3.12 NOISE

This section assesses the potential noise/vibration impacts associated with implementation of the proposed Plan. The following includes acoustical terminology and background information relevant to the proposed Plan, a presentation of applicable regulatory standards, assessment of acoustical impacts related to implementation of the proposed Plan, and identification of potentially feasible noise mitigation measures where appropriate.

Comments received in response to the Notice of Preparation addressed the effects of population growth during the Plan period and the effects of the COVID-19 pandemic on road and air travel frequency. The effects of population growth in the Plan area between now and 2050 on ambient noise levels are addressed in this section. Additionally, the reduction in vehicular travel on roadways, as well as decreased air traffic from nearby airports, related to the COVID-19 pandemic and the consequent reduction in associated ambient noise levels are addressed. Comments also raised concerns with overall noise pollution, vehicle noise, aircraft, and seagoing freighters associated with population growth. Impacts related to traffic noise are discussed in Impact NOISE-2, and aircraft noise impacts are addressed in Impact NOISE-4. Increases in the use of seagoing freighters would not result in increased community noise levels and are not evaluated in this EIR.

The CEQA Guidelines note that comments received during the NOP scoping process can be helpful in "identifying the range of actions, alternatives, mitigation measures, and significant effects to be analyzed in depth in an EIR and in eliminating from detailed study issues found not to be important." (CEQA Guidelines Section 15083.) Neither the CEQA Guidelines nor Statutes require a lead agency to respond directly to comments received in response to the NOP, but they do require they be considered. Consistent with these requirements, the comments in response to the NOP have been carefully reviewed and considered by MTC/ABAG in the preparation of impacts in this chapter. Appendix B includes all NOP comments received.

3.12.1 Environmental Setting

ACOUSTIC FUNDAMENTALS

Acoustical Terminology

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). Noise is generally defined as unwanted sound (i.e., loud, unexpected, or annoying sound). Acoustics is defined as the physics of sound. In acoustics, the fundamental scientific model consists of a sound (or noise) source, a receiver, and the propagation path between the two. The loudness of the noise source and obstructions or atmospheric factors affecting the propagation path to the receiver determine the sound level and characteristics of the noise perceived by the receiver. Acoustics addresses primarily the propagation and control of sound.

Frequency

The number of sound pressure peaks traveling past a given point in a single second is referred to as the frequency, expressed in cycles per second, or hertz (Hz). A given sound may consist of energy at a single frequency (pure tone) or in many frequencies over a broad frequency range (or band). Human hearing is generally affected by sound frequencies between 20 Hz and 20,000 Hz (20 kilohertz).

Amplitude

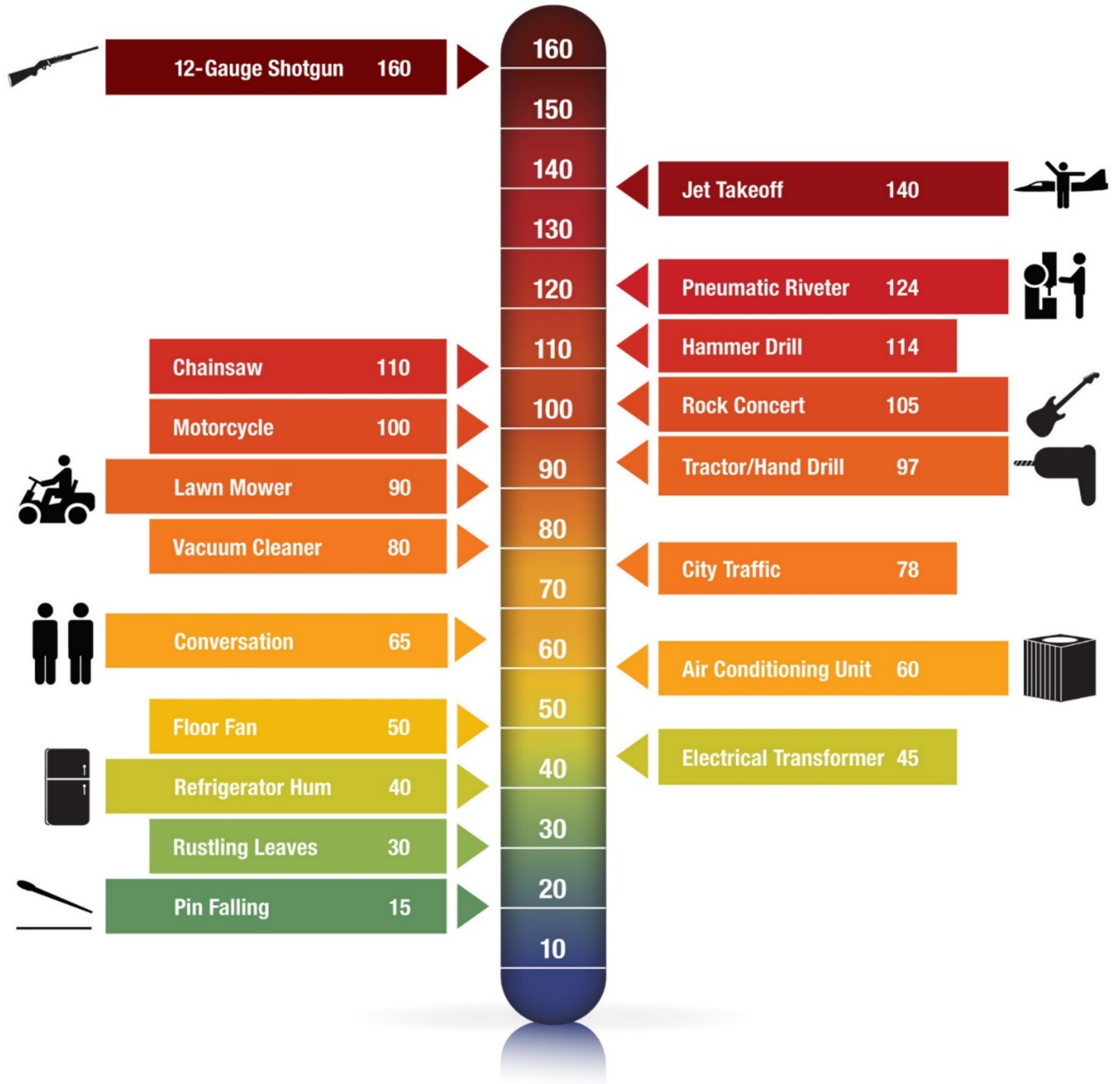
The amplitude of pressure waves generated by a sound source determines the perceived loudness of that source. Sound pressure amplitude is measured in micro-Pascals (μPa). One μPa is approximately one hundred billionths (0.00000000001) of normal atmospheric pressure. Sound pressure amplitudes for different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

Addition of Decibels

Because decibels are logarithmic units, addition and subtraction of SPL is not linear. Under the decibel scale, a doubling of sound energy corresponds to a 3-dB increase. In other words, when two sources are each producing sound of the same loudness, the resulting sound level at a given distance would be approximately 3 dB higher than one of the sources 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 of approximately 5 dB louder than one source, and 10 sources of equal loudness together produce a sound level of approximately 10 dB louder than the single source.

A-Weighted Decibels

Figure 3.12-1 illustrates sound levels associated with common sound sources. The perceived loudness of sounds is dependent on many factors, including sound pressure level and frequency content. However, within the usual range of environmental sound levels, perception of loudness is relatively predictable and can be approximated by frequency filtering using the standardized A-weighting network. There is a strong correlation between A-weighted sound levels (expressed as dBA) and community response to noise. For this reason, the A-weighted sound level has become the standard descriptor for environmental noise assessment. All noise levels reported in this section are presented in terms of A-weighting.



Sources: National Institute of Occupational Safety and Health 2020; 3M 2016

Figure 3.12-1: Decibel Scale and Common Noise Sources

Human Response to Changes in Noise Levels

As discussed above, doubling sound energy results in a 3-dB increase in the sound level. However, an exact doubling of the sound level as measured by precise instrumentation will usually differ from the subjective human perception of a doubling of loudness.

Under controlled conditions in a laboratory setting, the trained, healthy human ear is able to discern 1-dB changes in sound levels when exposed to steady, single-frequency ("pure-tone") signals in the midfrequency range (1,000–8,000 Hz). 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 that would result in a 3-dB increase in sound pressure level would generally be perceived as barely detectable. Please refer to **Table 3.12-1**.

Table 3.12-1: Approximate Relationship between Increases in Environmental Noise Level and Human Perception

Noise Level Increase, dB	Human Perception (Typical)
Up to about 3	Not perceptible
About 3	Barely perceptible
About 6	Distinctly noticeable
About 10	Twice as loud
About 20	Four times as loud

Source: Egan 2007

Noise-Sensitive Land Uses

Noise-sensitive land uses are generally defined as locations where people reside or where the presence of unwanted sound could adversely affect the use of the land. Noise-sensitive land uses typically include residences, hospitals, schools, transient lodging, libraries, and certain types of recreational uses. Noise-sensitive residential receivers are found throughout the Plan area.

Noise Descriptors

Noise in daily environments fluctuates over time. Various noise descriptors have been developed to describe time-varying noise levels. The following noise descriptors are the most commonly used in environmental noise analysis:

- **Equivalent Sound Level (L_{eq}):** The L_{eq} represents an average of the sound energy occurring over a specified time period. In effect, the 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 1-hour period, and it is the basis for noise abatement criteria (NAC) used by the California Department of Transportation (Caltrans) and the Federal Highway Administration (FHWA).

- **Percentile-Exceeded Sound Level (L_n):** The L_n represents the sound level exceeded "n" percentage of a specified period (e.g., L_{10} is the sound level exceeded 10 percent of the time, and L_{90} is the sound level exceeded 90 percent of the time).

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

- **Day-Night Average Level (L_{dn}):** The 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 (10 p.m.–7 a.m.). The L_{dn} is often noted as the DNL.

- **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 (10 p.m.–7 a.m.) and a 5-dB penalty applied to the A-weighted sound levels occurring during evening hours (7 p.m.–10 p.m.). The CNEL is usually within 1 dB of the L_{dn}, and for all intents and purposes, the two are interchangeable.

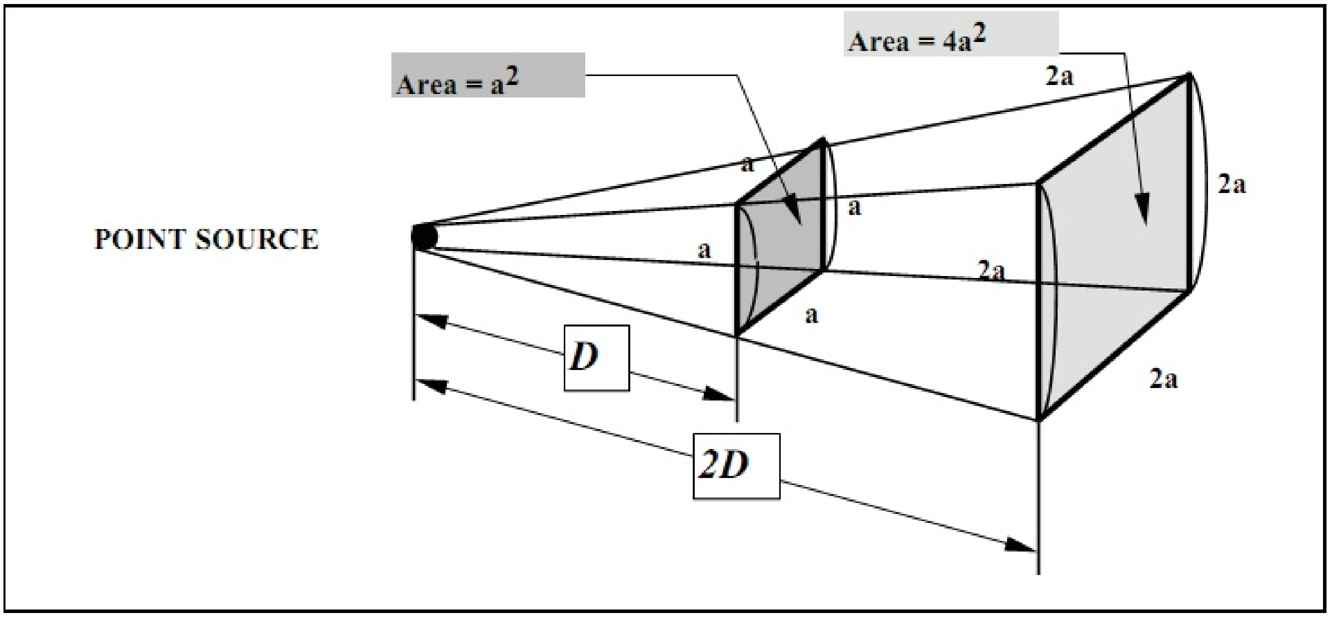
- **Single-Event Noise Level (SEL):** SEL is a receiver's cumulative noise exposure from a single impulsive-noise event, which is defined as an acoustical event of short duration that involves a change in sound pressure above some reference value. It is typically used for evaluating noise exposure from aircraft flight events.

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.

