteria during pile driving located within 300 feet of noise sensitive receptors and for other construction located within 120 feet of receptors.

Noise-sensitive receptors in areas where noise barriers are removed and replaced would experience increased traffic noise levels during the period of time between removal of the existing wall and construction of the replacement wall. Noise level increases were calculated to reach up to 9 dBA in some locations with the removal of existing barriers, with resulting worst-hour traffic noise levels calculated to be as high as 76 dBA L_{eq} at receptor locations. Local noise ordinances would not typically be applied to temporary traffic noise increases.

8.4. Construction Noise Minimization Measures

To reduce the potential for noise impacts resulting from project construction, the following measures should be implemented during project construction.

- All construction equipment should conform to Section 14-8.02, Noise Control, of the latest Standard Specifications.

- When feasible, noise-generating construction activities should be restricted to between 7:00 a.m. and 8:00 p.m. on weekdays, with no construction occurring on weekends or holidays. If work is necessary outside of these hours, Caltrans should require the contractor to implement a construction noise monitoring program and provide additional mitigation where practical and feasible.

- Pile driving activities shall be limited to daytime hours only.

- Equip all internal combustion engine driven equipment with manufacturer recommended intake and exhaust mufflers that are in good condition and appropriate for the equipment.

- Unnecessary idling of internal combustion engines within 100 feet of residences should be strictly prohibited.

- Locate stationary noise generating equipment as far as possible from sensitive receptors when sensitive receptors adjoin or are near the construction project area.

- Utilize "quiet" air compressors and other "quiet" equipment where such technology exists.

- In locations where existing barriers are planned to be removed and replaced, construct each replacement barriers as soon as feasible after the removal of the existing barrier.

Chapter 9. References

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Fehr & Peers. June 2018. I-280/Wolfe Road Interchange Improvement, Draft Traffic Operations Analysis and Report.

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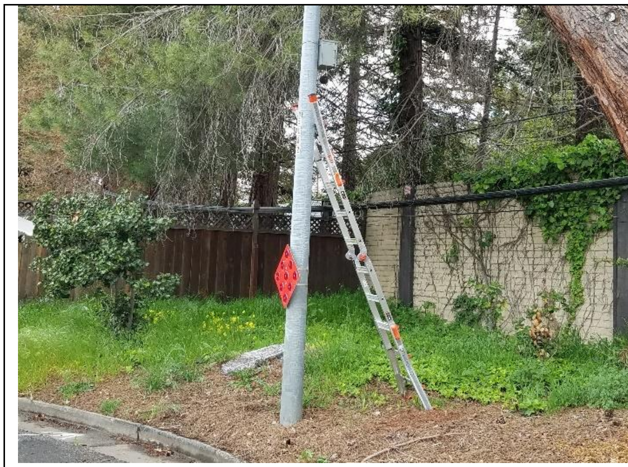
Appendix A Definition of Technical Terms

Term	**Definition**
Decibel, dB	A unit describing, the amplitude of sound, equal to 20 times the logarithm to the base 10 of the ratio of the pressure of the sound measured to the reference pressure. The reference pressure for air is 20 micro-Pascals.
Sound Pressure Level	Sound pressure is the sound force per unit area, usually expressed in micro Pascals (or 20 micro Newtons per square meter), where 1 Pascal is the pressure resulting from a force of 1 Newton exerted over an area of 1 square meter. The sound pressure level is expressed in decibels as 20 times the logarithm to the base 10 of the ratio between the pressures exerted by the sound to a reference sound pressure (e.g., 20 micro Pascals). Sound pressure level is the quantity that is directly measured by a sound level meter.
Frequency, Hz	The number of complete pressure fluctuations per second above and below atmospheric pressure. Normal human hearing is between 20 Hz and 20,000 Hz. Infrasonic sound are below 20 Hz and Ultrasonic sounds are above 20,000 Hz.
A-Weighted Sound Level, dBA	The sound pressure level in decibels as measured on a sound level meter using the A-weighting filter network. The A-weighting filter de-emphasizes the very low and very high frequency components of the sound in a manner similar to the frequency response of the human ear and correlates well with subjective reactions to noise.
Equivalent Noise Level, L_{eq}	The average A-weighted noise level during the measurement period.
L_{max}, L_{min}	The maximum and minimum A-weighted noise level during the measurement period.
L_{01}, L_{10}, L_{50}, L_{90}	The A-weighted noise levels that are exceeded 1%, 10%, 50%, and 90% of the time during the measurement period.
Day/Night Noise Level, L_{dn}	The average A-weighted noise level during a 24-hour day, obtained after addition of 10 decibels to levels measured in the night between 10:00 p.m. and 7:00 a.m.
Community Noise Equivalent Level, CNEL	The average A-weighted noise level during a 24-hour day, obtained after addition of 5 decibels in the evening from 7:00 p.m. to 10:00 p.m. and after addition of 10 decibels to sound levels measured in the night between 10:00 p.m. and 7:00 a.m.
Ambient Noise Level	The composite of noise from all sources near and far. The normal or existing level of environmental noise at a given location.
Intrusive	That noise which intrudes over and above the existing ambient noise at a given location. The relative intrusiveness of a sound depends upon its amplitude, duration, frequency, and time of occurrence and tonal or informational content as well as the prevailing ambient noise level.

