3.12 Noise and Vibration

3.12.1 Introduction

This section examines the potential impacts associated with noise and vibration that would be generated by the Expo Phase 2 project alternatives. The analysis includes measurements to document existing conditions, predictions of the noise and vibration levels during operation, and an evaluation of measures to minimize the potential noise and vibration impacts.

CEQA does not provide Noise and Vibration criteria. Therefore, the FTA Noise and Vibration Criteria and analytical methodologies are used.

In response to the many comments received on the DEIR regarding noise and vibration impacts, additional noise and vibration measurements, testing and analysis were conducted in the FEIR. These efforts focused on sensitive receptors such as residential areas, schools and recording studios, as well as issues associated with the maintenance facility. The results of this analysis, including changes to the project and proposed mitigation measures are presented in this section.

A separate *Noise and Vibration Technical Background Report* was prepared and is referenced throughout this section. Those interested in greater detail on the existing conditions, methods used to assess impacts, and background calculations that support the conclusions of this section should consult the technical background report. Full bibliographic references can be found in Appendix B (Bibliography).

Noise and Vibration Sources Associated with Light-Rail Transit (LRT) Systems

Following is a summary of the noise and vibration sources that have been evaluated in this study:

- **Light-Rail Vehicle Operations:** This is the normal noise from the operation of light-rail vehicles and includes noise from steel wheels rolling on steel rails (wheel/rail noise) and from propulsion motors, air conditioning, and other auxiliary equipment on the vehicles. As expected, the wheel/rail noise increases with speed. At speeds greater than 20 to 30 mph, the wheel/rail noise usually dominates noise from the vehicle auxiliary equipment. Train operations also create groundborne vibration that may be intrusive to occupants of buildings when the tracks are relatively close to buildings.
- **Traffic Noise:** The proposed project would result in changes in traffic patterns and volumes in the vicinity of stations and locations where the light-rail transit (LRT) would share the right-of-way with an existing street, such as Segment 1a (Venice/Sepulveda). In all cases, the forecasted change in traffic volume is insufficient to cause more than a 1 decibel (dB) change in sound levels. Therefore, a detailed assessment of noise impacts from traffic noise has not been performed as part of this study.

  However, there are areas along Venice and Sepulveda Boulevards where land would be acquired and the existing buildings removed to accommodate the proposed project. Because these buildings provide acoustic shielding, removing them could increase the levels of traffic and rail noise for residences or other noise-sensitive receptors located behind these buildings. Such locations are noted in the analysis.

- **Audible Warnings:** Audible warnings are required by the California Public Utilities Commission (CPUC) at all gate-protected at-grade crossings. The required audible warnings are ringing bells that are located on the masts of the crossing gates and sounding of horns located on the lead vehicle of the trains. No audible warnings are required at street crossings where the light-rail trains would operate in the street right-of-way and would be controlled by traffic signals, as would be the case for the at-grade sections of Segment 1a (Venice/Sepulveda), Segment 3 (Olympic), and Segment 3a (Colorado). There are three vehicle-mounted warning devices: a horn, a “quacker,” and a “gong.” The horn is a high-intensity horn used by Metro for emergencies only, while the quacker is a low-intensity horn used by Metro for standard operations. The gong is a relatively low-volume bell sound that is sometimes used when trains enter stations. All devices will comply with requirements of the CPUC. The CPUC requires that the horn create a minimum sound level of 85 dBA at 100 feet (ft) in front of the train ~~horn~~. This is a little bit louder than a typical automobile horn. The quacker is a relatively low-volume sound (75 dBA at 100 ft. in front of the lead vehicle) and has a marginal effect on community noise exposure at train speeds greater than 35 mph. Measures have been incorporated into the design of the proposed project that would ~~eliminate all~~reduce potential noise effect from audible warnings at at-grade crossings to FTA acceptable levels.