Geometric Spreading

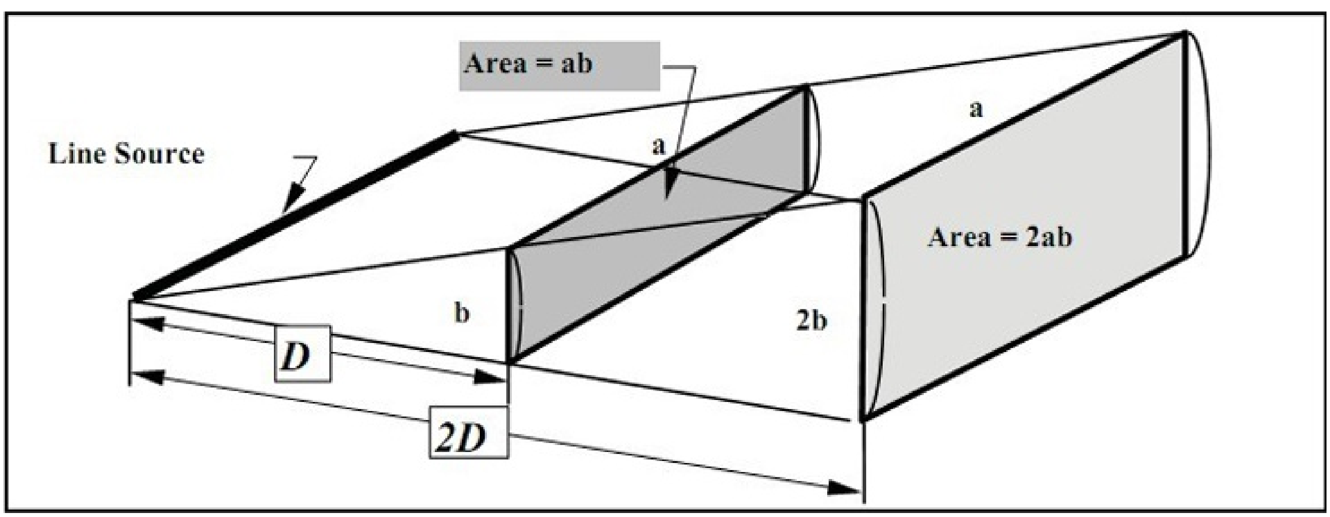
Sound from a localized source (i.e., point source) propagates uniformly outward in a spherical pattern; therefore, this type of propagation is called *spherical spreading*. The sound level attenuates (or decreases) at a rate of 6 dB for each doubling of distance from a point/stationary source as its energy is continuously spread out over a spherical surface (see **Figure 3.12-2**).



Source: Caltrans 2013

Figure 3.12-2: Point Source Spreading with Distance

Roadways and highways, and to some extent, moving trains, consist of several localized noise sources on a defined path and hence are treated as "line" sources, which approximate the effect of several point sources (see **Figure 3.12-3**). Noise from a line source propagates over a cylindrical surface, often referred to as *cylindrical spreading*. Sound levels attenuate at a rate of 3 dB for each doubling of distance from a line source. Therefore, noise attributable to a line source attenuates less with distance than that of a point source with increased distance.



Source: Caltrans 2013

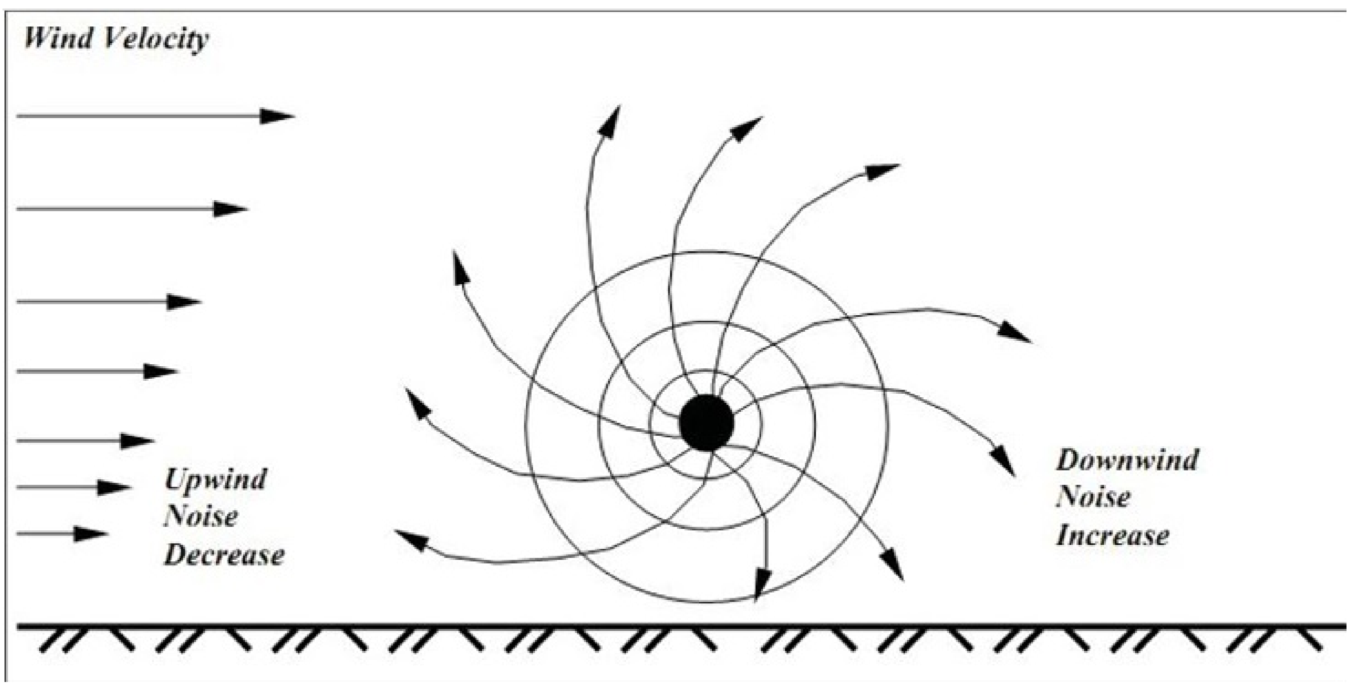
Figure 3.12-3: Line Source Spreading with Distance

Ground Absorption

The propagation path of noise from many typical sources, such as roadways, to a receiver is usually very close to the ground. Noise attenuation from ground absorption and reflective-wave canceling adds to the attenuation associated with geometric spreading. Traditionally, the excess attenuation has also been expressed in terms of attenuation per doubling of distance. For acoustically hard sites (i.e., sites with a reflective surface between the source and the receiver, such as a paved parking lot or body of water), no excess ground attenuation is generally assumed. For acoustically absorptive or soft sites (i.e., those sites with an absorptive ground surface between the source and the receiver, such as soft dirt, grass, or scattered bushes and trees), an excess ground-attenuation value of 1.5 decibels per doubling of distance is typically assumed. When added to cylindrical spreading from traffic noise sources, the excess ground attenuation results in an overall drop-off rate of 4.5 dB per doubling of distance. When added to spherical spreading (point sources), it results in an overall drop-off rate of approximately 7.5 dB. These approximations are generally applicable only for receivers within 300 feet of the noise source(s) and should not be applied to sound path lengths of more than 300 feet.

Atmospheric Effects

Receivers located downwind from a source can be exposed to increased noise levels relative to calm conditions, whereas receivers upwind from the source can have lowered noise levels. This is illustrated in **Figure 3.12-4**.



Source: Caltrans 2013

Figure 3.12-4: Wind Effects on Noise Levels

In addition to the enhancing effect produced by wind, sound levels can increase at large distances from the source (e.g., more than 500 feet) because of atmospheric temperature inversions (i.e., increasing temperature with elevation) or can decrease with distance from the source at a higher rate than the typical spreading loss with distance rate (see above) because of a temperature lapse condition (i.e., decreasing temperature with elevation).

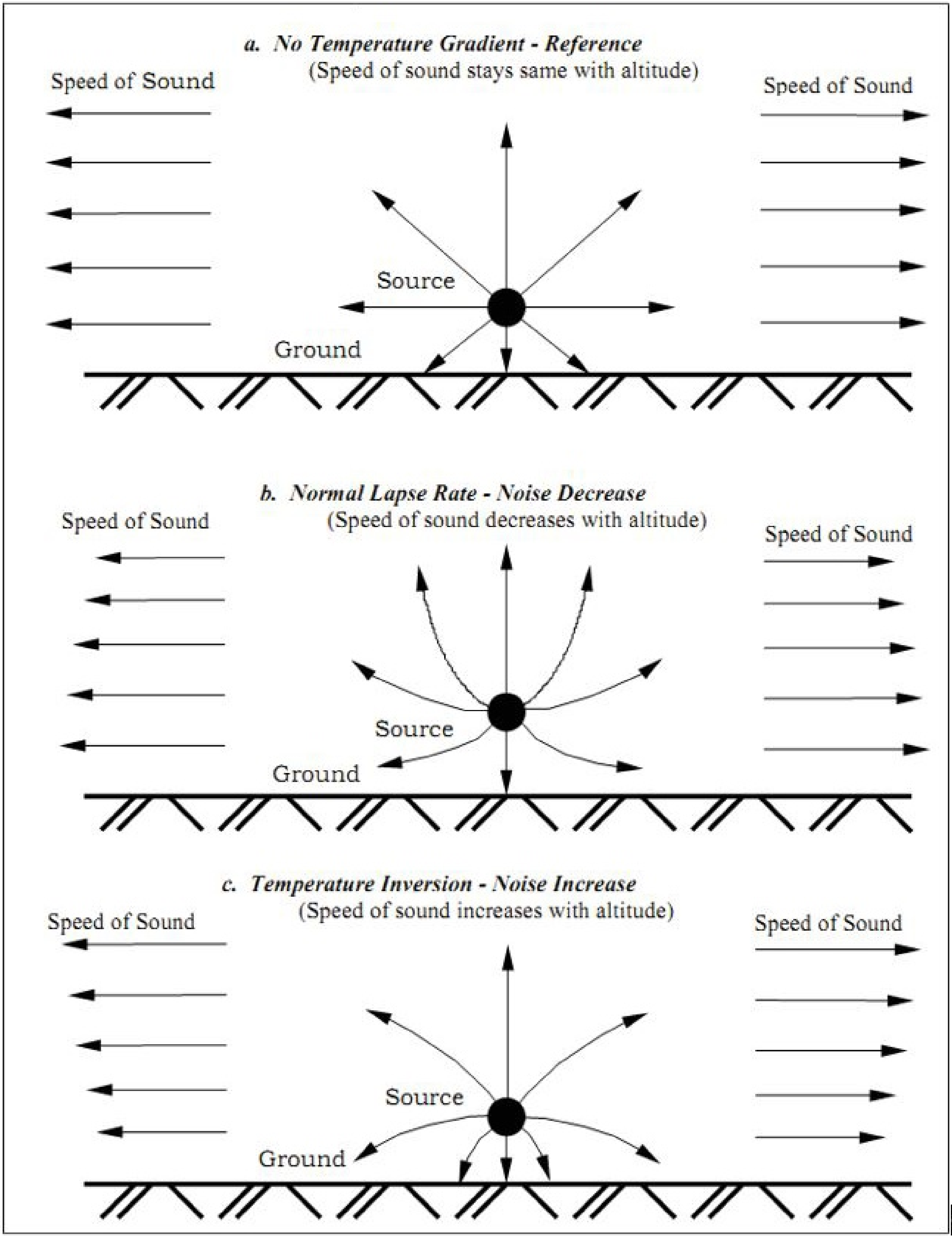
Temperature inversions are a common part of the meteorological environment in California. During a temperature inversion, the air temperature at the ground is cooler than that several hundred feet above the ground. These temperature inversions are typically caused when a warm, sunny day is followed by a cold, clear night; generally, this occurs more frequently and with higher intensity in the fall and the spring seasons. The sun warms the earth surface during the day, and generally the air temperature near the ground is higher than the air temperature at higher elevations, but when the sun sets, the earth cools quickly by infrared radiation into space, and so does the air mass at lower elevations, so that the temperature of air at high elevations soon becomes warmer than that of the air near the ground. The speed of sound is higher in warmer air, and this inverted temperature profile causes the sound waves in the warmer air to overtake those travelling in cooler air; thus, the sound “bends” back toward the ground (**Figure 3.12-5**).

Other factors, such as air temperature, humidity, and turbulence, can also affect sound propagation. For instance, air temperature and humidity affect the rate of molecular absorption as sound travels large distances. A sound consisting primarily of middle frequencies, such as speech or animal vocalization, attenuates approximately five additional decibels for every 1,000 feet of travel with an air temperature of 70 degrees Fahrenheit and a humidity of 30–40 percent. This atmospheric effect is in addition to the other effects discussed above.

Vibration

Generally speaking, vibration is energy transmitted in waves through the ground. These energy waves dissipate with distance from the vibration source. Because energy is lost during the transfer of energy from one particle to another, the vibratory energy is reduced with increasing distance from the source. Vibration attenuates at a rate of approximately 50 percent for each doubling of distance from the source. This approach takes into consideration only the attenuation from geometric spreading. Because there are additional factors that reduce vibration over distance (e.g., damping from soil condition), this approach tends to provide for a conservative assessment of vibration level at the receiver.

Vibration is an oscillatory motion that can be described in terms of displacement, velocity, or acceleration. Vibration is typically described by its peak amplitude and its root-mean-square (RMS) amplitude. The RMS value can be considered an average value over a given time interval. The peak vibration velocity is the same as the “peak particle velocity” (PPV), generally presented in units of inches/second (in/sec). PPV is defined as the maximum instantaneous positive or negative peak of the vibration signal, and PPV is generally used to assess the potential for damage to buildings and structures. The RMS amplitude is typically used for assessing human annoyance to vibration.



Source: Caltrans 2013

Figure 3.12-5: Effects of Temperature Gradients on Noise

PHYSICAL SETTING

The existing noise environment in the Bay Area is composed of two primary categories of noise sources: transportation and non-transportation. Transportation sources include surface vehicle traffic; railroad train operations, including light rail and commuter trains; and aircraft operations. Non-transportation, or stationary/fixed, sources include commercial/industrial equipment, construction equipment, and any other sources not associated with the transportation of people or goods. Existing noise exposure in the Bay Area associated with these primary noise sources is presented below.

Traffic Noise Sources

The ambient noise environment in urban areas is primarily influenced by traffic noise. Traffic noise exposure is primarily a function of the volume of vehicles per day, the speed of those vehicles, the type of ground (i.e., hard or soft), the number of those vehicles represented by medium and heavy trucks, the distribution of those vehicles during daytime and nighttime hours, and the proximity of noise-sensitive receivers to the roadway. Baseline traffic noise (based on the traffic study) within the Plan area has been characterized by traffic noise modeling. The baseline for the noise analysis is a simulation of 2015 traffic levels and land use. Based on modeling conducted for all roadway types within the Plan area, average noise levels range from 52.6 dBA CNEL (next to collector and small roads) to as high as 74.9 dBA CNEL (next to freeways). Refer to Impact NOISE-2 and **Table 3.12-7** for more details regarding traffic noise modeling. The traffic noise assessment in this analysis is inclusive of bus transit, as buses are an assumed percentage of overall roadway volumes used in the calculation of roadside noise levels.