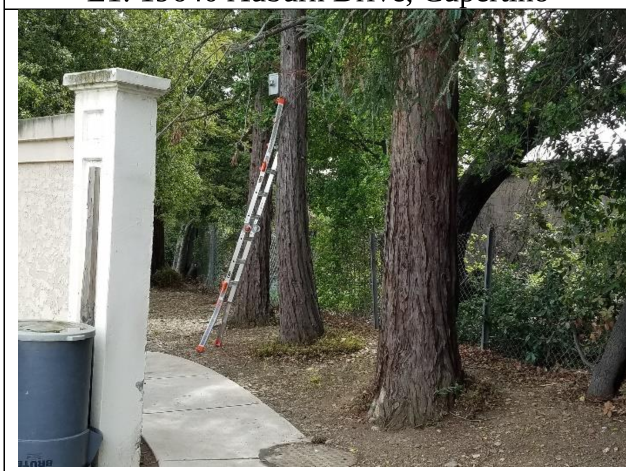
Source: Handbook of Acoustical Measurements and Noise Control, Harris, 1998.

Appendix B Site Photographs



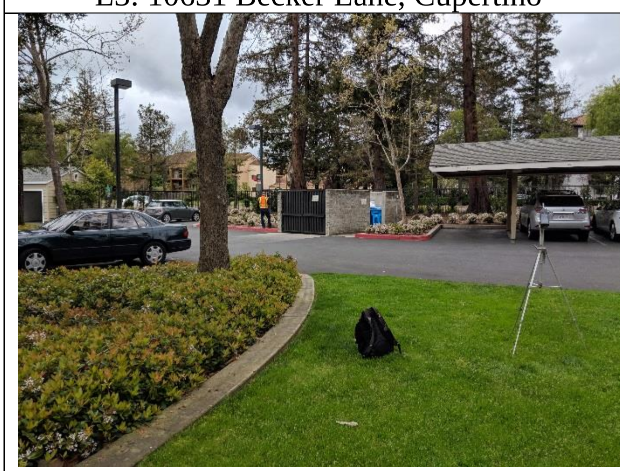
L1: 19640 Auburn Drive, Cupertino

L2: 19500 Pruneridge Avenue, Cupertino



L3: 10631 Becker Lane, Cupertino

S1: 19500 Pruneridge Avenue, Cupertino



S2/S3: 10750 N Wolfe Road, Cupertino

S4: 831 Shetland Place, Sunnyvale

S5: 826 Shetland Place, Sunnyvale

S6: 19700 Drake Drive, Cupertino

S7: 19711 Drake Drive, Cupertino

S8: 10605 N Wolfe Road, Cupertino

S9: 10631 Becker Lane, Cupertino

Appendix C Receptor Locations and Noise Barriers

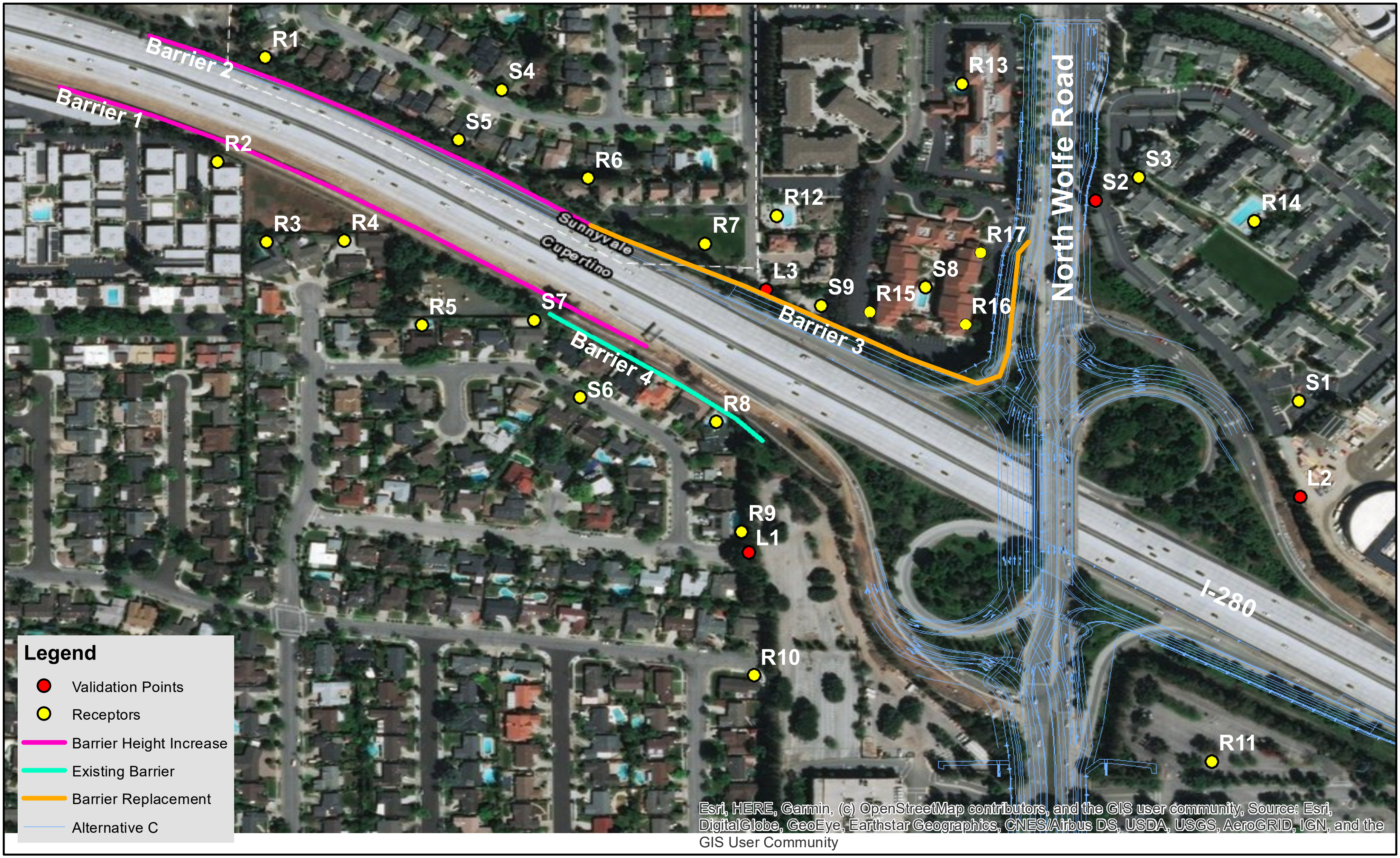
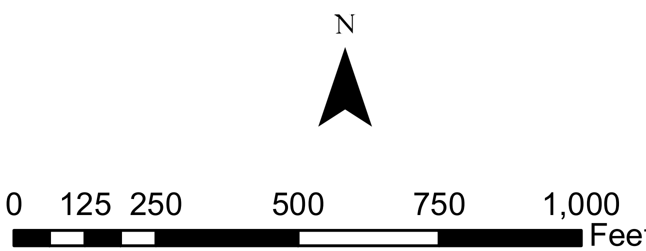