  After further consultation with Metro, the following text was removed because vehicles on the Blue Line are expected to undergo retrofit. ~~Note that the audible warnings used on the Metro Blue Line between Los Angeles and Long Beach are substantially different than would be used on the Exposition Corridor. The Blue Line trains sound a much louder horn before at-grade crossings and use mechanical bells at the at-grade crossings that do not have a volume adjustment.~~

- **Station Public Address System:** Public address (PA) systems will be installed at the stations to announce when trains are arriving at the stations and to provide other information to patrons. These systems will have automatic volume adjustment controls that are designed so the announcements are only a few decibels above ambient noise levels. With proper design of the public address systems and the automatic volume adjustment, the noise from the PA system should not generate any adverse effects in communities near the stations.

- **Special Trackwork:** The Expo Phase 2 project would be constructed of continuously welded rail as are virtually all modern light-rail systems. Welded rail eliminates most rail joints, which means that the “clickety-clack” noise associated with older rail systems is eliminated. The one exception is at the special trackwork for turnouts and crossovers. Turnouts and crossovers require that two rails cross; the special fixture used where two rails cross is referred to as a “frog.” Standard frogs have gaps where the two rails cross and the wheels must “jump” across the gap. The wheels striking the ends of the gap increases noise levels near special trackwork by approximately 6 dB and groundborne vibration by approximately 10 dB. Because noise and vibration levels are higher near special trackwork, it is common for many of the predicted noise and vibration impacts to be near special trackwork.

- **Wheel Squeal:** Wheel squeal can be generated when steel-wheel transit vehicles traverse tight radius curves. It is very difficult to predict when and where wheel squeal will occur. A general guideline is that there is potential for wheel squeal at any curve with a radius that is less than 600 ft.

- **Ancillary Equipment:** Traction power substations (TPSS) are the only ancillary equipment associated with the proposed project with potential for creating noise impacts. The ventilation fans provided at each substation are the dominant noise source of most TPSS units. There would be eight to nine TPSS units distributed along the proposed project depending upon the alignment and including the Maintenance Facility. Several of the proposed sites are adjacent to residential land uses, because the TPSS sites must be spaced at regular intervals and near the guideway. As long as the air conditioning equipment for the TPSS units is located a minimum of 50 ft from residences, the adverse noise effects will be minimal. The locations of all noise producing equipment will be reviewed during the design process to ensure that it will be placed in an appropriate location where it will not generate noise impacts. Communications and Signal Buildings (C&S) have small air conditioning systems that are approximately equivalent to residential air conditioning units. Therefore, the noise from these units has not been included in the noise analysis.
- **Construction Noise and Vibration:** All the sources discussed above are associated with operation of the proposed project. Similar to any other major infrastructure project, construction would require use of heavy equipment that generates relatively high noise levels. All issues related to construction noise and vibration are presented in Chapter 4 (Construction Impacts) of this document.

Background on Noise

Sound is mechanical energy transmitted by pressure waves in a compressible medium such as air. Noise is generally defined as unwanted or excessive sound. Sound can vary in intensity by over one million times within the range of human hearing. Therefore, a logarithmic scale, known as the decibel (dB) scale, is used to quantify sound intensity and compress the scale to a more convenient range.

Sound is characterized by both its amplitude (volume) and frequency (pitch). The human ear does not hear all frequencies equally. In particular, it deemphasizes low and very high frequencies. To better approximate the sensitivity of human hearing, the A-weighted decibel scale has been developed. A-weighted decibels are abbreviated as “dBA.” This scale is commonly used and accepted for noise studies. On this scale, the human range of hearing extends from approximately 3 dBA to around 140 dBA. As a point of reference, Figure 3.12-1 (Typical Outdoor and Indoor Noise Levels) includes examples of A-weighted sound levels from transit sources and common indoor and outdoor sounds.

Using the decibel scale, sound levels from two or more sources cannot be directly added together to determine the overall sound level. Rather, the combination of two sounds at the same level yields an increase of 3 dB. The smallest recognizable change in sound level is approximately 1 dB. A 3 dB increase in the A-weighted sound level is generally considered perceptible, whereas a 5 dB increase is readily perceptible. A 10 dB increase is judged by most people as an approximate doubling of the perceived original loudness.