Rail Noise Sources

The Bay Area is also affected by noise from freight and passenger rail operations. While these operations generate significant noise levels in the immediate vicinity of the railways, train operations are intermittent and area railways are widely dispersed. Commuter rail, such as San Francisco Municipal Railway and Valley Transportation Authority, operate with more frequency than standard gauge rail operations but at lower speeds, resulting in lower noise levels. Bay Area Rapid Transit operations, on the other hand, can attain higher speeds and have the potential for greater noise levels along extended stretches. Based on available data, noise levels from rail operations within the Plan area can range from 62 dBA CNEL to 81 dBA CNEL (California High-Speed Rail Authority 2020). Train operations may also be a source of ground vibration near the tracks. Vibration levels depend on several factors, including track and train type, ground type, and the speed and weight of the passing train.

Aircraft Noise Sources

The Bay Area has many airports, including public use, private use, and military facilities. Major airports include San Francisco International, Oakland International, and Norman Y. Mineta San Jose International. In addition to the daily aircraft operations originating and terminating at these facilities, aircraft not using these airports frequently fly over the Bay Area. All of these operations contribute to the overall ambient noise environment. In general, like rail noise, the proximity of the receiver to the airport and aircraft flight path determines the noise exposure. Other contributing factors include the type of aircraft operated, altitude of the aircraft, and atmospheric conditions. Atmospheric conditions may contribute to the direction of aircraft operations (flow) and affect aircraft noise propagation.

As discussed in further detail below, State law requires land use commissions to prepare and adopt an airport land use compatibility plan (ALUCP) for each public use and military airport. These plans typically include airport noise contour maps, which are modeled based on airport-specific activity data. Airport noise contours are specific to each airport. However, for informational purposes, noise contours from three of the largest airports within the Plan area (San Francisco International Airport, Oakland International Airport, and Mineta San Jose International Airport) are briefly identified below.

Based on the ALUCP for San Francisco International Airport, the 65 dBA CNEL contour extends approximately 6 miles northwest of the airport (C/CAG 2012). Based on the ALUCP for Oakland International Airport, the 65 dBA CNEL contour extends approximately 5 miles south of the airport (Alameda County 2010). Based on the ALUCP for Mineta San Jose International Airport, the 65 dBA CNEL contour extends approximately 2.5 miles northwest of the airport (Santa Clara County 2016). Many other smaller airports and airstrips in the Plan area with widely varying noise levels contribute to the existing ambient noise levels.

Construction Noise Sources

New development and implementation of transportation improvements will necessarily include construction activities that create relatively short-term noise exposure. Noise production from construction equipment varies greatly depending on factors such as the operation being performed and the equipment type, model, age, and condition. Noise associated with heavy equipment diesel engine operations often dominates the noise environment in the vicinity of construction sites. Stationary sources, such as generators, pumps, and compressors, may also produce a significant contribution; however, if present, operations from impact equipment (e.g., pile driving, pavement breaking) will generally produce the highest noise levels and may also produce significant vibration in the vicinity. Maximum noise exposure from typical construction equipment operations is approximately 75–100 dB (L_{max} at 50 feet) with noise from heavy demolition and pile driving operations having the highest noise production. Please refer to **Table 3.12-2** for typical construction noise levels.

Table 3.12-2: Typical Noise Levels from Demolition/Construction Equipment Operations

Construction Equipment	Noise Exposure Level, dB L_{max} at 50 Feet
Air Compressor	78–81
Backhoe	78–80
Ballast Equalizer	82
Ballast Tamper	83
Compactor	82–83
Concrete Mixer (Truck)	79–85
Concrete Pump (Truck)	81–82
Concrete Vibrator	76–80
Crane	81–88
Dozer	82–85
Generator	81
Grader	85
Impact Wrench	85
Jack Hammer	88–89
Loader	79–85
Paver	77–89
Pile Driver (Impact)	101
Pneumatic Tool	85
Pump	76–81

Construction Equipment	Noise Exposure Level, dB L_{max} at 50 Feet
Rail Saw	90
Rock Drill	81–98
Roller	74–80
Saw	76
Scarifier	83–90
Scraper	84–89
Shovel	82
Spike Driver	77
Tie Cutter	84
Tie Handler	80
Tie Inserter	85
Heavy Diesel Truck	88

Source: FTA 2018

INDUSTRY AND OTHER NON-TRANSPORTATION NOISE SOURCES

A wide variety of industrial and other non-transportation noise sources are located within the Bay Area. These include manufacturing plants, landfills, treatment plants (e.g., water), power generation facilities, food packaging plants, lumber mills, and aggregate mining facilities, just to name a few. Noise generated by these sources varies widely but, in many cases, may be a significant if not dominant contributor to the noise environment.

3.12.2 Regulatory Setting

FEDERAL REGULATIONS

Title 23, Part 772 of the Code of Federal Regulation

Title 23, Part 772 of the CFR is the federal regulation governing traffic noise impact. A federal or federally funded project would have a traffic noise impact if it involves the construction of a new highway, or includes substantial modification of an existing highway, where the project would result in a substantial operational noise increase or where the predicted operational noise level approaches or exceeds the FHWA Noise Abatement Criteria (NAC). In this case, a “substantial increase” is not defined by FHWA but is generally defined by the state and/or local governing agencies. The noise level is defined as “approaching” the NAC if it is within 1 dB of the applicable criterion. **Table 3.12-3** summarizes the FHWA NAC as presented in the U.S. Department of Transportation (DOT)/FHWA Highway Traffic Noise Analysis and Abatement Policy and Guidance document.

Table 3.12-3: Summary of FHWA Noise Abatement Criteria

Activity Category	NAC, Hourly-Average Noise Level (L_{eq}[h], dBA)	Description of Activities
A	57 Exterior	Lands on which serenity and quiet are of extraordinary significance and serve an important public need and where the preservation of those qualities is essential if the area is to continue to serve its intended purpose
B	67 Exterior	Picnic areas, recreation areas, playgrounds, active sport areas, parks, residences, motels, hotels, schools, churches, libraries, and hospitals
C	72 Exterior	Developed lands, properties, or activities not included in categories A or B above
D	--	Undeveloped lands
E	52 Interior	Residences, motels, hotels, public meeting rooms, schools, churches, libraries, hospitals, and auditoriums

Source: DOT 2011

Title 14, Part 36 of the Code of Federal Regulation

Aircraft operated in the United States are subject to federal requirements for noise emission levels. The requirements are set forth in 14 CFR 36, which establishes maximum acceptable noise levels for specific aircraft types, considering model year, aircraft weight, and number of engines.

The Federal Aviation Administration (FAA) Part 150 program encourages airports to prepare noise exposure maps that show land uses that are incompatible with high noise levels (FICON 1992). The program proposes measures to reduce any incompatibility. With an FAA Part 150 program approved, airport projects such as land acquisition and residential/school sound insulation become eligible for federal Airport Improvement Program funding.

Federal Transit Administration Noise Impact Criteria

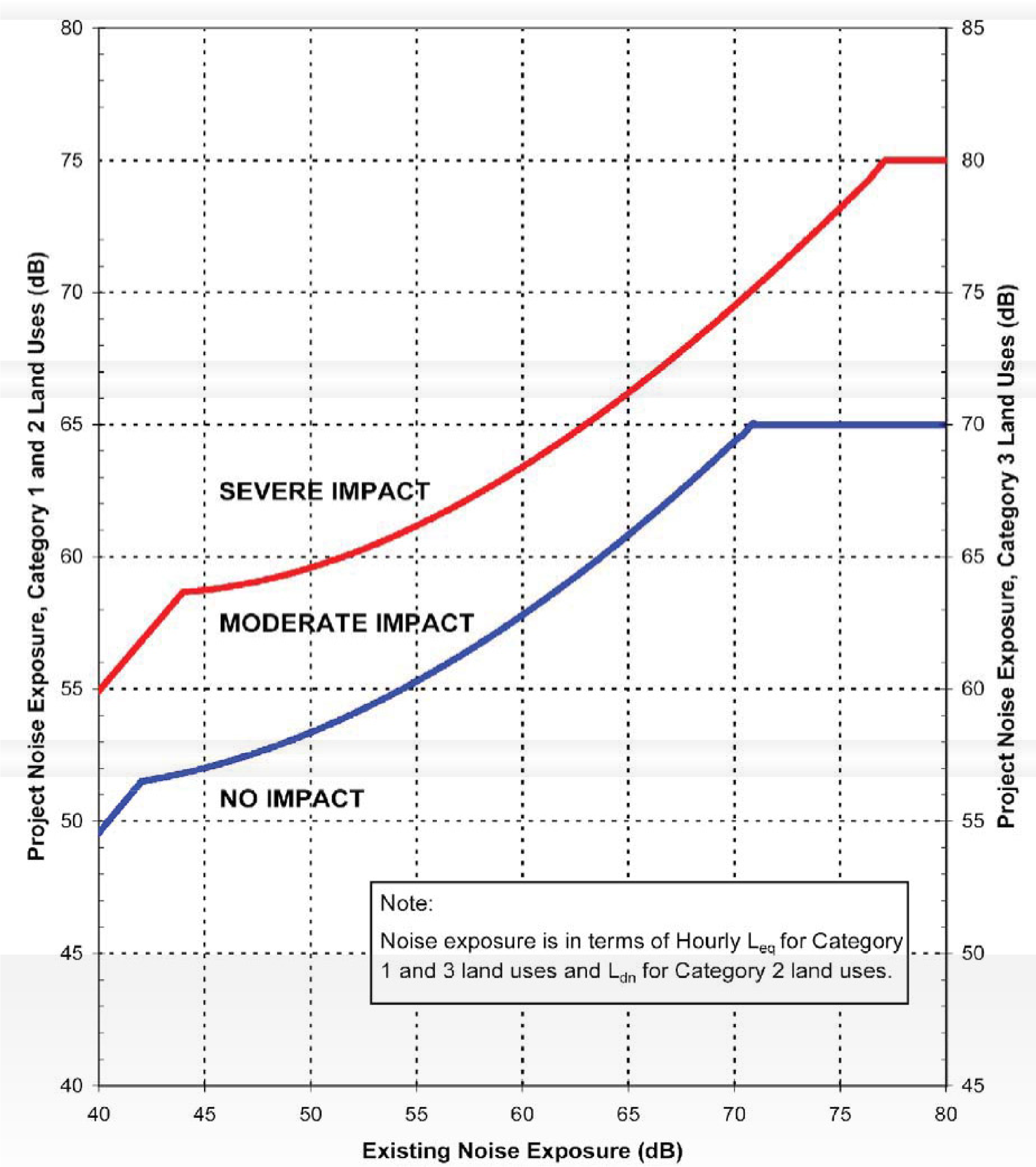
Transit Operations Noise

The Federal Transit Administration (FTA) offers regulations regarding noise exposure associated with federally funded transit projects. “Moderate impact” and “severe impact” criteria are established based on the existing ambient noise environment and the noise sensitivity of the receiving land use. Three categories of land use are established for the impact analysis:

- Category 1: Includes lands set aside for serenity and quiet or for outdoors performing arts entertainment (e.g., national historic landmarks, outdoor amphitheaters)
- Category 2: Residences and buildings where people normally sleep (e.g., homes, hospitals, hotels)
- Category 3: Institutional land with primary daytime and/or evening use (e.g., schools, libraries, churches, medical offices, theaters, parks)

Figure 3.12-6 is a graphical representation of the FTA noise impact criteria. Please note that Categories 1 and 3 apply the L_{eq} for the noisiest hour of transit-related activity during hours of noise sensitivity. Category 2 applies the L_{dn} because these receivers may be affected by nighttime (10 p.m.–7 a.m.) transit-related events.

Subjectively, a “moderate impact” is generally noticeable to most people but may not be sufficient to cause strong, adverse reactions from the community. A “severe impact” would likely produce a high percentage of highly annoyed people in the community.



Source: FTA 2018

Figure 3.12-6: FTA Noise Impact Criteria

Federal Transit Administration Vibration and Noise Impact Criteria

FTA offers regulations regarding vibration exposure associated with federally funded transit projects. Three categories of land use are established for the impact analysis:

- Category 1: Buildings where vibration would interfere with interior operations
- Category 2: Residences and buildings where people normally sleep (e.g., homes, hospitals, hotels)
- Category 3: Institutional land with primary daytime and/or evening use (e.g., schools, libraries, churches, medical offices, theaters, parks)

Table 3.12-4 summarizes the FTA vibration impact criteria.

Table 3.12-4: FTA Ground-Borne Vibration Impact Criteria for General Assessment

Land Use Category	GVB Impact Levels (VdB re 1 micro-inch /sec)		
	Frequent Events[1]	Occasional Events[2]	Infrequent Events[3]
Category 1: Buildings where vibration would interfere with interior operations	65 VdB[4]	65 VdB[4]	65 VdB[4]
Category 2: Residences and buildings where people normally sleep	72 VdB	75 VdB	80 VdB
Category 3: Institutional land uses with primary daytime use.	75 VdB	78 VdB	80 VdB

Notes: GVB = ground-borne vibration; VdB re 1 micro-inch /sec = vibration decibels referenced to 1 microinch per second and based on the root mean square velocity amplitude.

1 "Frequent Events" is defined as more than 70 vibration events of the same source per day. Most rapid transit projects fall into this category.

2 "Occasional Events" is defined as between 30 and 70 vibration events of the same source per day. Most commuter trunk lines have this many operations.

3 "Infrequent Events" is defined as fewer than 30 vibration events of the same kind per day. This category includes most commuter rail branch lines.

4 This criterion limit is based on levels that are acceptable for most moderately sensitive equipment, such as optical microscopes. Vibration-sensitive manufacturing or research would require detailed evaluation to define the acceptable vibration levels. Ensuring lower vibration levels in a building often requires special design of the HVAC systems and stiffened floors.

Source: FTA 2018:123–126

Construction Noise

In addition to transit operations noise, FTA offers guidance with respect to the evaluation of transit construction noise exposure. Like the operational noise criteria, construction noise criteria should consider the existing (ambient) noise environment. Additionally, construction noise exposure should consider the duration of construction activities and the receiving land use (i.e., sensitivity of receiver). The FTA construction noise guidelines are summarized in **Table 3.12-5**.