Figure C-3:
Noise Measurements, Receptors, and Barriers
Alternative C
I-280 and North Wolfe Road, Cupertino, CA

ILLINGWORTH & RODKIN, INC.
Acoustics • Air Quality



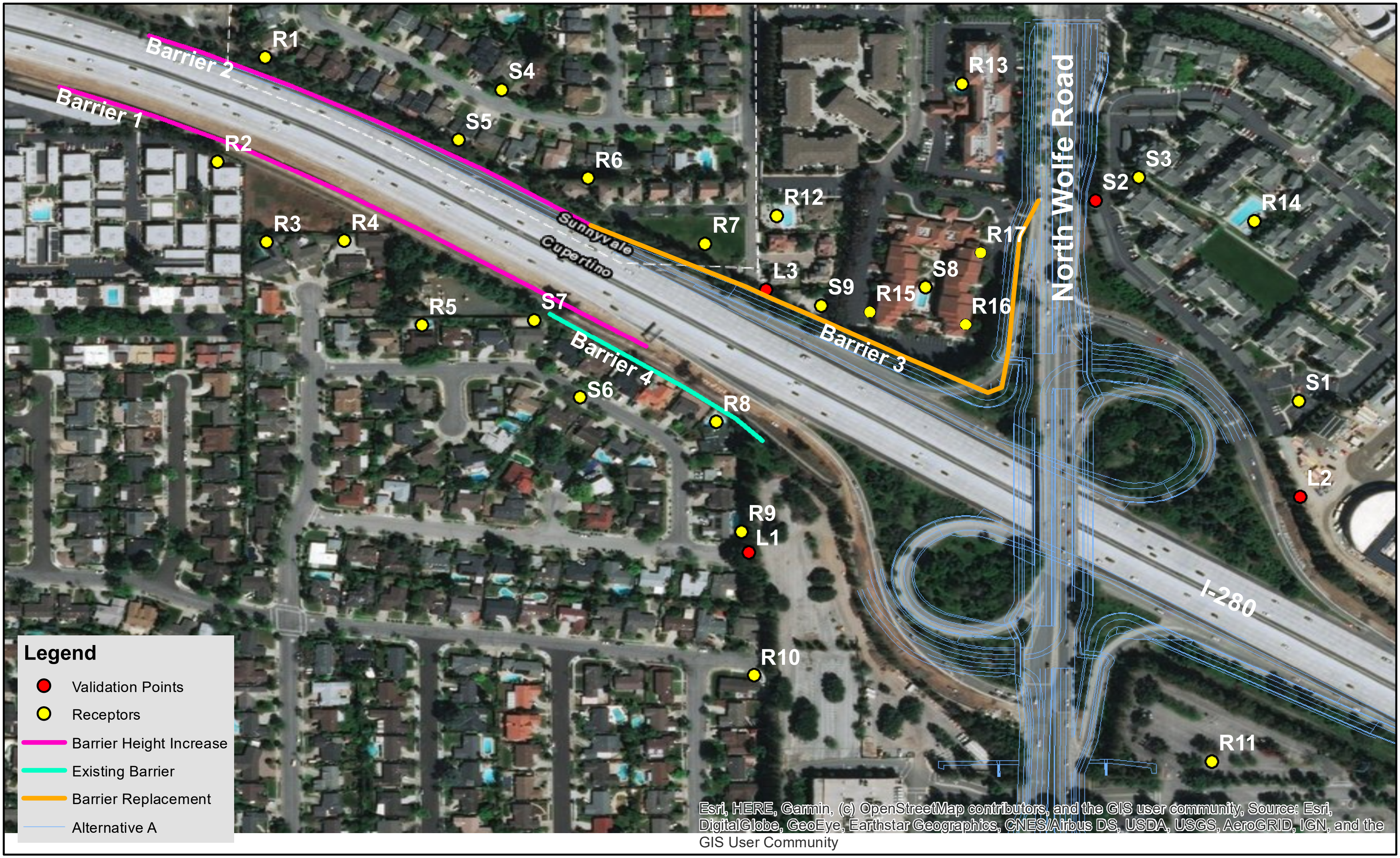
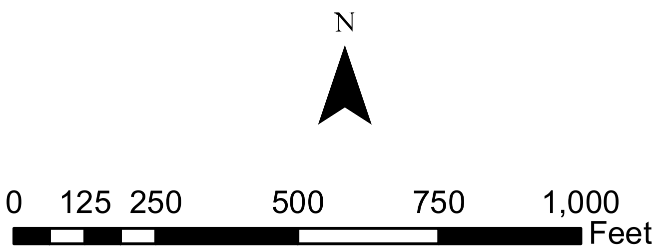