The two primary factors that reduce levels of environmental sounds are increasing the distance between the sound source and the receiver and/or having intervening obstacles such as walls, buildings, or terrain features block the direct path between the sound source and the receiver. Factors that act to make environmental sounds louder include moving the sound source closer to the receiver, sound enhancements caused by reflections, and focusing caused by various meteorological conditions.

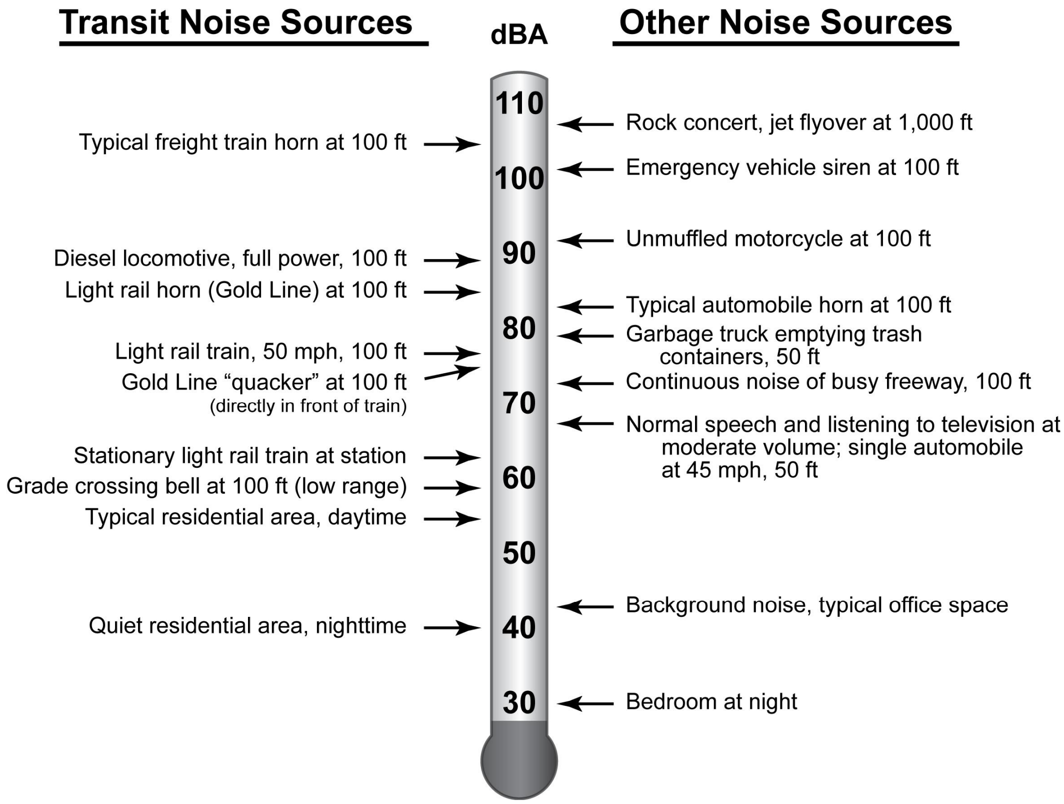


Figure 3.12-1 Typical Outdoor and Indoor Noise Levels

Following are brief definitions of the measures of environmental noise used in this study:

- *Maximum Sound Level (L_{max}):* L_{max} is the maximum sound level that occurs during an event such as a train passing.
- *Equivalent Sound Level (L_{eq}):* Environmental sound fluctuates constantly. The equivalent sound level (L_{eq}) is the most common means of characterizing community noise. L_{eq} represents a constant sound that, over a specified period of time, has the same sound energy as the time-varying sound. L_{eq} is used by the FTA to evaluate noise impacts at institutional land uses, such as schools, churches, and libraries, from proposed transit projects.
- *Day-Night Sound Level (L_{dn}):* L_{dn} is basically a 24-hour L_{eq} with an adjustment to reflect the greater sensitivity of most people to nighttime noise. The adjustment is a 10 dB penalty for all sound that occurs between the hours of 10:00 P.M. to 7:00 A.M.
- *L_{XX}:* This is the percent of time a sound level is exceeded during the measurement period. For example, the L_{99} is the sound level exceeded during 99 percent of the measurement period. The tables of the hourly noise levels in Appendix B include L_1, L_{33}, L_{50}, and L_{99}, the sound levels exceeded 1 percent, 33 percent, 50 percent and 99 percent of the hour.
- *Sound Exposure Level (SEL):* SEL is a measure of the acoustic energy of an event such as a train passing. In essence, the acoustic energy of the event is compressed into a 1-second period. SEL increases as the sound level of the event increases and as the

duration of the event increases. It is often used as an intermediate value in calculating overall metrics such as L_{eq} and L_{dn}.

Background on Vibration

One potential community impact from the proposed project is vibration that is transmitted from the tracks through the ground to adjacent buildings. This is referred to as *groundborne vibration*. When evaluating human response, groundborne vibration is usually expressed in terms of decibels using the root mean square (RMS) vibration velocity. RMS is defined as the average of the squared amplitude of the vibration signal. To avoid confusion with sound decibels, the abbreviation VdB is used for vibration decibels. All vibration decibels in this report use a decibel reference of 1 micro-inch/second (µin/sec).[70] The potential impacts of rail transit groundborne vibration are as follows:

- **Perceptible Building Vibration:** This is when building occupants feel the vibration of the floor or other building surfaces. Experience has shown that the threshold of human perception is around 65 VdB and that vibration that exceeds 75 to 80 VdB may be intrusive and annoying to building occupants.
- **Rattle:** The building vibration can cause rattling of items on shelves and hanging on walls, and various different rattle and buzzing noises from windows and doors.
- **Reradiated Noise:** The vibration of room surfaces radiates sound waves that may be audible to humans. This is referred to as *groundborne noise*. When audible groundborne noise occurs, it sounds like a low-frequency rumble. For a surface rail system such as the proposed LRT Alternatives, the groundborne noise is usually masked by the normal airborne noise radiated from the transit vehicle and the rails.
- **Damage to Building Structures:** Although it is conceivable that vibration from a light rail system could cause damage to fragile buildings, the vibration from light-rail transit systems is usually one to two orders of magnitude below the most restrictive thresholds for preventing building damage. Hence, the vibration impact criteria focus on human annoyance, which occurs at much lower amplitudes than does building damage.

Vibration is an oscillatory motion that can be described in terms of the displacement, velocity, or acceleration of the motion. The response of humans to vibration is very complex. However, the general consensus is that for the vibration frequencies generated by passenger trains, human response is best approximated by the vibration velocity level. Therefore, vibration velocity has been used in this study to describe train-generated vibration levels.

Figure 3.12-2 (Typical Vibration Levels) shows typical vibration levels from rail and non-rail sources as well as the human and structure response to such levels.

Although there has been relatively little research into human and building response to groundborne vibration, there is substantial experience with vibration from other rail systems. In general, the collective experience indicates that:

- Groundborne vibration from rail systems almost never results in building damage, even minor cosmetic damage. The primary consideration, therefore, is whether vibration will be intrusive to building occupants or will interfere with interior activities or machinery.

[70] One µin/sec= 10^{-6} in/sec.

- The threshold for human perception is approximately 65 VdB. Vibration levels in the range of 70 to 75 VdB are often noticeable but acceptable. Beyond 80 VdB, vibration levels are often considered unacceptable.
- There is a relationship between the number of daily events and the degree of annoyance caused by groundborne vibration. The FTA Guidance Manual (FTA 2006) includes an 8 VdB higher impact threshold if there are fewer than 30 events per day and a 3 VdB higher threshold if there are fewer than 70 events per day to ensure that potentially annoying but relatively infrequent events are not ~~under~~over-represented.