Table 3.12-5: Summary of FTA Construction Noise Criteria (Guidelines)

Affected Land Use Type	Hourly L_{eq} dBA		8-hour L_{eq} dBA	
	Daytime (7 a.m.–10 p.m.)	Nighttime (10 p.m.–7 a.m.)	Daytime (7 a.m.–10 p.m.)	Nighttime (10 p.m.–7 a.m.)
Residential	90	80	80	70
Commercial	100	100	85	85
Industrial	100	100	90	90

Note: In urban areas with very high ambient noise levels, construction noise should not exceed ambient noise levels plus 10 dB.
Source: FTA 2018

Construction Vibration

FTA has published guidance relative to impacts from vibration exposure. FTA has established a general impact criterion of 0.5 in/sec PPV. Structural damage to buildings would not be expected below this value. It is expected that regularly experienced vibration levels of 80 vibration decibels (VdB, 0.01 in/sec PPV) or higher may create an annoyance response from human receivers and may be considered a nuisance.

STATE REGULATIONS

California Department of Transportation Noise and Vibration Standards

Traffic Operations Noise

The Caltrans Traffic Noise Analysis Protocol (Protocol) establishes the policies and procedures to be used in the assessment of traffic noise exposure and impact for new construction and reconstruction projects. The NAC in the Protocol are the same as those presented in 23 CFR 772 (see DOT/FHWA information above). The Protocol defines a substantial project-related traffic noise level increase when the project's worst-case hour exceeds the ambient worst-case hour by 12 dB or more.

Rail Operations Noise

Caltrans endorses the use of the FTA noise criteria and methodologies for assessing project-related rail noise and vibration impacts.

Construction Noise

Caltrans Standard Specifications, Section 14-8.02, Noise Control, establishes a construction noise exposure/production limit of 86 dB (L_{max}) at a distance of 50 feet. Additionally, this specification establishes that all internal combustion engines should be equipped with manufacturer-recommended mufflers and that no internal combustion engines may be operated without mufflers (Caltrans 2018).

Vibration

In 2020, Caltrans published the Transportation- and Construction-Induced Vibration Manual, which provides general guidance on vibration issues associated with construction and operation of projects in relation to human perception and structural damage (Caltrans 2020). **Table 3.12-6** presents Caltrans-recommended levels of vibration that could result in damage to structures exposed to continuous vibration.

Table 3.12-6: Caltrans-Recommended Vibration Levels

PPV (in/sec)	Effect on Buildings
0.4–0.6	Architectural damage and possible minor structural damage
0.2	Risk of architectural damage to normal dwelling houses
0.1	Virtually no risk of architectural damage to normal buildings
0.08	Recommended upper limit of vibration to which ruins and ancient monuments should be subjected
0.006–0.019	Vibration unlikely to cause damage of any type

Notes: PPV = peak particle velocity; in/sec=inches per second.
Source: Caltrans 2020

California Code of Regulations

Aircraft Operations

The California Airport Noise Standards, Title 21, Section 5000 et seq. of the CCR apply to any airport that is deemed to have a "noise problem" as established by the local county board of supervisors in accordance with the provisions in the regulation. Currently, within the Bay Area, Norman Y. Mineta-

San Jose International Airport and San Francisco International Airport have been given this designation. The standards establish a noise exposure limit "acceptable to a reasonable person residing in the vicinity of an airport" of 65 dB CNEL.

Noise Insulation Standards

The California Noise Insulation Standards found in CCR, Title 24, Part 2 (Volume 1, Chapter 12, Interior Environment, Section. 1207.11.2) establish requirements for new multifamily residential units, hotels, and motels that may be subject to relatively high levels of transportation noise. In this case, the noise insulation criterion is 45 dB L_{dn}/CNEL inside habitable, noise-sensitive spaces. For developments with exterior transportation noise exposure (e.g., freeway, expressway, parkway, major street, thoroughfare, airport, rail line, rapid transit line noise) exceeding 60 dB L_{dn}/CNEL, an acoustical analysis and mitigation (if required) must be provided showing compliance with the 45 dB L_{dn}/CNEL interior noise exposure limit.

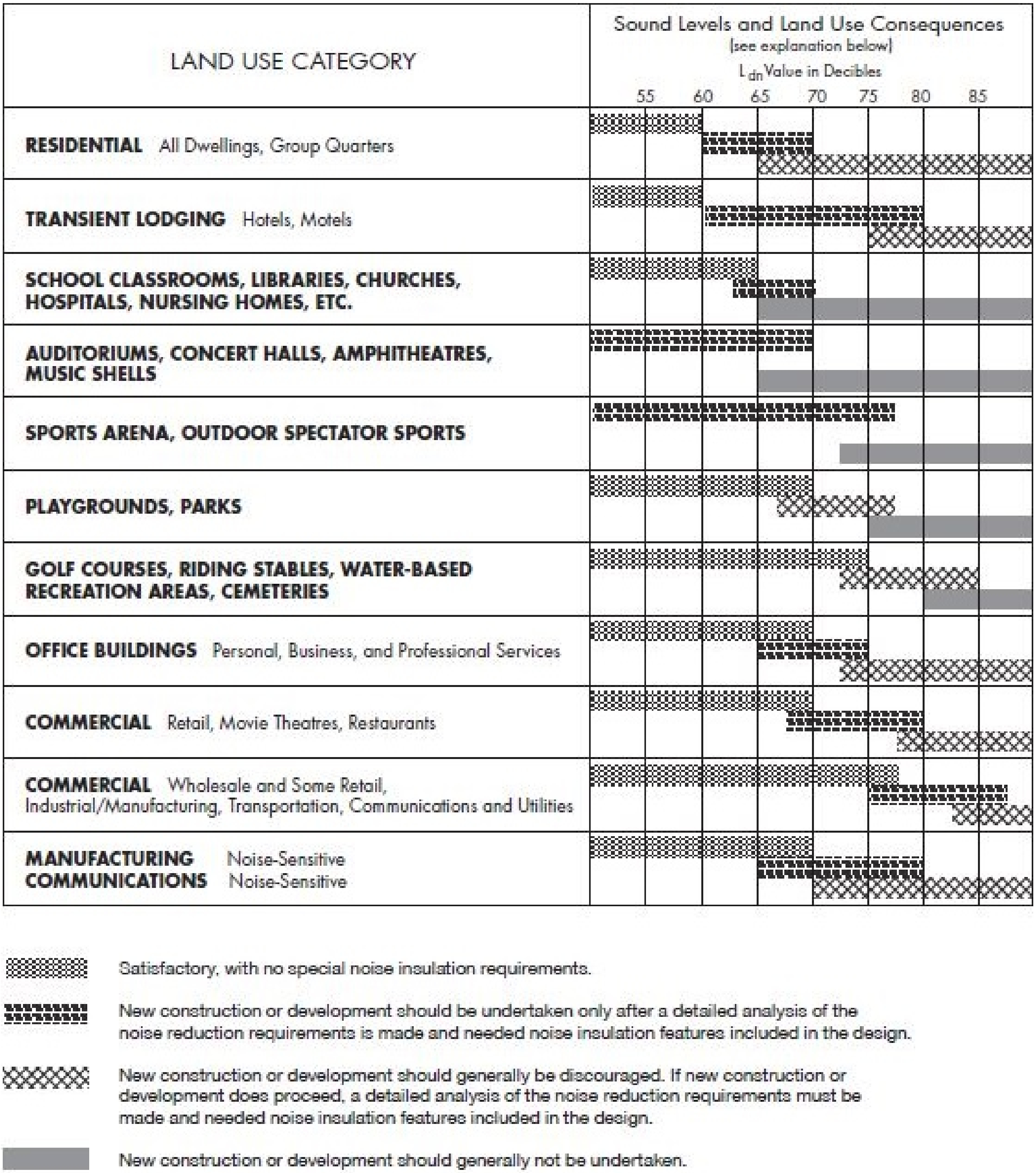
REGIONAL AND LOCAL REGULATIONS

City and County General Plans

Cities and counties within California must adopt a noise element as part of their general plans to identify, assess, and provide mitigation for noise problems within their communities. According to California Government Code 65302, the noise element of a general plan is to be used as "a guide for establishing a pattern of land uses in the land use element that minimizes the exposure of community residents to excessive noise." The noise element should assess current and projected future noise levels associated with local noise sources, including, but not limited to, traffic, trains, aircraft, and industrial operations. California general plan guidance establishes land use compatibility guidelines for various land uses and considers exterior noise levels of below 60 dBA CNEL as normally acceptable for low-density residential land uses, and below 65 dBA CNEL as normally acceptable for multifamily residential land uses. Local jurisdictions may adopt their own noise exposure goals and policies, which may or may not be the same as or similar to those recommended by the State.

In general, State guidance reflects the fact that noise-sensitive land uses are compatible with exterior transportation-related noise exposure not exceeding 65 dB L_{dn}/CNEL, typical standards for suburban areas. However, urban development, such as would occur in transit priority areas, which are required to be near transit, typically near highly trafficked roadways, are frequently located in areas subject to higher noise, and local standards often provide that higher noise levels are conditionally acceptable for residential uses in such areas, so long as it can be demonstrated that interior noise levels would be acceptable, as discussed further below. One example of an urban area with higher noise compatibility standards is the City of San Francisco, which lists noise levels as high as 70 dB L_{dn}/CNEL as conditionally acceptable for residential land uses (see **Figure 3.12-7**). Thus, in San Francisco in areas exceeding 70 dBA CNEL, if appropriate measures are taken to reduce noise exposure, especially interior noise levels, higher exterior noise levels are considered acceptable.

Additionally, based on the Title 24 standards described above and State general plan guidelines, interior noise exposure should not exceed 45 dB L_{dn}/CNEL within noise-sensitive spaces, whether in suburban or urban environments. Standard modern building techniques and requirements, such as use of dual-paned windows, typically reduce exterior to interior noise transmission by 25 dB. The standards within the noise element of locally adopted general plans are for planning policy purposes and are generally not regulatory. Most jurisdictions regulate noise through their municipal code.



Source: City of San Francisco 2004

Figure 3.12-7: City of San Francisco Representative Land Use Compatibility Criteria

The local noise code is generally applied to address noise complaints associated with nontransportation sources (e.g., public address systems, mechanical equipment) and may also address construction noise exposure/production limits. Noise exposure criteria presented within municipal codes should match performance criteria presented in the noise element of the general plan for the given jurisdiction.

Cities and counties often provide noise level performance standards for nontransportation noise sources (e.g., commercial/industrial facilities, mechanical equipment). These standards are used to address intermittent noise exposure and are often in terms of the hourly average noise level (L_{eq}) or maximum noise level (L_{max}). These criteria are generally tied directly to the standards presented in the city/county municipal code (i.e., noise ordinance).

3.12.3 Impact Analysis

SIGNIFICANCE CRITERIA

The following significance criteria are based on CEQA Guidelines Appendix G, the criteria used in the Plan Bay Area 2040 EIR (2017), and professional judgment. Under these criteria, implementation of the proposed Plan would have a potentially significant adverse impact if it would:

- generate a substantial temporary increase in ambient noise levels in the vicinity of the project in excess of standards established in the local general plan or noise ordinance, or applicable standards of other agencies (Criterion NOISE-1);
- generate a substantial permanent increase in ambient noise levels in the vicinity of the project in excess of standards established in the local general plan or noise ordinance, or applicable standards of other agencies (Criterion NOISE-2);
- generate excessive groundborne vibration or groundborne noise levels (Criterion NOISE-3); or
- for a project located within the vicinity of a private airstrip or an airport land use plan or, where such a plan has not been adopted, within two miles of a public airport or public use airport, expose people residing or working in the project area to excessive noise levels (Criterion NOISE-4).

The following impact discussions include numeric thresholds that apply to the applicable significance criteria, where appropriate.

METHOD OF ANALYSIS

The method for the programmatic analysis of noise impacts is described below. Because this analysis is programmatic and focuses on impacts of the Plan on a regional basis, it does not account for site-specific conditions (elevation differences, noise barriers, precise site conditions, detailed traffic conditions). It is expected that project-specific noise and/or acoustical analyses may be required as part of the environmental review prior to project approval by the appropriate lead agency.

Existing traffic noise within the Plan area has been characterized by traffic noise modeling. The baseline for the noise analysis is a simulation of 2015 traffic patterns using Travel Model 1.5. Based on modeling conducted for all roadway types within the Plan area, average noise levels in the 2015 baseline range from 52.6 dBA CNEL (next to collector and small roads) to 74.9 dBA CNEL (next to freeways). Traffic-noise modeling results are presented in **Table 3.12-7** (refer to Appendix F for modeling details).

Table 3.12-7: Average Noise Levels by Roadway Type by County

County	Roadway Type	Modeled Traffic-Noise (CNEL/L_{dn} [dBA] at 100 feet from Roadway Centerline)		
		2015	2050 Plan	Net Change (dB)
San Francisco	Freeway	**72.6**	**73.6**	+1.0
	Expressway	69.3	67.1	-2.3
	Major Arterial	61.9	64.0	+2.2
	Collector and Other	53.1	56.0	+2.9
San Mateo	Freeway	**71.3**	**71.7**	+0.3
	Expressway	66.8	68.8	+2.1
	Major Arterial	58.8	61.7	+2.9
	Collector and Other	52.7	55.5	+2.8
Santa Clara	Freeway	**73.3**	**71.2**	-2.0
	Expressway	67.5	**70.1**	+2.6
	Major Arterial	59.6	62.6	**+3.0**
	Collector and Other	52.6	55.5	+2.9
Alameda	Freeway	**74.9**	**72.3**	-2.5
	Expressway	69.1	**71.2**	+2.1
	Major Arterial	60.2	63.0	+2.7
	Collector and Other	53.7	57.0	**+3.3**
Contra Costa	Freeway	**73.7**	**71.8**	-1.9
	Expressway	68.5	69.4	+0.9
	Major Arterial	59.6	60.4	+0.7
	Collector and Other	54.9	57.1	+2.2
Solano	Freeway	**74.2**	**71.7**	-2.5
	Expressway	66.8	70.0	**+3.3**
	Major Arterial	57.5	57.5	+0.0
	Collector and Other	53.7	55.4	+1.7
Napa	Freeway	**73.2**	**71.3**	-1.9
	Expressway	**70.5**	**70.8**	+0.4
	Major Arterial	60.5	58.4	-2.1
	Collector and Other	52.6	53.1	+0.5
Sonoma	Freeway	**70.9**	70.0	-0.9
	Expressway	**70.1**	**70.7**	+0.6
	Major Arterial	60.0	58.7	-1.3
	Collector and Other	56.5	57.3	+0.8
Marin	Freeway	**73.3**	**72.0**	-1.3
	Major Arterial	60.0	59.2	-0.8
	Collector and Other	53.7	55.8	+2.0

Notes: Bolded text represents areas that exceed project-specific maximum noise exposure limits (i.e., 70 dBA CNEL for freeways and expressways and 65 dBA CNEL for major arterials, collectors, and all other roads) and where a substantial permanent increase in noise of 3.0 dB or greater would occur.