Figure C-1:
Noise Measurements, Receptors, and Barriers
Alternative A
I-280 and North Wolfe Road, Cupertino, CA

ILLINGWORTH & RODKIN, INC.
Acoustics • Air Quality



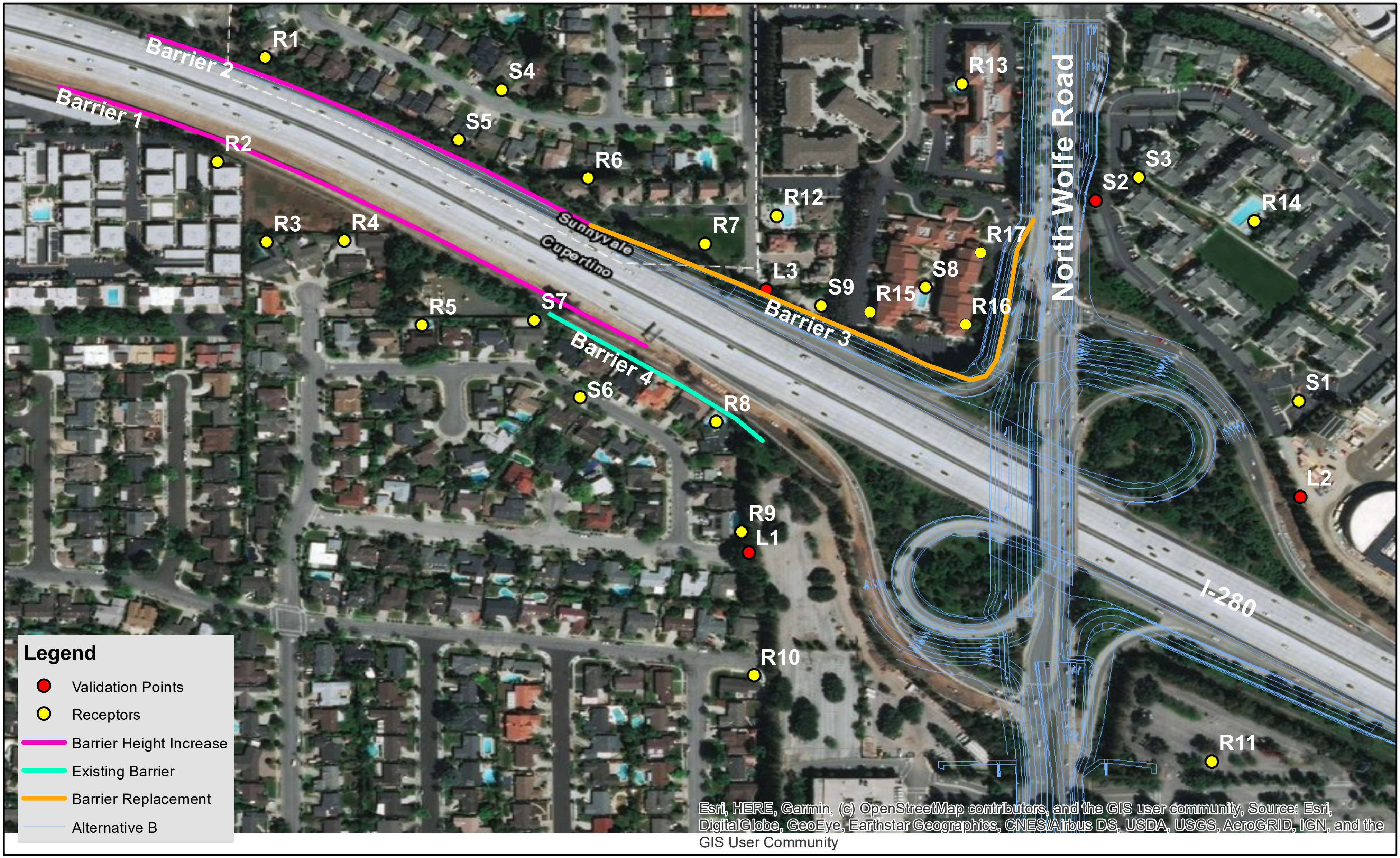
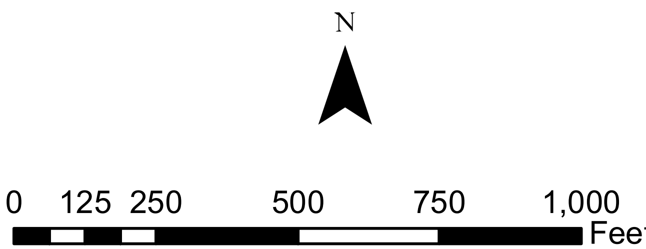


Figure C-2:
Noise Measurements, Receptors, and Barriers
Alternative B
I-280 and North Wolfe Road, Cupertino, CA