Often it is necessary to determine the contribution at different frequencies when evaluating vibration or noise signals. The ⅓-octave band spectrum is the most common procedure used to evaluate frequency components of acoustic signals. The FTA Guidance Manual (FTA 2006) is a good reference for additional information on transit noise and vibration and the technical terms used in this section.

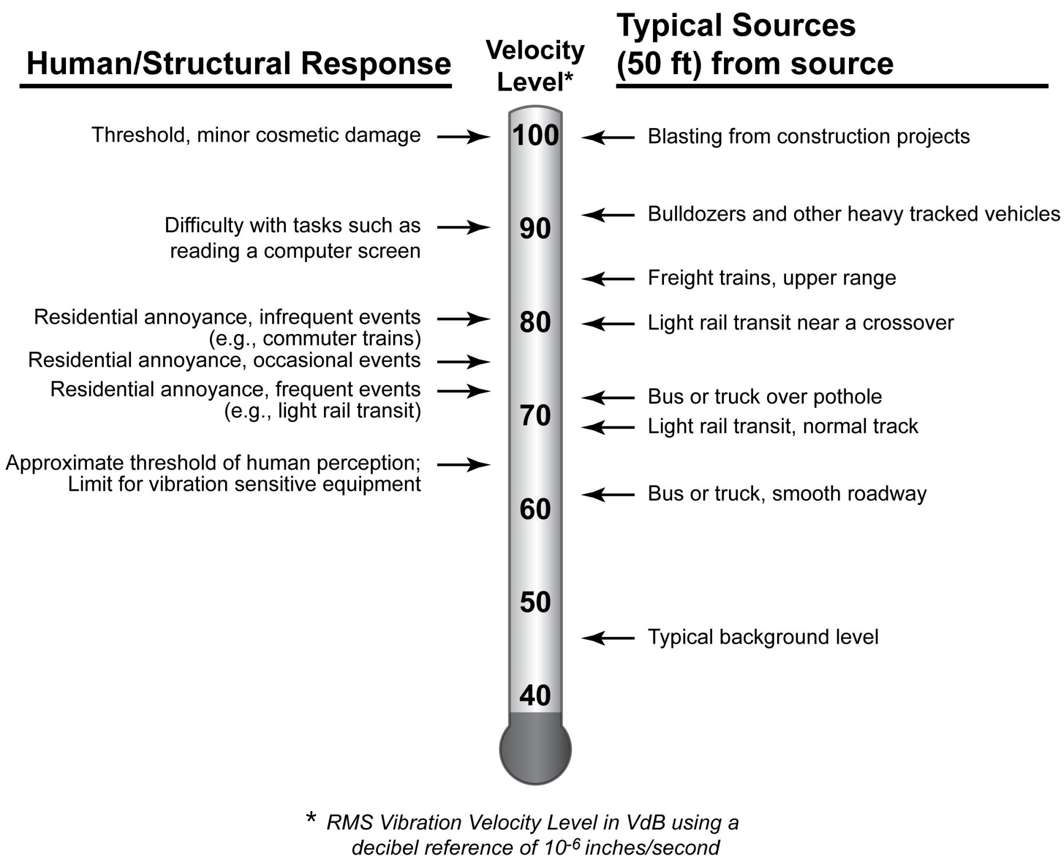


Figure 3.12-2 Typical Vibration Levels

3.12.2 Existing Conditions

<u>Existing Noise</u>

The existing noise conditions along the proposed Expo Phase 2 alternative alignments were documented through monitoring performed at representative noise-sensitive sites along the proposed alignments. Noise-sensitive sites are defined as institutional land uses, such as schools, churches, and libraries, and where people normally sleep (residences, hotels, hospitals, etc.). The noise-sensitive receptors along the Expo Phase 2 alignments include single- and multi-family residences, schools and other institutions, and recording studios. In addition there are a number of commercial, industrial, and office space land uses along the proposed project alignments that are not generally considered to be noise sensitive by the FTA.