Regional Growth/Land Use Changes

The proposed Plan includes housing and economic strategies to accommodate 2.7 million new persons, 1.4 million new households, 1.5 new forecasted housing units, and 1.4 million new jobs by 2050 (compared to the 2015 baseline). For more details, please see Section 2, "Project Description," and Section 3.1, "Approach to the Analysis." This impact analysis assesses how implementation of the proposed Plan could affect the noise environment. The analysis of noise impacts associated with the forecasted land use development pattern assesses the potential noise levels associated with future mobile and stationary sources of noise. A comprehensive review of noise compatibility standards for cities and counties within the Plan area was conducted, and it revealed widely varying standard of noise levels that are considered acceptable for different land uses (e.g., residential, commercial, schools). However, the overarching theme identified was that acceptable noise levels for sensitive land uses likely to be located within urbanized and densely populated areas, such as downtowns and/or near major roadways or transit corridors (e.g., U.S. Highway 101, BART right-of-way), would be higher than for land uses that would likely be in suburban or rural areas.

Under the proposed Plan, forecasted land use development would be primarily focused within existing urbanized areas and highly concentrated within the largest cities in the Plan area (e.g., San Francisco, Oakland, and San Jose), which currently experience relatively high noise levels. Therefore, considering the relatively high noise environment where development would occur and available guidance from the State and local jurisdictions within the Plan area, the noise compatibility thresholds described above were established based on the range of standards in the region. In addition to exterior noise compatibility guidelines, this analysis also considers interior noise standards set by the California Building Code.

Transportation Network

Traffic and Transit Noise

Changes in land use and the implementation of proposed transportation strategies, such as tolling and speed limits, would affect the distribution of vehicle travel throughout the region. Bay Area UrbanSim 2.0 and Travel Model 1.5 allow for the proposed Plan (2050) traffic simulation to reflect both the forecasted development pattern and the implementation of transportation projects and strategies. However, Travel Model 1.5 is not sensitive to the full range of strategies in the proposed Plan. The results presented in Table 3.12-7, and throughout this analysis, do not account for the implementation of Strategy EN09, "Expand Transportation Demand Management Initiatives," due to limitations that do not allow for distribution of the VMT reductions by county.

Therefore, with respect to the potential for an increase in regional roadway noise, this impact assessment includes overall VMT increases from implementation of both the land use growth patterns and transportation projects under the proposed Plan. However, freeway volumes are projected to go down due to the Plan Bay Area 2050 strategies, including Strategy T05, "Implement Per-Mile Tolling on Congested Freeways with Transit Alternatives" and Strategy T09, "Advance Regional Vision Zero Policy through Street Design and Reduced Speeds," both of which are designed to reduce freeway traffic and, thus, per capita VMT.

For this noise analysis, 24-hour CNEL traffic-noise levels were modeled using outputs from Travel Model 1.5, including traffic volume, speed information, vehicle type (i.e., passenger vehicles, trucks, buses), and time of day volume profiles. The modeled traffic-noise levels are based on average daily traffic volumes occurring on every road type (e.g., freeway, expressway, arterial, collector) throughout each county. Thus, reported noise levels represent average noise levels by roadway type in each county within the Plan area.

Traffic-noise modeling for the proposed Plan does not account for noise attenuation provided by existing noise barriers and, therefore, represents a conservative and worst-case approach. To evaluate the proposed Plan, the base year (2015) condition was compared with the proposed Plan (2050). The analysis reports the potential for noise impacts associated with absolute noise levels, as well as increases in noise.

With regard to transit noise, existing noise levels were determined based on available data for transit (i.e., BART, Caltrain) within the Plan area. Increases in transit noise were not modeled but evaluated based on best available information, such as growth projections and ridership data.

Consistent with the method used to establish the noise compatibility thresholds discussed above, traffic and transit noise was also evaluated by considering existing traffic-noise levels and reviewing applicable traffic-noise standards already established by local agencies. Traffic noise is generally the primary noise source within urban areas; therefore, it is treated separately by many agencies when establishing noise standards.

Freeways, expressways, and transit routes are designed to carry heavy traffic volumes and, therefore, typically generate the highest noise levels. Further, these types of facilities are typically concentrated in urban areas in proximity to commercial centers where ambient noise levels are highest. For these reasons, these facilities are inherently noisy and contribute substantially to ambient noise levels. Major arterials, collectors, and all other roadway types do not carry as much traffic as freeways and expressways, and typically extend to beyond the centralized urban core to potentially quieter areas less influenced by freeways. Therefore, these roadway types result in lower noise levels than freeways, expressways, and transit routes and also use lower significance thresholds because they serve fewer urban areas.

In addition to the use of a maximum noise threshold for transportation noise, relative noise increases with implementation of the proposed Plan were also evaluated. As ambient noise levels increase, a smaller increase in noise is sufficient to cause annoyance. Therefore, when existing noise levels exceed applicable thresholds, a smaller increase threshold was applied.

Transit Vibration

To evaluate vibration levels from transit-related vibration, Caltrans and FTA guidance was used. Caltrans guidance provides reference levels for structural damage and FTA guidance provides reference vibration levels for human disturbance. Generally, available data (e.g., the increase in the number of additional hourly train pass-by events) are insufficient to provide a detailed analysis; therefore, vibration impacts were assessed using the best available data from published sources and established reference vibration levels.

Construction

The proposed Plan's forecasted land use growth and transportation projects would be expected to generate short-term noise and vibration level increases during construction. These levels may be substantially higher than existing ambient noise levels or exceed the applicable local construction noise standards, Caltrans, or FTA criteria, adversely affecting acoustically sensitive receivers in the vicinity. Because detailed construction information was not available, the analysis addresses these potential impacts at a program level.

IMPACTS AND MITIGATION MEASURES

Impact NOISE-1: Generate a substantial temporary increase in ambient noise levels in the vicinity of the project in excess of standards established in the local general plan or noise ordinance, or applicable standards of other agencies (PS)

Land Use Impacts

Construction noise is an unavoidable result of planned growth in a given location. This impact analysis focuses on construction-related noise effects. Please see Impact NOISE-2 for a discussion of operation-related noise effects. As discussed above in Section 3.12.1, "Environmental Setting," noise levels, including construction-related noise, dissipate rapidly from the source. Thus, sensitive land uses closest to activities are of greatest concern when evaluating construction noise. In addition, construction activities are typically temporary and change throughout the day. Construction of projected development could result in temporary noise impacts associated with grading, excavating, earthmoving, paving, building or structure construction, and other related activities. Construction activities would require the use of various noise-generating construction equipment, such as dozers, loaders, forklifts, cranes, jackhammers, pile drivers, paving equipment, and trucks.

As explained above in Section 3.1, "Approach to Analysis," the regional growth forecast for the Bay Area projects that by 2050 the region will support an additional 2.7 million residents and 1.4 million jobs, resulting in 1.4 million new households. The proposed Plan designates growth geographies and identifies a set of land use strategies to accommodate the projected growth that result in focused housing and job growth concentrated primarily in or adjacent to already urban and built-up areas and along existing transit corridors. Construction noise standards vary throughout the Plan area but generally limit construction activities to times when noise would have the least effect on nearby land uses (i.e., during the daytime). Some cities include robust noise ordinances that contain either property line performance standards on construction equipment relative to land use and time of day (Oakland Planning Code Section 17.120.050) or identify performance noise standards for construction equipment at a specific distance (Article 29 of the San Francisco Police Code). The City of San Jose restricts construction-related activities to certain hours of the day (City of San Jose Municipal Code Section 20.100.450). In addition, some jurisdictions have identified maximum allowable noise limits specifically for construction activities (e.g., Napa County, San Mateo County). Consequently, depending on the extent of construction activities involved and the proximity of construction to existing receptors, localized construction-related noise effects may vary substantially throughout the Plan area. This analysis applies the following criteria to evaluate temporary construction noise impacts:

- Local jurisdiction: construction noise standards and limits
- Caltrans: 86 dB L_{max} at a distance of 50 feet
- FTA: Construction Noise Criteria, not to exceed ambient levels plus 10 dB

Implementation of the proposed Plan's land use growth pattern would result in construction activities. However, due to the regional scale of the proposed Plan and the programmatic level of this analysis and that specific development projects have not been proposed, specific construction-related details (e.g., location, schedule, equipment) for individual land use development projects are not available. Therefore, to evaluate potential construction impacts, a representative construction scenario, including typical equipment (e.g., pile driver, cranes, trucks, generators, jackhammers, backhoes), was assumed. Based on reference noise levels for these types of construction equipment (shown in **Table 3.12-2**), construction noise could reach levels of 92.8 dBA L_{eq} and 97.0 dBA L_{max} at 50 feet from construction sites (see Appendix F for modeling inputs and results). It should be noted that although other specialized equipment may be used (e.g., for tunnel boring), the ones chosen for the modeling include the loudest construction equipment (e.g., jackhammer and impact pile driver), which would generate similar or louder noise levels; thus, construction noise levels would be considered conservatively high.

Based on the modeling conducted, construction-related noise levels could exceed local construction-related noise standards and thresholds, depending on proximity to existing land uses and duration of construction activities, resulting in a potentially significant (PS) noise impact.

Sea Level Rise Adaptation Impacts

The proposed Plan includes sea level rise adaptation infrastructure to protect communities that are in regularly inundated shoreline areas that may be affected by sea level rise. The implementation of this adaptation infrastructure would result in construction of a variety of levees, seawalls, elevated roadways, marsh restoration, and tidal gates. This adaptation infrastructure could result in temporary construction noise impacts associated with grading, excavating, earthmoving, and other related activities. The associated noise levels would be like those presented above for construction associated with land use development projects because similar construction equipment would be used, generating similar noise levels.

Like noise levels associated with land use development, noise levels related to sea level rise adaptation infrastructure construction could exceed local standards and thresholds identified, depending on proximity to existing land uses and duration of construction activities. Therefore, implementation of the proposed Plan's sea level rise adaptation infrastructure may result in generation of excessive temporary construction noise levels, and this impact would be potentially significant (PS).

Transportation System Impacts

Construction-related noise impacts of transportation projects, similar to land use development, would depend on the extent of construction being undertaken, proximity to existing sensitive land uses, and applicable noise standards. Nonetheless, construction noise would be of greatest concern to the land uses closest to construction activities. Similar to the projected land use development discussed above, transportation projects would have the potential for localized noise impacts, particularly when pile driving or other similar invasive foundation work would be required. In addition, specialized equipment, such as tunnel boring machinery, may be used during construction of the Transbay rail crossing.

Proposed transportation projects are spread throughout the Bay Area and are generally limited to existing transportation corridors. Refer to **Table 2-11** (see Chapter 2, "Project Description") for specific transportation project types and locations. In addition, transportation projects typically progress in a linear fashion (i.e., along the right-of-way), and construction is sometimes required to occur during the night, to minimize traffic congestion during peak travel periods. Construction activities may affect individual receptors for shorter periods of time as construction moves in a linear fashion but could result in greater disturbance to nearby receptors if construction occurs during sleeping hours. Further, transportation construction activities that occur in less urbanized areas, where existing ambient noise levels would be less than in urbanized and densely populated areas, could result in a greater relative increase in temporary noise levels. High noise levels added to a lower existing ambient noise level result in a greater increase of annoyance than the same high noise level added to an existing high level.

Implementation of the proposed Plan would result in construction activities associated with transportation projects. However, specific construction-related details (e.g., location, schedule, equipment) for individual projects are unknown at this time. Therefore, to evaluate potential construction impacts, a representative construction scenario, including typical equipment (e.g., pile driver, cranes, trucks, generators, jackhammers, backhoes) was assumed. Based on reference noise levels for these types of construction equipment (shown in **Table 3.12-2**), construction noise could reach levels of 92.8 dBA L_{eq} and 97.0 dBA L_{max} at 50 feet from future proposed construction sites. Refer to Appendix F for modeling inputs and results.

Based on the modeling conducted, construction-related noise levels could exceed Caltrans-recommended levels of 86 dBA L_{max}, would likely exceed FTA construction noise criteria (i.e., ambient levels plus 10 dB), and could exceed local construction-related noise standards and thresholds identified, depending on proximity to existing land uses and duration of construction activities. Construction noise and impacts would be potentially significant (PS).

Conclusion

Because implementation of the proposed Plan's land use development pattern, sea level rise adaptation infrastructure, and transportation projects have the potential to result in substantial construction noise levels such that nearby receptors could be adversely affected and applicable noise standards exceeded, this impact is considered **potentially significant (PS)**. Mitigation Measure NOISE-1 addresses this impact and is described below.

Mitigation Measures

Implementing agencies and/or project sponsors shall implement measures, where feasible and necessary based on project- and site-specific considerations, that include those identified below.