ILLINGWORTH & RODKIN, INC.
Acoustics • Air Quality



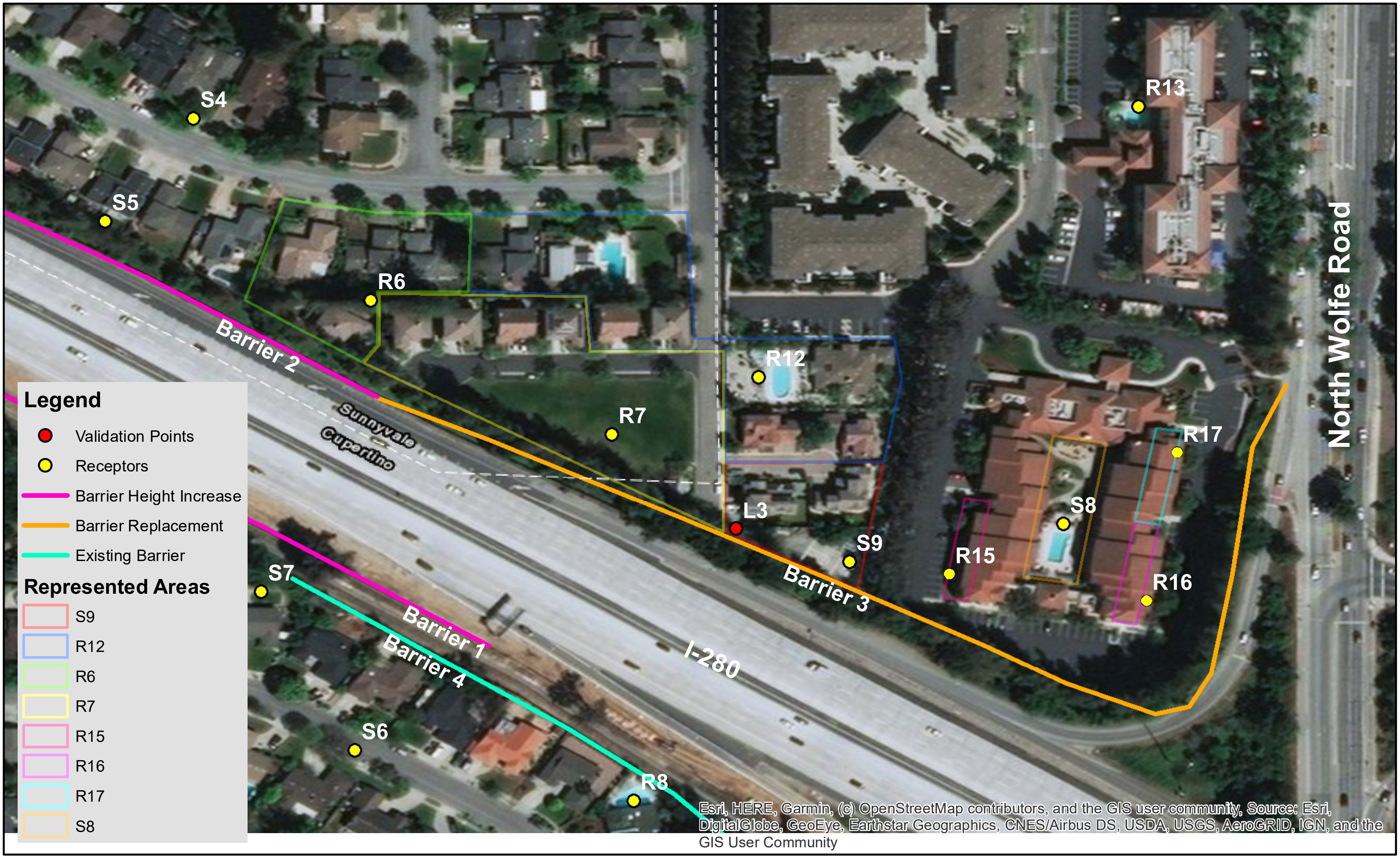


Figure C-4:
Areas Represented by Receptors Located Behind Barrier 3
I-280 and North Wolfe Road, Cupertino, CA

N

ILLINGWORTH & RODKIN, INC.
Acoustics • Air Quality

0 62.5 125 250 375 500 Feet

Appendix D Long-Term Noise Data

Figure D1. Daily Noise Trends at LT-1, 19640 Auburn Drive, Cupertino, Wednesday, April 3, 2019

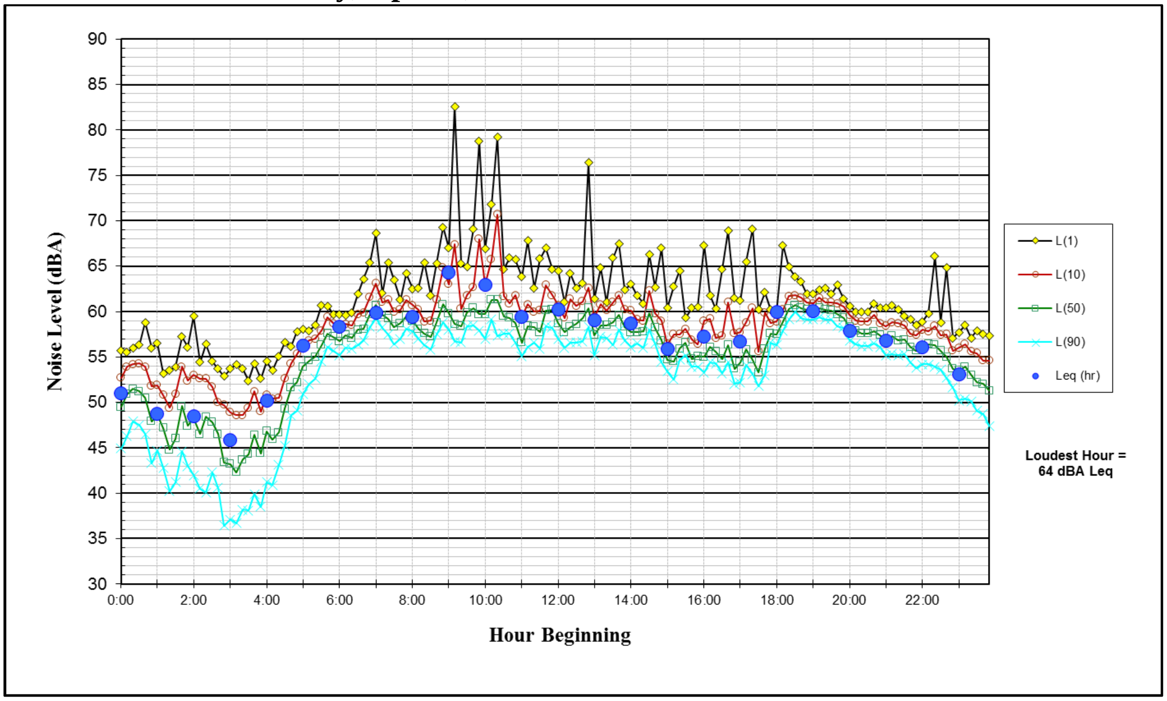


Figure D2. Daily Noise Trends at LT-2, 19500 Pruneridge Avenue, Cupertino, Wednesday, April 3, 2019