Noise-sensitive land uses were identified using conceptual engineering drawings, aerial photographs, and visual surveys. Long-term and short-term noise measurements at twenty-one sites along the proposed alignments were taken during the period from April 12 through December 6, 2007. Supplemental noise measurements were taken during the period from May 20 to November 15, 2009. Estimating existing noise exposure is an important step because the thresholds for noise impacts are based on the existing levels of noise exposure. In addition to the measurements of noise levels within the Expo Corridor, measurements were taken at the Green Line maintenance and storage facility in El Segundo to characterize noise from existing Metro yard and shop activities.

Long-term noise measurements were taken at ~~fourteen~~seventeen locations that are representative of the residential and institutional land uses along the corridor. The monitors were programmed to continuously collect data for a minimum of ~~20~~ 10 hours. The microphones were generally located at the set-back distance of the ~~residences~~ buildings in the area from the proposed alignments. The general locations of the long-term measurement sites are shown in Figure 3.12-3 (Noise Measurement Sites, Segment 1 [Revised]) through Figure 3.12-7 (Noise Measurement Sites, Segment 3a [Revised]). Table 3.12-1 (Summary of Long-Term Measurement Results) gives the details of each individual long-term measurement.

In addition to the long-term measurements, ~~30-minute~~ short-term noise measurements were taken at seven ~~six~~ locations. The general locations of the short-term measurement sites are also shown in Figure 3.12-3 (Noise Measurement Sites, Segment 1 [Revised]) through Figure 3.12-7 (Noise Measurement Sites, Segment 3a [Revised]). They are representative of the ~~institutional~~ land uses within the proposed segments, including ~~(e.g.,~~ schools, churches, temples, and recording studios~~)~~. Table 3.12-2 (Summary of Short-Term Measurement Results) gives the details of each individual short-term measurement.

The noise monitors were programmed to report average noise levels at intervals of 1 to 15 seconds. These results were used to calculate various other noise metrics including hourly L_{eq} and L_{dn}. As will be discussed in Section 3.12.3 (Regulatory Setting), L_{eq} is used by the FTA to characterize noise exposure at institutional land uses such as schools, churches, and libraries (FTA Category 3) and L_{dn} is used by the FTA to characterize noise exposure at residential land uses (FTA Category 2).

Source: Metro, 2008; DMJM Harris, 2008

Figure 3.12-3 Noise Measurement Sites, Segment 1 [Revised]

Source: Metro, 2008; DMJM Harris, 2008

Figure 3.12-4 Noise Measurement Sites, Segment 1a

Source: Metro, 2008; DMJM Harris, 2008

Figure 3.12-5 Noise Measurement Sites, Segment 2 [Revised]

Source: Metro, 2008; DMJM Harris, 2008

Figure 3.12-6 Noise Measurement Sites, Segment 3

Source: Metro, 2008; DMJM Harris, 2008

Figure 3.12-7 Noise Measurement Sites, Segment 3a [Revised]

Both L_{dn} and L_{eq} measure the total noise environment in an area over a period of time, including all natural and man-made sounds. Whenever any additional sound is introduced into the environment, L_{eq} and L_{dn} will increase. A quiet sound, such as birds chirping, increases L_{eq} and L_{dn} by an infinitesimal amount; a loud sound, such as an emergency vehicle siren, can dominate L_{eq} and L_{dn} even if the loud sound occurs for only a few minutes per day. Although a number of different measures of noise exposure have been proposed by researchers for characterizing human annoyance with noise, none have been shown to provide a better correlation with annoyance than L_{eq} and L_{dn}. This is why the increase in L_{eq}, L_{dn}, or similar noise metrics, is the most common approach for characterizing impacts from transit noise.

The overall noise monitoring results are summarized in Table 3.12-1 (Summary of Long-Term Measurement Results~~ [Residential Land Uses]~~) and Table 3.12-2 (Summary of Short-Term Measurement Results~~ [Institutional Land Uses]~~).