Mitigation Measure NOISE-1 To reduce construction noise levels to achieve the applicable noise standards of the relevant jurisdiction within the Plan Area, implementing agencies and/or project sponsors shall implement measures, where feasible and necessary based on project- and site-specific considerations, that include those identified below:

- Comply with local construction-related noise standards, including restricting construction activities to permitted hours as defined under local jurisdiction regulations (e.g., Alameda County Code restricts construction noise to between 7:00 am and 7:00 pm on weekdays and between 8:00 am and 5:00 pm on weekends).
- Notify neighbors and occupants within 300 feet of the project construction area at least 30 days in advance of anticipated times when noise levels are expected to exceed limits established in the noise element of the general plan or noise ordinance.
- Designate an on-site construction complaint and enforcement manager for the project.
- Post procedures and phone numbers at the construction site for notifying the implementing agency staff, local Police Department, and construction contractor (during regular construction hours and off-hours), along with permitted construction days and hours, complaint procedures, and who to notify in the event of a problem.
- Properly maintain construction equipment and outfit construction equipment with the best available noise suppression devices (e.g., mufflers, silencers, wraps).
- Prohibit idling of construction equipment for extended periods of time in the vicinity of sensitive receptors.

- Locate stationary equipment, such as generators, compressors, rock crushers, and cement mixers, a minimum of 50 feet from sensitive receptors, but further if possible.

- Use hydraulically or electrically powered tools (e.g., jack hammers, pavement breakers, and rock drills) for project construction to avoid noise associated with compressed air exhaust from pneumatically powered tools. However, where use of pneumatic tools is unavoidable, an exhaust muffler on the compressed air exhaust should be used; this muffler can lower noise levels from the exhaust by up to about 10 dBA. External jackets on the tools themselves should be used, if such jackets are commercially available, and this could achieve a further reduction of 5 dBA. Quieter procedures should be used, such as drills rather than impact equipment, whenever such procedures are available and consistent with construction procedures.

- Erect temporary construction-noise barriers around the construction site when adjacent occupied sensitive land uses are present within 75 feet.

- Use noise control blankets on building structures as buildings are erected to reduce noise emission from the site.

Significance after Mitigation

Implementation of Mitigation Measure NOISE-1 would provide substantial reduction in day and night construction noise levels by ensuring proper equipment use (i.e. by locating equipment away from sensitive land uses and requiring the use of enclosures, shields, and noise curtains) (noise curtains typically can reduce noise by up to 10 dB [EPA 1971]). To the extent that a local agency requires an individual project to implement all feasible mitigation measures described above, construction-noise levels could be reduced by 10 dB. Greater reductions may be achieved and the frequency and intensity of construction-related noise at nearby receptors may be further reduced, depending on actual construction activities and proximity to receptors. However, there could be cases where noise levels reductions from implementation of mitigation measures would not be sufficient to reduce sounds levels to an acceptable level. This impact would remain **significant and unavoidable (SU)**.

Projects taking advantage of the CEQA streamlining provisions of SB 375 (PRC Sections 21155.1, 21155.2, and 21159.28) must apply the mitigation measures described above, as applicable, to address site-specific conditions. However, MTC/ABAG cannot require local implementing agencies to adopt the above mitigation measures, and it is ultimately the responsibility of a lead agency to determine and adopt mitigation. Therefore, this impact would be **significant and unavoidable (SU)** for purposes of this program-level review.

Impact NOISE-2: Generate a substantial permanent increase in ambient noise levels in the vicinity of the project in excess of standards established in the local general plan or noise ordinance, or applicable standards of other agencies (PS)

Land Use Impacts

As noted above, this impact discussion focuses on the operation-related noise impacts of proposed Plan implementation. The proposed Plan's forecasted land use development pattern would occur throughout the region, resulting in changes to traffic and associated traffic noise, transit operations, noise associated with land uses development. Many of the growth geographies in the proposed Plan are purposely located along existing and projected transit corridors to facilitate a reduction in VMT within the region, but growth and development would also result in traffic and traffic noise increases. Transit noise exposure would vary greatly depending on proximity to existing noise sources (i.e., transit corridors) and ambient noise levels; and typically, urbanized areas where a majority of development would occur would experience higher noise levels compared to more rural or less densely populated areas. In addition, new development would include stationary sources (e.g., HVAC equipment) and land use development-related sources (e.g., playgrounds, truck loading/unloading), which also contribute to the noise environment. These sources are discussed separately, below.

Land Use-Related Traffic Noise

Traffic noise impacts were assessed at the county level and based on baseline (2015) and buildout (2050) modeled traffic volumes by roadway types, including all on-road vehicles and buses. Thus, traffic-noise modeling represents both regional and local noise levels, but because it is based on outputs from the regional travel demand model ("Travel Model 1.5"), the noise modeling is necessarily imprecise and should be treated as representative of likely noise levels and changes from baseline conditions. To assess long-term permanent increases in traffic noise, the following criteria were used:

- based on the range of existing standards in the Plan area, exceeds project-specific exterior noise levels of 70 dBA CNEL associated with noise levels from major freeways/expressways and 65 dBA CNEL from all other roadway types;
- California Building Code and California General Plan Guidelines–recommended interior noise levels of 45 dBA CNEL for any roadway type; and
- results in a long-term perceptible increase in the ambient noise level (1.5 dBA or greater) in an area where the applicable noise threshold is already exceeded; in areas where applicable thresholds are not exceeded, a 3-dBA increase or greater would be considered substantial.

Implementation of the proposed Plan would result in a mixture of development and redevelopment within the land use growth footprint throughout the Plan area, primarily in designated growth geographies. Changes in land use due to forecasted development would generate new trips, and these trips would be distributed on existing and proposed Plan roadways, transit, bicycle, or pedestrian systems. Due to the anticipated growth for the region, an absolute increase in roadway volumes within the Plan area is anticipated, despite more efficient land uses and transportation projects and strategies. There would be increases in roadway volumes on some highways and roadways in the Plan area and decreases on other highways and roadways, depending on the proposed Plan's land use development pattern relative to the local roadway system.

Significant impacts from traffic noise would result if the noise levels identified in the significance criteria (by roadway type) are exceeded or if traffic noise levels substantially increase. Based on the principal outlined by FTA (2018), that as the existing level of ambient noise increases, the allowable level of transit noise increases, but the total amount that community noise exposure is allowed to increase is reduced, a "substantial" increase is defined as an increase of 1.5 dBA if existing traffic noise is already above thresholds or an increase of 3 dBA if existing noise levels are below noise thresholds. Specifically, FTA allows a 1 dB increase in noise when existing levels exceed 65 dBA, thus 1.5 dB would be considered substantial when existing levels exceed standards. FTA allows 3 dB increases when existing levels are 55 dB and increasingly more allowable increase as existing levels go down. However, 3 dB is the level at which humans perceive a change in noise, thus, conservatively applied for all roadway types where noise currently does not exceed established thresholds.

Table 3.12-7 identifies existing and existing-plus-proposed Plan average noise levels by roadway type (e.g., freeways, expressways, major arterials, and collectors) for each county within the Plan area and identifies significant noise increases in bolded text.

Based on the modeling conducted, and indicated by bold numbers within the 2015 column in **Table 3.12-7**, average noise levels on freeways under existing conditions exceed applicable noise thresholds of 70 dBA CNEL in every county within the region. In addition, existing noise levels on expressways exceed 70 dBA in Napa and Sonoma Counties. Existing average noise levels on smaller roads, such as major arterials and collectors, do not currently exceed levels of 65 dBA CNEL (i.e., threshold applied to roads other than freeways/expressways) in any county.

In areas where traffic-noise levels currently exceed thresholds, it would continue to exceed these thresholds with implementation of the proposed Plan, except in Sonoma County, where freeway noise would decrease with proposed Plan implementation and would no longer exceed thresholds as demand for travel on US-101 in Sonoma County is expected to decline as a result of the proposed Plan's land use and transportation strategies.

As shown in **Table 3.12-7**, increases in traffic-related noise will occur with implementation of the Plan's land use development pattern and transportation projects on almost every roadway type within the Plan area, ranging from 0.3 dB to 3.3 dB. With regard to interior noise thresholds of 45 dBA CNEL, buildings provide varying degrees of exterior-to-interior noise reduction but typically can achieve a minimum 25-dBA reduction. Thus, receptors within areas experiencing noise levels below the exterior noise thresholds of 70 dBA CNEL would also experience acceptable interior noise levels of 45 dBA CNEL (i.e., areas further way from a freeway's 70-dBA CNEL contour). Based on the modeling conducted, under baseline conditions, freeway 70-dBA CNEL contours within the Plan area range from a minimum distance of 122 feet to a maximum distance of 230 feet from the freeway centerlines. With implementation of the proposed Plan, freeway 70-dBA CNEL contours within the Plan area would range from a minimum distance of 106 feet to a maximum distance of 189 feet from the freeway centerlines, a decrease of 41 feet (see Appendix F for noise contour details). In other words, the plan would result in a slight noise reduction on the overall freeway network within the Plan area.

Given that noise levels associated with freeways within the Plan area currently exceed 70 dBA CNEL (up to 230 feet from the freeway centerlines) and would continue to exceed 70 dBA CNEL (up to 189 feet from the freeway centerline) under the proposed Plan, the interior noise thresholds may also be exceeded in these areas. However, while interior and exterior noise levels may continue to exceed thresholds, these exceedances would be less pronounced in all counties except San Francisco and San Mateo Counties with implementation of the proposed Plan. Therefore, while traffic-related noise resulting from implementation of the proposed Plan could result in excessive noise levels (i.e., 70-dBA CNEL land use compatibility and traffic-noise threshold) along some roadways, as well as a substantial permanent noise increase at existing and future projected developments in the area, implementation of the Plan would reduce the extent to which the impacts occur in these counties compared to existing conditions, as indicated in **Table 3.12-7**.

Because the proposed Plan would result in traffic-noise levels that exceed applicable noise thresholds and would result in a substantial noise increase in some areas, this impact would be potentially significant (PS).

Land Use-Related Stationary Noise Sources

Typical community noise sources include small mechanical devices (e.g., lawn mowers, leaf blowers), parks and playgrounds, restaurants and bars, commercial uses, and industrial plants. Stationary sources may include HVAC units, delivery trucks loading and unloading at commercial land uses, and other equipment associated with commercial and industrial land uses (e.g., pumps, back-up generators, auto body shops). To assess long-term increases in stationary noise sources, the following criteria were used:

- based on the range of existing standards in the Plan area, exceeds exterior project-specific noise levels of 70 dBA CNEL (applicable to urban areas/mixed-use/Transit Priority Areas [TPAs]) and 65 dBA CNEL (applicable to suburban/rural areas) and
- California Building Code and California General Plan Guidelines–recommended interior noise level of 45 dBA CNEL. (land use compatibility all noise sources and land use).

To evaluate noise exposure to existing and new receptors, the land use compatibility thresholds of 70 dBA CNEL (exterior) and 45 dBA CNEL (interior) established for this EIR were used. To evaluate substantial increases in noise from new stationary sources resulting from land use development, substantial increases in noise were based on existing noise levels. Because traffic noise is generally the primary noise source within communities, modeled traffic noise shown in **Table 3.12-7** for 2015 was used to characterize existing ambient levels.

The Plan's development pattern would result in new residential, commercial, and industrial land uses that could include stationary sources (e.g., HVAC units, mechanical equipment) and community noise that could expose existing receptors to excessive noise levels or result in a substantial permanent increase in noise. Noise levels from HVAC equipment vary substantially depending on unit efficiency, size, and location, but generally range from 45 to 70 dB L_{eq} at a distance of 50 feet (EPA 1971). Reference noise-level measurements of emergency generators with rated power outputs from 50 to 125 kilowatts (kw) result in noise levels ranging from 61 to 73 dB L_{eq} and 63 to 84 dB L_{max} at a distance of 45 feet (EPA 1971; FHWA 2006). Based on reference noise values and accounting for typical usage factors of equipment used for commercial loading/unloading, noise levels could reach 82 dB L_{eq} and 86 dB L_{max} at a distance of 50 feet.

Stationary and community noise typically is intermittent in nature and fluctuates throughout the day. For example, HVAC units do not typically run all day but operate in short bursts, while noise generated at commercial loading docks may occur more frequently early in the morning, and noise associated with bars and nightclubs would generally occur more frequently in the evening hours. Stationary equipment and community noise is typically regulated through local municipal codes, which provide specific performance-based noise standards, specific to the noise source, and give the local jurisdiction the ability to enforce noise sources that violate the code (e.g., equipment operating loudly, people causing disturbances at night, excessive dog barking).

However, implementation of the proposed Plan would result in increased land use development within areas already experiencing high noise levels. Although specific locations for these noise sources are not known at this time, considering the projected high density of land development in already urbanized areas, where existing sensitive receptors already exist, it is possible that implementation of the Plan's forecasted land use development (and associated noise sources) could result in exposure to existing sensitive receptors to noise levels above 65 dBA CNEL or 70 dBA CNEL (exterior) and 45 dBA CNEL (interior) or a substantial increase in noise (i.e., 1.5 dB). This would be a potentially significant impact (PS).

Sea Level Rise Adaptation Impacts

The proposed Plan also includes sea level rise adaptation infrastructure to protect communities that are located in regularly inundated shoreline areas that may be affected by sea level rise. The adaptation infrastructure would include construction of a variety of levees, seawalls, elevated roadways, marsh restoration, and tidal gates. For construction-related impacts refer to NOISE-1 and NOISE-3.

Regarding levees, seawalls, marsh restoration, and tidal gates, no long-term increases in noise would occur because this infrastructure would not include stationary equipment that generate noise. Regarding elevated roadway projects, research has shown that noise levels of traffic on elevated urban and suburban roadways, such as freeway overpasses 15–20 feet above grade, are no greater or even less than noise levels generated by traffic on at-grade roadways, largely because the direct line of sound propagation from the noise source is elevated above receptors (Zimmer and Buffington 1997). The following adaptation infrastructure may involve elevating existing roadways 15–20 feet above grade, enough to result in noticeable decreases in noise levels, in anticipation of sea level rise:

- I-580/US-101/SMART | Sea Level Rise Resilience Project (Marin),
- SR-37 | Sea Level Rise Resilience Project (Marin, Sonoma, Solano),
- SR-84 | Sea Level Rise Resilience Project (Alameda),
- US-101 | Peninsula Sea Level Rise Resilience Project (San Mateo), and
- SR-237/VTA | Sea Level Rise Resilience Project (Santa Clara).