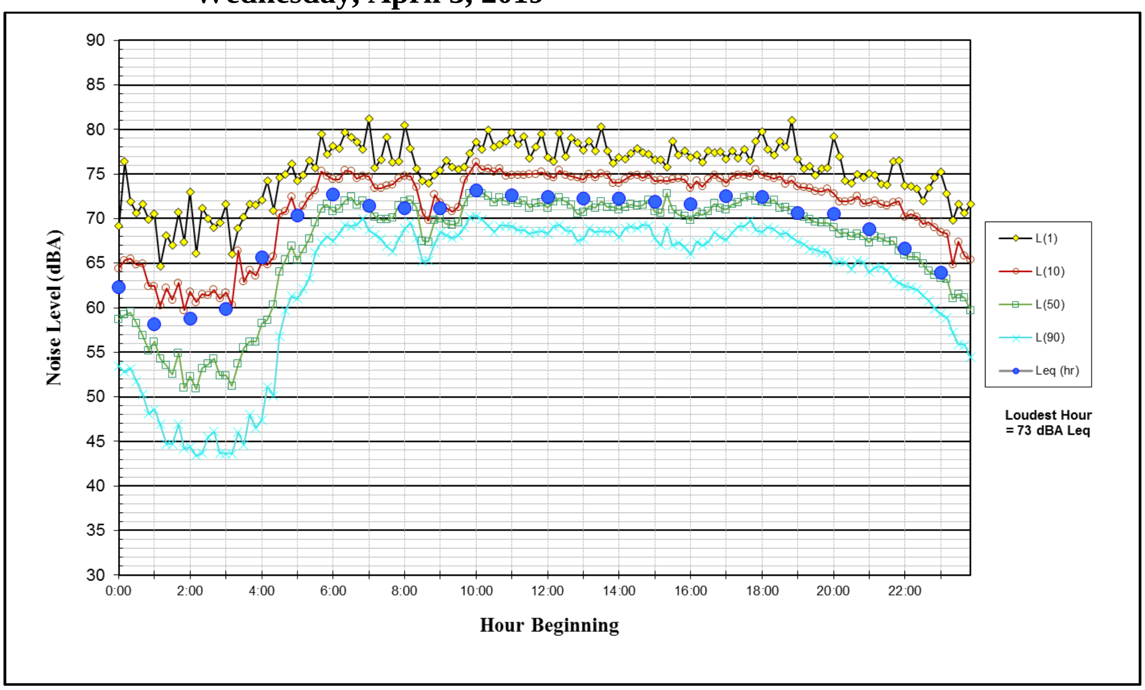
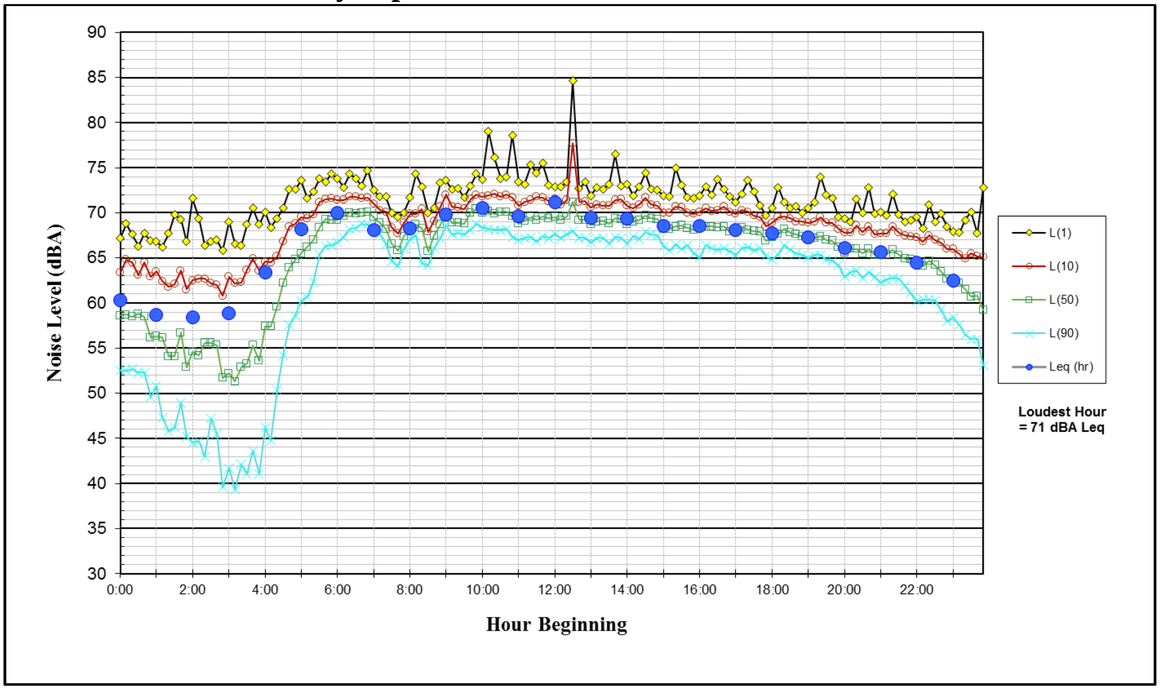