Table 3.12-1 Summary of Long-Term Measurement Results~~ (Residential Land Uses)~~

Site No. by Segment	Location	Primary Noise Source	Measurement Start		Duration	Meas. L_{dn} (dBA)
			Date	Time		
Segment 1: Expo ROW (LRT Alternatives 1 and 2)						
LT-1	Side yard of multi-family residence between Faris Dr. and Watseka Ave.	I-10 Freeway	05/14/07	8:38 A.M.	44 Hrs	~~67~~68[a]
LT-2	Southeast corner of Northvale Rd. and Dunleer Dr.	I-10 Freeway	05/15/07	~~11:39~~2:00 ~~P~~A.M.	43 Hrs	65
LT-3	Backyard of a single-family residence at Dunleer Pl. and Coventry Pl.	I-10 Freeway	05/08/07	7:12 P.M.	24 Hrs	59(56)[b]
LT-4	Side yard of a single-family residence at Northvale Dr. and Roundtree Rd.	I-10 Freeway and Overland Ave.	05/08/07	8:22 P.M.	24 Hrs	59
LT-5	Backyard of a single-family residence on Ashby Ave.	Overland Ave.	05/08/07	7:51 P.M.	24 Hrs	~~57~~58[a]
LT-6	Side yard of a single-family residence, north side of Exposition Blvd. east of Military Ave.	Military Ave.	05/16/07	4:25 P.M.	20 Hrs	~~67~~59[c]

Table 3.12-1 Summary of Long-Term Measurement Results ~~(Residential Land Uses)~~

Site No. by Segment	Location	Primary Noise Source	Measurement Start Date	Measurement Start Time	Duration	Meas. L_{dn} (dBA)
LT-16.1[d]	Bungalow Classroom Exterior	Overland Ave.	08/17/09	10:21 A.M.	54 Hrs	64[f]
LT-16.2[d]	Bungalow Classroom Interior	HVAC System, Overland Ave.	08/17/09	11:30 A.M.	54 Hrs	39[f]
Segment 1a: Venice/Sepulveda (LRT Alternatives 3 and 4)						
LT-12	Front yard of property on southeast corner of Venice Blvd. and Huron Ave.	Sepulveda Ave.	05/10/07	1:12 P.M.	24 Hrs	74
LT-13	Gardens of UCLA residences on west side of Sepulveda Blvd. between Queensland St. and National Blvd.	Venice Blvd.	05/14/07	9:29 A.M.	44 Hrs	71
Segment 2: Sepulveda to Cloverfield (All LRT Alternatives)						
LT-7	Side yard of a multi-family residence on Exposition Blvd. west of I-405	I-405 Freeway	05/10/07	1:56 P.M.	30 Hrs	63
LT-8	Front yard of a multi-family residence on Exposition Blvd. between Bundy Dr. and Westgate Ave.	Bundy Dr.	05/10/07	2:54 P.M.	25 Hrs	59
LT-9	Front yard of a multi-family residence on Exposition Blvd. between Dorchester Ave. and Centinela Ave.	Exposition Blvd.	05/16/07	3:26 P.M.	25 Hrs	60
LT-15	Front yard of a residence on Exposition Blvd. east of Stewart St.	I-10 Freeway, Exposition Blvd., Olympic Blvd.	06/26/08	2:39 P.M.	24 Hrs	58[e]

Table 3.12-1 Summary of Long-Term Measurement Results ~~(Residential Land Uses)~~