Thus, although traffic noise would increase as a result of the Plan, as discussed above, the sea level rise adaptation infrastructure could reduce noise levels at the respective project locations, but at a minimum, would not result in additional increases in noise, because an elevated road could move an existing noise source out of the direct line-of-sight of existing receptors. Further, the elevated roads would not be widened, which would allow an increase in capacity, so average daily volumes and associated noise would not increase as a result of the project. Therefore, adaptation infrastructure involving construction of elevated roadways would not result in a significant change in traffic-related noise levels, and this impact would be less than significant (LTS).

<u>Transportation System Impacts</u>

Transit expansion projects would occur in multiple locations within the Plan area but would occur primarily in urbanized areas and near existing transit facilities. Increases in transit-related noise as a result of the proposed Plan could occur throughout the region as transit lines are expanded and service frequency increased. Noise levels would vary greatly depending on the type of transit facility and proximity to existing sensitive land uses. To assess long-term permanent increases in transit noise, the following criteria were used:

- based on the range of existing standards in the Plan area, exceeds project-specific exterior noise levels of 70 dBA CNEL;
- California Building Code and California General Plan Guidelines–recommended interior noise levels of 45 dBA CNEL; and
- results in a long-term perceptible increase in the ambient noise level (1.5 dBA or greater) in an area where the applicable noise threshold is already exceeded; in areas where applicable thresholds are not exceeded, a 3-dBA increase or greater would be considered substantial.

Noise from rail transit can vary depending on the frequency of trains passing throughout the day, the type of train (i.e., electric or diesel), whether or not a warning horn is used, and the type of track (i.e., elevated or not). Based on available data for Caltrain lines within the region, 24-hour noise levels can range from 70 dBA CNEL/L_{dn} at 50 feet from the track to 82 dBA CNEL/L_{dn} at 45 feet from the track (Peninsula Corridor Joint Powers Board 2014).

Extension of passenger rail transit service, as well as increases in transit frequency, could result in exposure of existing sensitive land uses to noise levels exceeding the thresholds developed for this analysis (i.e., 70 dBA CNEL). Such projects include:

- BART Silicon Valley Extension, Phase II – San Jose (Berryessa) to Santa Clara (Santa Clara County),
- Caltrain/California High-Speed Rail – Downtown San Francisco Extension (San Francisco),
- Capitol Corridor – South Bay Connect (Alameda County),
- Dumbarton Rail Group Rapid Transit (San Mateo County),
- Mineta San Jose International Airport Connector Automated People Mover (San Jose),
- SMART – Santa Rosa to Windsor (Sonoma County),
- Transbay Rail – New San Francisco–Oakland Crossing (San Francisco and Oakland), and
- Valley Link – Central Valley to Livermore (Alameda County).

The severity of this impact would depend upon the type (diesel or electric powered) and frequency of rail pass-by events and the existing ambient noise level at the existing receptor. These projects are generally located in urban areas that are already exposed to high levels of vehicle traffic noise.

Expansion of existing or construction of new transit lines would result in a new substantial noise source that could result in excessive noise exposure depending on the type of existing land uses and proximity to the new noise sources. It is likely that new rail lines would have noise levels similar to those discussed above. Therefore, they could exceed applicable exterior (i.e., 70 dBA CNEL) and interior (i.e., 45 dBA CNEL) noise thresholds at existing sensitive land uses. In addition, because new or expanded rail lines could result in noise levels of 70 dBA CNEL and up to 82 dBA CNEL, when compared to existing conditions where no rail currently exists, noise levels would substantially increase (i.e., likely more than 3 dB above ambient levels). It should be noted that implementing agencies or sponsors of transportation projects would coordinate with local jurisdictions to comply with local policies and regulations. In addition to future project-level CEQA review, transportation projects subject to review by the Federal Transit Administration, Federal Railroad Administration, or the Federal Highway Administration would be subject to project-level NEPA review and compliance with applicable guidance related to noise assessments and mitigation.

Because trains could generate noise levels of up to 82 dBA CNEL/L_{dn}, and transit lines are currently located in urbanized areas near major roads and freeways, where noise levels are currently relatively high, a 1.5-dBA increase in transit noise would be considered significant. As explained in Impact TRA-1 in Section 3.15, "Transportation," the proposed Plan includes major investments that create new transit lines or boost frequencies on existing lines. Thus, it is expected that implementation of the proposed Plan would result in a 1.5-dBA or more increase in transit noise. Increases in transit noise on existing facilities would result in a potentially significant (PS) impact.

Conclusion

Implementation of the proposed Plan's land use development pattern and transportation projects could result in regional average noise increases and localized traffic-related noise levels that exceed applicable thresholds, resulting in a substantial permanent increase in noise in some areas. However, as seen in **Table 3.12-7**, along some roadways in some counties, noise levels would decrease with implementation of the Plan. Implementation of the proposed Plan could result in noise exposure to existing or new sensitive receptors in excess of land use compatibility thresholds and could result in a permanent substantial increase in noise. New and expanded passenger rail lines would result in new noise sources and substantial increases in noise depending on proximity to existing sensitive land uses. Due to the traffic noise increases and threshold exceedances in some areas, substantial increases in stationary noise sources, and new or expanded transit services, this impact would be **potentially significant (PS).** Mitigation Measures NOISE-2(a), NOISE-2(b), and NOISE-2(c) address this impact and are described below.

Mitigation Measures

Implementing agencies and/or project sponsors shall implement measures, where feasible and necessary based on project- and site-specific considerations, that include those identified below.

Mitigation Measure NOISE-2(a) To reduce exposure from traffic noise when significant to achieve the applicable noise thresholds for each roadway type (i.e., 70 dBA CNEL for major roads/freeway, 65 dBA CNEL for all other roads), implementing agencies and/or project sponsors shall implement measures, where feasible and necessary based on project- and site-specific considerations, that include those identified below:

- Design adjustments to proposed roadway or transit alignments to reduce noise levels in noise-sensitive areas (e.g., below-grade roadway alignments can effectively reduce noise levels in nearby areas by providing a barrier between the source and receptor).
- Use techniques such as landscaped berms, dense plantings, reduced-noise paving materials, and traffic-calming measures in the design of transportation improvements.
- Use rubberized asphalt or “quiet pavement” to reduce road noise for new roadway segments, roadways in which widening or other modifications require re-pavement, or normal reconstruction of roadways where re-pavement is planned.
- Maximize the distance between existing noise-sensitive land uses and new noise-generating facilities and transportation systems.
- Contribute to the insulation of buildings or construction of noise barriers around sensitive receptor properties adjacent to the transportation improvement.
- Use land use planning measures, such as zoning, restrictions on development, site design, and buffers to ensure that future development is noise compatible with adjacent transportation facilities and land uses.
- Monitor the effectiveness of noise reduction measures by taking noise measurements and installing adaptive mitigation measures to achieve the standards for ambient noise levels established by the noise element of the general plan or noise ordinance

Mitigation Measure NOISE-2(b) To reduce the exposure of existing sensitive receptors to non-transportation noise associated with projected development and achieve a noise reduction below 70 dBA CNEL or local applicable noise standard, implementing agencies and/or project sponsors shall implement measures, where feasible and necessary based on project- and site-specific considerations, that include those identified below:

- Local agencies approving land use projects shall require that routine testing and preventive maintenance of emergency electrical generators be conducted during the less sensitive daytime hours (per the applicable local municipal code). Electrical generators or other mechanical equipment shall be equipped with noise control (e.g., muffler) devices in accordance with manufacturers’ specifications.
- Local agencies approving land use projects shall require that external mechanical equipment, including HVAC units, associated with buildings and other stationary sources (e.g., commercial loading docks) incorporate features designed to reduce noise to below 70 dBA CNEL or the local applicable noise standard. These features may include locating equipment or activity areas within equipment rooms or enclosures that incorporate noise reduction features, such as acoustical

louvers, and exhaust and intake silencers. Enclosures shall be oriented so that major openings (i.e., intake louvers, exhaust) are directed away from nearby noise-sensitive receptors. Site design considerations shall also incorporate appropriate setback distances, to the extent practical, from the noise and existing sensitive receptors to minimize noise exposure.

Mitigation Measure NOISE-2(c) To reduce transit-related noise exposure to existing receptors within 50 feet of a rail transit line to below 70 dBA, or other applicable standard, implementing agencies and/or project sponsors shall implement measures, where feasible and necessary based on project- and site-specific considerations, that include those identified below:

- When finalizing development project site plans or transportation project design, sufficient setback between occupied structures and the railroad tracks shall be provided to minimize noise exposure to the extent feasible.
- When finalizing development project site plans, noise-sensitive outdoor use areas shall be sited as far away from adjacent noise sources as possible and site plans shall be designed to shield noise-sensitive spaces with buildings or noise barriers whenever possible.
- Prior to project approval, the implementing agency for a transportation project shall ensure that the transportation project sponsor applies the following mitigation measures (or other technologically feasible measures) to achieve a site-specific exterior noise level of 70 dBA CNEL (or other applicable local noise standard) and interior noise level of 45 dBA CNEL at sensitive land uses, as applicable for transit projects:
  - use sound reduction barriers, such as landscaped berms and dense plantings;
  - locate rail extension below grade as feasible;
  - use damped wheels on railway cars;
  - use vehicle skirts;
  - use undercar acoustically absorptive material; and
  - install sound insulation treatments for affected structures.

Significance after Mitigation

Implementation of Mitigation Measure NOISE-2(a) would result in substantial reductions in traffic-related noise. Depending on barrier construction, up to 10 dBA in noise reduction is typically feasible (FHWA 2006), which would be adequate to bring the highest modeled traffic noise levels of 73.6 dBA CNEL to below the 70-dBA CNEL threshold. Site design, including proximity to the noise source, can achieve varying degrees of noise reduction depending on the distance to the source. Building construction methods can typically achieve a minimum of 25-dB exterior-to-interior noise reduction, but much higher levels of reduction are achievable through additional wall insulation and sound-proofing techniques. Implementation of Mitigation Measure NOISE-2(b) would require operational measures to that stationary noise sources would be designed to reduce noise to below 70 dBA CNEL and comply with any applicable local noise codes. Implementation of Mitigation Measure NOISE-2(c) would ensure that site-specific planning would include all technologically feasible measures to reduce transit noise to below 70 dBA CNEL for exterior noise levels and 45 dBA CNEL for interior noise levels. Further, site planning and building construction would be developed to achieve the necessary noise reduction, based on site-specific parameters. To the extent that a local agency requires an individual project to implement all feasible mitigation measures described above, the impact would be less than significant with mitigation (LTS-M).

Projects taking advantage of the CEQA streamlining provisions of SB 375 (PRC Sections 21155.1, 21155.2, and 21159.28) must apply the mitigation measures described above, as applicable, to address site-specific conditions. However, MTC/ABAG cannot require local implementing agencies to adopt the above mitigation measures, and it is ultimately the responsibility of a lead agency to determine and adopt mitigation. Therefore, this impact would be **significant and unavoidable (SU)** for purposes of this program-level review.

Impact NOISE-3: Generate excessive groundborne vibration or groundborne noise levels (PS)

<u>**Land Use and Sea Level Rise Adaptation Impacts**</u>

Construction

Vibration sources include the use of impact equipment (e.g., pile driving) during construction and long-term operational sources associated primarily with heavy trucks and buses traveling on roads and transit systems (e.g., heavy rail and commuter rail). Regarding construction-related vibration, cities and counties, including the jurisdictions within the Plan area, typically do not establish individual standards. Thus, Caltrans guidance was used to evaluate potential damage to existing structures from vibration activities, and FTA vibration criteria were used to evaluate potential disturbance to sensitive receptors from vibration noise, using the following criteria:

- Caltrans-recommended vibration levels for structural damage (0.1 to 0.6 PPV in/sec depending on building type) and
- FTA vibration impact criteria for human annoyance (65 VdB to 80 VdB depending on event frequency).

Construction activities may result in varying degrees of temporary ground vibration, depending on the specific construction equipment used and activities involved. When considering new construction, pile driving generates the highest vibration levels and is, therefore, of greatest concern when evaluating construction-related vibration impacts. The proposed Plan includes sea level rise adaptation infrastructure that would include construction of a variety of levees, seawalls, elevated roadways, marsh restoration, and tidal gates. Some of these activities could involve pile driving for elevated roadway projects.

According to FTA, vibration levels associated with pile driving are 1.518 in/sec PPV at 25 feet. Based on FTA's recommended procedure for applying a propagation adjustment to these reference levels, vibration levels from pile driving could exceed the Caltrans-recommended level of 0.5 in/sec PPV with respect to the structural damage for older structures within 50 feet of pile driving activities (refer to Appendix F for modeling details). Therefore, because the majority of projected development would occur in already urban and built-up areas the potential exists for pile driving to occur within 50 feet of a historic or old building, exceeding Caltrans-recommended levels for structural damage.

Vibration levels can also result in interference or annoyance impacts for residences or other land uses where people sleep, such as hotels and hospitals. According to FTA, vibration levels associated with pile driving are 112 VdB at 25 feet (FTA 2018). FTA vibration annoyance potential criteria depend on the frequency of the vibration events. When vibration events occur more than 70 times per day, as would likely be the case with pile driving, they are considered "frequent events." Frequent events in excess of 72 VdB are considered to result in a significant vibration impact. Based on FTA's recommended procedure for applying propagation adjustments to these reference levels, vibration levels from pile driving could exceed FTA's recommended guidance for "frequent events" within 550 feet of an existing sensitive land use (refer to Appendix F for modeling details). The potential exists for pile driving within 550 feet of an existing sensitive land use, exceeding FTA-recommended levels for vibration annoyance.

Therefore, because the potential exists for pile driving to occur within 50 feet of an older building, exceeding Caltrans-recommended levels for structural damage, and within 550 feet of an existing sensitive land use, exceeding FTA-recommended levels for vibration annoyance, this would be a potentially significant (PS) vibration impact, and Mitigation Measure NOISE-3(a) would address this impact.