Figure D3. Daily Noise Trends at LT-3, 10631 Becker Lane, Cupertino, Wednesday, April 3, 2019



Appendix E Traffic Data

Table E-1. Traffic Data for Existing Conditions

Roadway	Number of Lanes	Loudest Hour Traffic Volume	Auto		Medium Trucks		Heavy Trucks		Speed, mph
			%	Volume	%	Volume	%	Volume	
NB Wolfe to I-280 SB	1	571	96.7%	552	1.9%	11	1.4%	8	45
NB Wolfe to I-280 NB	1	482	96.7%	466	1.9%	9	1.4%	7	45
NB I-280 Off Ramp to Wolfe	2	1,003	96.7%	970	1.9%	19	1.4%	14	45
SB Wolfe to I-280 NB	1	505	96.7%	488	1.9%	10	1.4%	7	45
SB Wolfe to I-280 SB	1	436	96.7%	422	1.9%	8	1.4%	6	45
SB I-280 Off Ramp to Wolfe	2	758	96.7%	733	1.9%	14	1.4%	11	45
NB Wolfe crossing Bridge	2	1,500	96.7%	1,451	1.9%	29	1.4%	21	35
SB Wolfe crossing Bridge	2	1,543	96.7%	1,492	1.9%	29	1.4%	21	35

Table E-2. Traffic Data for 2045 No Build

Roadway	Number of Lanes	Loudest Hour Traffic Volume	Auto		Medium Trucks		Heavy Trucks		Speed, mph
			%	Volume	%	Volume	%	Volume	
NB Wolfe to I-280 SB	1	900	96.7%	870	1.9%	17	1.4%	13	45
NB Wolfe to I-280 NB	1	890	96.7%	861	1.9%	17	1.4%	12	45
NB I-280 Off Ramp to Wolfe	2	1,755	96.7%	1,697	1.9%	33	1.4%	24	45
SB Wolfe to I-280 NB	1	830	96.7%	803	1.9%	16	1.4%	12	45
SB Wolfe to I-280 SB	1	790	96.7%	764	1.9%	15	1.4%	11	45
SB I-280 Off Ramp to Wolfe	2	1,335	96.7%	1,291	1.9%	25	1.4%	19	45
NB Wolfe crossing Bridge	2	2,000	96.7%	1,934	1.9%	38	1.4%	28	35
SB Wolfe crossing Bridge	2	2,000	96.7%	1,934	1.9%	38	1.4%	28	35

Table E-3. Traffic Data for 2045 Build Alternatives A and B

Roadway	Number of Lanes	Loudest Hour Traffic Volume	Auto		Medium Trucks		Heavy Trucks		Speed, mph
			%	Volume	%	Volume	%	Volume	
NB Wolfe to I-280 SB	2	900	96.7%	870	1.9%	17	1.4%	13	45
NB Wolfe to I-280 NB	2	890	96.7%	861	1.9%	17	1.4%	12	45
NB I-280 Off Ramp to Wolfe	2	1,755	96.7%	1,697	1.9%	33	1.4%	24	45
SB Wolfe to I-280 NB	2	830	96.7%	803	1.9%	16	1.4%	12	45
SB Wolfe to I-280 SB	2	790	96.7%	764	1.9%	15	1.4%	11	45
SB I-280 Off Ramp to Wolfe	2	1,335	96.7%	1,291	1.9%	25	1.4%	19	45
NB Wolfe crossing Bridge	3	3,000	96.7%	2,901	1.9%	57	1.4%	42	35
SB Wolfe crossing Bridge	3	3,000	96.7%	2,901	1.9%	57	1.4%	42	35

Table E-4. Traffic Data for 2045 Build Alternative C

Roadway	Number of Lanes	Loudest Hour Traffic Volume	Auto		Medium Trucks		Heavy Trucks		Speed, mph
			%	Volume	%	Volume	%	Volume	
NB I-280 Off Ramp to Wolfe	2	1,755	96.7%	1,697	1.9%	33	1.4%	24	45
Wolfe On Ramp to I-280 NB	2	1,720	96.7%	1,663	1.9%	33	1.4%	24	45
SB I-280 Off Ramp to Wolfe	2	1,335	96.7%	1,291	1.9%	25	1.4%	19	45
Wolfe On Ramp to I-280 SB	2	1,690	96.7%	1,634	1.9%	32	1.4%	24	45
NB Wolfe crossing Bridge	3	3,000	96.7%	2,901	1.9%	57	1.4%	42	35
SB Wolfe crossing Bridge	3	3,000	96.7%	2,901	1.9%	57	1.4%	42	35

Appendix F RCNM Output Files

Roadway Construction Noise Model (RCNM),Version 1.1

Report date: 04/17/2019
Case Description: Demolition

**** Receptor #1 ****

		Baselines (dBA)		
Description	Land Use	Daytime	Evening	Night
50 ft	Residential	60.0	55.0	50.0

Equipment

Description	Impact Device	Spec Usage (%)	Lmax (dBA)	Actual Lmax (dBA)	Receptor Distance (feet)	Estimated Shielding (dBA)
Concrete Saw	No	20		89.6	50.0	0.0
Excavator	No	40		80.7	50.0	0.0
Dozer	No	40		81.7	50.0	0.0
Backhoe	No	40		77.6	50.0	0.0

Results

	Calculated (dBA)		Noise Limits (dBA)						Noise Limit Exceedance (dBA)					
			Day		Evening		Night		Day		Evening		Night	
Equipment	Lmax	Leq	Lmax	Leq	Lmax	Leq	Lmax	Leq	Lmax	Leq	Lmax	Leq	Lmax	Leq
Concrete Saw	89.6	82.6	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Excavator	80.7	76.7	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Dozer	81.7	77.7	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Backhoe	77.6	73.6	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Total	89.6	84.9	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

Roadway Construction Noise Model (RCNM),Version 1.1

Report date: 04/17/2019
Case Description: Final Grading

**** Receptor #1 ****

		Baselines (dBA)		
Description	Land Use	Daytime	Evening	Night
50 ft	Residential	60.0	55.0	50.0

Equipment

Description	Impact Device	Spec Usage (%)	Actual Lmax (dBA)	Receptor Lmax (dBA)	Estimated Distance (feet)	Shielding (dBA)
Concrete Mixer Truck	No	40		78.8	50.0	0.0
Paver	No	50		77.2	50.0	0.0
Concrete Pump Truck	No	20		81.4	50.0	0.0
Roller	No	20		80.0	50.0	0.0
Backhoe	No	40		77.6	50.0	0.0

Results

			Noise Limits (dBA)						Noise Limit Exceedance (dBA)					
	Calculated (dBA)		Day		Evening		Night		Day		Evening		Night	
Equipment	Lmax	Leq	Lmax	Leq	Lmax	Leq	Lmax	Leq	Lmax	Leq	Lmax	Leq	Lmax	Leq
Concrete Mixer Truck	78.8	74.8	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Paver	77.2	74.2	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Concrete Pump Truck	81.4	74.4	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Roller	80.0	73.0	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Backhoe	77.6	73.6	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Total	81.4	81.0	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

Roadway Construction Noise Model (RCNM),Version 1.1

Report date: 04/17/2019
Case Description: Grading

**** Receptor #1 ****

Baselines (dBA)

Description	Land Use	Daytime	Evening	Night
50 ft	Residential	60.0	55.0	50.0

Equipment

Description	Impact Device	Usage (%)	Spec Lmax (dBA)	Actual Lmax (dBA)	Receptor Distance (feet)	Estimated Shielding (dBA)
Grader	No	40	85.0		50.0	0.0
Grader	No	40	85.0		50.0	0.0
Dozer	No	40		81.7	50.0	0.0
Dozer	No	40		81.7	50.0	0.0
Excavator	No	40		80.7	50.0	0.0
Backhoe	No	40		77.6	50.0	0.0
Backhoe	No	40		77.6	50.0	0.0

Results

	Calculated (dBA)		Noise Limits (dBA)						Noise Limit Exceedance (dBA)					
			Day		Evening		Night		Day		Evening		Night	
Equipment	Lmax	Leq	Lmax	Leq	Lmax	Leq	Lmax	Leq	Lmax	Leq	Lmax	Leq	Lmax	Leq
Grader	85.0	81.0	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Grader	85.0	81.0	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Dozer	81.7	77.7	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Dozer	81.7	77.7	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Excavator	80.7	76.7	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Backhoe	77.6	73.6	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Backhoe	77.6	73.6	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Total	85.0	86.7	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

Roadway Construction Noise Model (RCNM),Version 1.1

Report date: 04/17/2019
Case Description: Structure

**** Receptor #1 ****

Baselines (dBA)

Description	Land Use	Daytime	Evening	Night
50 ft	Residential	60.0	55.0	50.0

Equipment

Description	Impact Device	Usage (%)	Spec Lmax (dBA)	Actual Lmax (dBA)	Receptor Distance (feet)	Estimated Shielding (dBA)
Crane	No	16		80.6	50.0	0.0
Generator	No	50		80.6	50.0	0.0
Backhoe	No	40		77.6	50.0	0.0
Welder / Torch	No	40		74.0	50.0	0.0

Results

	Calculated (dBA)		Noise Limits (dBA)						Noise Limit Exceedance (dBA)					
			Day		Evening		Night		Day		Evening		Night	
Equipment	Lmax	Leq	Lmax	Leq	Lmax	Leq	Lmax	Leq	Lmax	Leq	Lmax	Leq	Lmax	Leq
Crane	80.6	72.6	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Generator	80.6	77.6	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Backhoe	77.6	73.6	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Welder / Torch	74.0	70.0	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Total	80.6	80.4	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

Appendix G Traffic Volumes Used for TNM Model Validation

Table G-1 Hourly Equivilent[1] Northbound Interstate 280 Traffic Volumes, April 4, 2019

Start Time	Northbound					Southbound				
	A	M	H	B	X	A	M	H	B	X
10:40 am	4434	90	36	0	0	3642	84	132	6	6
10:50 am	4218	48	30	0	24	3210	90	72	0	18
11:05 am	4320	72	72	0	0	2988	96	0	12	0
11:10 am	3762	66	48	0	12	3102	120	66	6	6
11:50 am	3348	36	60	6	0	3516	120	54	6	12
12:00 pm	3396	60	54	0	6	3558	84	72	30	6
12:40 pm	3702	66	30	12	12	3612	102	30	12	0
12:50 pm	3336	54	48	18	0	3558	72	66	18	18
1:30 pm	3480	42	60	6	0	3828	138	54	12	6
1:40 pm	3666	72	48	18	0	3900	114	60	42	6

1 Hourly equivalent traffic volumes were calculated by multiplying 10-minute duration traffic counts conducted concurrent with the 10-minute duration short-term noise measurements by 6.

2 A: Light Vehicles, M: Medium Duty Trucks, H: Heavy Duty Trucks, B: Buses, X: Motorcycles.