Operation

New transportation-related vibration sources (e.g., new or expanded transit systems) are discussed below under Transportation System Impacts. Implementation of the land use development pattern and strategies in the proposed Plan would not result in new vibration sources because the majority of the new development would occur as infill development, in accordance with the adopted land use plans and zoning ordinances of the cities and counties in the Plan area. Forecasted development under the proposed Plan would create more centralized residential areas and commercial centers and would not result in industrial uses that could generate operational vibration. New development built near or even above or adjacent to new or existing vibration sources would be constructed to higher standards, due to increasingly more stringent energy efficiency requirements with better insulation and materials, that reduce vibration exposure. The sea level rise adaptation infrastructure would not involve any construction or modification of operational sources of vibration and thus would not result in any long-term permanent increases in vibration levels. This impact would be less than significant (LTS).

<u>Transportation System Impacts</u>

Construction

Construction-related vibration impacts from transportation project implementation would be similar to those described above for land use and sea level rise adaptation infrastructure. This would be a potentially significant (PS) vibration impact, and Mitigation Measure NOISE-3(a) would address this impact.

Operation

Transit expansion projects would occur in multiple areas within the region but would occur primarily in urbanized areas and near existing transit facilities. Increases in transit-related vibration as a result of the proposed Plan could occur throughout the region as transit lines are expanded and service frequency increased. However, vibration levels would vary greatly depending on the type of transit facility and proximity to existing sensitive land uses. Because vibration impacts would vary depending on the local conditions, these impacts are addressed at the local level below. To assess long-term vibration impacts, the following criteria was used:

- Caltrans-recommended vibration levels for structural damage (0.1 to 0.6 PPV in/sec depending on building type);
- FTA vibration impact criteria for human annoyance (65 VdB to 80 VdB depending on event frequency); and

- for vibration levels already exceeding applicable thresholds (without the proposed Plan), a Plan-related increase in vibration level of 1.5 VdB would be considered significant.

Vibration can result in structural damage to buildings or disturbance to people at nearby sensitive land uses (e.g., residences, hospitals, offices). However, vibration levels dissipate rapidly from the source and typically are associated with short-term events (e.g., passing train). Therefore, vibration effects are limited to localized areas near the vibration source. Further, the smoothness of the running surface (e.g. road or rail) is correlated to the level of vibration from a moving vehicle. Smooth roadways for buses and smooth rail running surfaces for rail systems substantially reduce vibration. In addition, urbanized and developed areas where roads are paved and maintained regularly would be considered a smooth surface for bus transit. In these instances, transit over rail would be considered the primary ground vibration sources within the Plan area.

Extension of rail transit service to new locations, as well as boosts in existing transit frequency, in the Bay Area could result in vibration levels that exceed vibration significance thresholds (i.e., levels developed by the FTA as shown in **Table 3.12-4**). Such projects include:

- BART Silicon Valley Extension, Phase II – San Jose (Berryessa) to Santa Clara (Santa Clara County),
- Caltrain/California High-Speed Rail – Downtown San Francisco Extension (San Francisco),
- Capitol Corridor – South Bay Connect (Alameda County),
- Dumbarton Rail Group Rapid Transit (San Mateo County),
- Mineta San Jose International Airport Connector Automated People Mover (San Jose),
- SMART – Santa Rosa to Windsor (Sonoma County),
- Transbay Rail – New San Francisco–Oakland Crossing (San Francisco and Oakland), and
- Valley Link – Central Valley to Livermore (Alameda County).

The FTA Transit Noise and Vibration Impact Assessment Guidelines provide recommended vibration levels for various land use types based on the frequency of exposure from vibration events (i.e., number of trains passing by a sensitive land use). In some areas within the region, existing development could be exposed to frequent vibration events (i.e., more than 70 trains per day), occurring adjacent to new or expanded rail lines used by BART, Caltrain, or others. The FTA-recommended level for which human disturbance would occur is 72 VdB. Thus, based on the Generalized Ground Surface Vibration curves in the FTA guidance, receptors at developments within 200 feet of a railroad could be exposed to vibration exceeding the recommended threshold for human disturbance of 72 VdB for sensitive receptors that are exposed to a higher frequency of vibration events (i.e., 70 or more trains passing by in 1 day).

The degree of increased vibration exposure would depend upon the type (diesel or electric powered) and frequency of rail pass-by events and the existing soil conditions at the existing receptor. Expanding or building new transit lines in unserved areas would result in a new substantial vibration source that could result in vibration effects that exceed FTA-recommended levels (i.e., 72 VdB) within 200 feet of the source. In addition, because new or expanded rail lines could result in vibration levels that exceed applicable criteria (i.e., 72 VdB) within 200 feet, when compared to existing conditions where no rail currently exists, vibration levels would substantially increase (i.e., more than 1.5 VdB). Some of the rail extension projects identified above would result in potentially significant (PS) impacts resulting from excessive vibration exposure to existing sensitive receptors along the extended transit alignment and permanent substantial increases in vibration levels. This would be a potentially significant (PS) impact.

Conclusion

Construction of the proposed Plan's land use development pattern, sea level rise adaptation infrastructure, and transportation facilities could generate substantial vibration levels, and the potential exists for pile driving to occur within 50 feet of an older building, exceeding Caltrans-recommended levels for structural damage, and within 550 feet of an existing sensitive land use, exceeding FTA-recommended levels for vibration annoyance. Implementation of the proposed Plan's land use development pattern and sea level rise adaptation infrastructure would not result in substantial sources of operational vibration. However, new and expanded transit lines would result in new vibration sources and substantial increases in vibration depending on proximity to existing sensitive land uses. Thus, this would be a **potentially significant (PS)** impact. Mitigation Measures NOISE-3(a) and NOISE-3(b) address this impact and are described below.

Mitigation Measures

Implementing agencies and/or project sponsors shall implement measures, where feasible and necessary based on project- and site-specific considerations, that include those identified below.

Mitigation Measure NOISE-3(a) To reduce construction vibration levels to acceptable levels (i.e., 65 VdB to 80 VdB depending on frequency of event and 0.1 to 0.6 PPV in/sec depending on building type), implementing agencies and/or project sponsors shall implement measures, where feasible and necessary based on project- and site-specific considerations, that include those identified below:

- To minimize disturbance of receptors within 550 feet of pile-driving activities, implement “quiet” pile-driving technology (such as predrilling of piles and the use of more than one pile driver to shorten the total pile driving duration), where feasible, in consideration of geotechnical and structural requirements and conditions.
- To reduce structural damage, where pile driving is proposed within 50 feet of an older or historic building, engage a qualified geotechnical engineer and qualified historic preservation professional (for designated historic buildings only) and/or structural engineer to conduct a preconstruction assessment of existing subsurface conditions and the structural integrity of nearby (i.e., within 50 feet) historic structures that would be exposed to pile-driving activity. If recommended by the preconstruction assessment, for structures or facilities within 50 feet of pile-driving activities, the project sponsors shall require ground vibration monitoring of nearby historic structures. Such methods and technologies shall be based on the specific conditions at the construction site. Conditions will be determined through activities such as the preconstruction surveying of potentially affected historic structures and underpinning of foundations of potentially affected structures, as necessary. The preconstruction assessment shall include a monitoring program to detect ground settlement or lateral movement of structures in the vicinity of pile-driving activities and identify corrective measures to be taken should monitored vibration levels indicate the potential for building damage. In the event of unacceptable ground movement with the potential to cause structural damage, all impact work shall cease, and corrective measures shall be implemented to minimize the risk to the subject, or adjacent, historic structure.
- Use cushion blocks to dampen impact noise from pile driving.

Mitigation Measure NOISE-3(b) To reduce vibration effects from rail operations, implementing agencies and/or project sponsors shall implement measures, where feasible and necessary based on project- and site-specific considerations, that include those identified below:

- Ensure that project sponsors apply the following mitigation measures to achieve FTA-recommended vibration levels of 72 VdB at residential land uses, or other applicable standard, for rail extension projects:
  - Use high-resilience (soft) direct fixation fasteners for embedded track.
  - Install ballast mat, or other approved technology for the purpose of reducing vibration, for ballast and tie track.
  - Conduct regular rail maintenance, including rail grinding and wheel truing to recontour wheels, to provide smooth running surfaces.

Significance after Mitigation

Implementation of Mitigation Measure NOISE-3(a) would reduce vibration impacts by requiring the use of quieter pile-driving technology and ensuring that the proper actions are taken to minimize vibration impacts to adjacent structures. Implementation of the Mitigation Measure NOISE-3(b) could provide a reduction of 15–20 VdB (FTA 2018), which would be adequate to reduce vibration levels to below 72 VdB within 200 feet. To the extent that a lead agency requires an individual project to implement all feasible mitigation measures described above, the impact would be less than significant with mitigation (LTS-M).

Projects taking advantage of the CEQA streamlining provisions of SB 375 (PRC Sections 21155.1, 21155.2, and 21159.28) must apply the mitigation measures described above, as applicable, to address site-specific conditions. However, MTC/ABAG cannot require local implementing agencies to adopt the above mitigation measures, and it is ultimately the responsibility of a lead agency to determine and adopt mitigation. Therefore, this impact would be **significant and unavoidable (SU)** for purposes of this program-level review.

Impact NOISE-4: For a project located within the vicinity of a private airstrip or an airport land use plan or, where such a plan has not been adopted, within two miles of a public airport or public use airport, expose people residing or working in the project area to excessive noise levels (PS)

This analysis considers the following thresholds of significance:

- California Airport Noise Standards, Title 21, Section 5000: 65 dBA CNEL and
- Federal Interagency Committee on Aviation Noise: 65 dBA (interior) single-event noise levels.

Land Use Impacts

Public airports typically service entire regions, whereas smaller private airports or airstrips tend to serve local users. However, like other noise sources, noise from airports and aircraft flight events have the greatest effect on nearby land uses. There are 25 public use airports in the Bay Area that serve commercial and general aviation users (see **Table 3.9-2** and **Figure 3.9-3** in Section 3.9, "Hazards and Wildfire"). Many of the public airports are in urbanized areas where the proposed Plan envisions land use development projects. Specifically, the following airports are located immediately adjacent to TPAs identified in the proposed Plan:

- Oakland International Airport,
- San Francisco International Airport,
- San Jose International Airport,
- Reid-Hillview Municipal Airport (San Jose),

- Moffett Federal Airfield (Mountain View),
- Travis Air Force Base (Fairfield),
- Livermore Municipal Airport, and
- Buchanan Field (Concord).

Most of these airports and airfields have an active Airport Land Use Compatibility Plan (ALUCP) (or the equivalent) to discourage incompatible land uses within the vicinity of the airport. The FAA Part 150 program encourages airports to prepare noise exposure maps that show land uses that are incompatible with high noise levels, and these are often included within the ALUCP. For example, the ALUCP for San Francisco International Airport includes information on the number of housing opportunity sites within the 70-CNEL contour for airport operations. In addition, noise contours identified in the Oakland International ALUCP indicate that the 65 dBA CNEL is close to existing development. Thus, the potential exists for forecasted development pursuant to the proposed Plan to occur in areas of 65 dBA CNEL or 70 dBA CNEL, exceeding recommended airport noise thresholds of 65 dBA CNEL for residential land uses and the project-specific land use compatibility thresholds of 70 dBA CNEL.

In addition to consideration of exterior CNEL noise levels, increases in interior noise levels near airports have the potential to result in sleep disturbance at nearby sensitive land uses. In accordance with FICAN guidance, aircraft-generated interior single-event noise levels of 65 dBA could result in a 5-percent or less chance of awakening someone.

Local land use compatibility standards contained in city and county general plans would typically dictate whether specific site review was required for construction of sensitive land uses in areas potentially affected by aircraft noise. However, given the regional scale of the proposed Plan and the high level of projected development throughout the region, it is possible that the Plan's forecasted land use development pattern could result in exposure to exterior and interior noise levels from existing airports or airstrips that exceed applicable thresholds. There would be a potentially significant (PS) impact resulting from excessive airport noise levels if projected development were to occur in close proximity to existing airports or airstrips that would require mitigation.

Sea Level Rise Adaptation Impacts

The proposed Plan includes sea level rise adaptation infrastructure that would include construction of a variety of levees, seawalls, elevated roadways, marsh restoration, and tidal gates. The adaptation infrastructure could potentially be located in areas close to existing airports or airstrips, specifically Oakland and San Francisco International Airports; however, they would not consist of habitable structures. Thus, no receptors would be exposed to excessive noise levels generated by nearby aircraft, and this impact would be less than significant (LTS).

Transportation System Impacts

There are no airport-related transportation projects identified in the proposed Plan. The transportation projects could potentially be located in areas close to existing airports or airstrips, specifically Oakland and San Francisco International Airports; however, they would not consist of habitable structures. Thus, no receptors would be exposed to excessive noise levels generated by nearby aircraft, and this impact would be less than significant Consequently, this would be a less-than-significant impact (LTS).

Conclusion

Because implementation of the proposed Plan’s land use development pattern could potentially result in land use development being located in close proximity to existing airports such that applicable exterior and interior noise thresholds would be exceeded. this would be a **potentially significant (PS)** impact. Mitigation Measure NOISE-4 addresses this impact and is described below.

Mitigation Measures

Implementing agencies and/or project sponsors shall implement measures, where feasible and necessary based on project- and site-specific considerations, that include those identified below.

Mitigation Measure NOISE-4 Local lead agencies for all new development proposed to be located within an existing airport influence zone, as defined by the locally adopted airport land use compatibility plan or local general plan, shall require a site-specific noise compatibility study. The study shall consider and evaluate existing aircraft noise, based on specific aircraft activity data for the airport in question, and shall include recommendations for site design and building construction to ensure compliance with interior noise levels of 45 dBA CNEL, such that the potential for sleep disturbance is minimized.

Significance after Mitigation

To the extent that a local agency requires an individual project to implement the feasible mitigation measure described above, the appropriate design and building construction would ensure interior noise levels of 45 dBA CNEL, and this impact would be less than significant with mitigation (LTS-M).

Projects taking advantage of the CEQA streamlining provisions of SB 375 (PRC Sections 21155.1, 21155.2, and 21159.28) must apply the mitigation measures described above, as applicable, to address site-specific conditions. However, MTC/ABAG cannot require local implementing agencies to adopt the above mitigation measures, and it is ultimately the responsibility of a lead agency to determine and adopt mitigation. Therefore, this impact would be **significant and unavoidable (SU)** for purposes of this program-level review.

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