Site No. by Segment	Location	Primary Noise Source	Measurement Start		Duration	Meas. L_{dn} (dBA)
			Date	Time		
Segment 3: Olympic (LRT Alternatives 1 and 3)						
LT-10	Parking lot of Crossroads High School on Olympic Blvd. between 20th St. and 21st St.	Olympic Blvd.	05/23/07	~~10:17~~9:25 A.M.	24 Hrs	~~67~~71
Segment 3a: Colorado (LRT Alternatives 2 and 4)						
LT-11	Parking lot of Crossroads Elementary School on Olympic Blvd. between 17th St. and 18th St.	Olympic Blvd.	05/~~24~~23/07	~~9:25~~10:17 A.M.	24 Hrs	~~71~~67
LT-14	Front yard of property on Colorado Ave. between 5th St. and 6th St.	Colorado Ave.	12/05/07	2:46 P.M.	24 Hrs	68
LT17[d]	Crossroads Elementary School	18th St./ Parking Lot, Olympic Blvd.	05/20/09	8:00 A.M.	10 Hrs	57[f]
Green Line Maintenance Yard						
LT18.1[d]	Entrance to Green Line Yard	Green Line Train activity	6/17/09	8:25 P.M.	24 Hrs	64
LT18.2[d]	Southern Perimeter of Green Line Yard	Operations within the yard	6/17/09	7:39 P.M.	24 Hrs	60

SOURCE: ATS Consulting, 2008; updated 2009.

a. LT-1 changed due to round-off error.

b. A maximum 1 hour L_{eq} of 70 dBA was recorded at 10 a.m. and was 15 dBA above the next highest hourly 1 hour L_{eq}. When the data from 10 a.m. is excluded from the calculation, the L_{dn} is 56 dBA, which was used for the analysis.

c. The measured L_{dn} at Site LT-6 was substantially higher than at the other measurement sites in the same general area. The reason for the higher noise levels was due to an error in the data transfer, which caused reported sound levels to be 8- decibels higher than they should have been~~is unclear~~; therefore, the existing noise levels in the vicinity of LT-6 ~~have been~~were assumed to have an existing noise level of 60 dBA L_{dn} in the DEIR based on the results at nearby measurement sites. This approach ensures that noise impacts are not overlooked because of an anomalous noise measurement. An existing noise level of 59 dBA Ldn was assumed in the FEIR based updated measurement sites. Therefore, the correction in the FEIR did not result in any changes to the impact assessment.

d. Supplemental noise measurement.

e~~b~~. Measurement site LT-15 is also applicable to the residential area near the proposed Stewart Street site for the Maintenance Facility.

f. The daytime L_{eq} is the noise metric for institutional land uses.

Note that this table is no longer exclusively residential land use due to the inclusion of LT-16, LT-17, and LT-18.

Table 3.12-2 Summary of Short-Term Measurement Results ~~(Institutional Land Uses)~~

Site No. by Segment	Location	Primary Noise Source	Measurement Start[a]		Measured L_{eq} (dBA)
			Date	Time	
Segment 1: Expo ROW (LRT Alternatives 1 and 2)					
ST-2	Southeast corner of Exposition Blvd. and Westwood Blvd.	Westwood Blvd.	04/12/07	3:18 P.M.	67
ST-3	Northeast corner of Overland Ave. and Northvale Road	Overland Ave.	04/12/07	3:56 P.M.	67
Segment 1a: Venice/Sepulveda (LRT Alternatives 3 and 4)					
ST-4	Southeast corner of Sepulveda Blvd. and Palms Blvd.	Sepulveda Blvd.	04/12/07	12:53 P.M.	70
ST-5	Southwest corner of Venice Blvd. and Mentone Ave.	Venice Blvd.	04/12/07	11:22 ~~P~~A.M.	69
ST-6	Northeast corner of Venice Blvd. and Delmas Terrace	Venice Blvd.	04/12/07	10:32 ~~P~~A.M.	71
Segment 2: Sepulveda to Cloverfield (no short-term measurements performed in Segment 2 ~~as there are no noise sensitive institutional uses~~)					
Segment 3: Olympic (LRT Alternatives 1 and 3)					
ST-1	Southeast corner of 21st St. and Olympic Blvd.	Olympic Blvd.	04/12/07	2:06 P.M.	66
Segment 3a: Colorado ~~(no short-term measurements performed in Segment 3a as there are no noise sensitive institutional uses)~~					
ST-7a[b]	Groove Masters Recording Studio Exterior	Colorado Ave.	07/15/09	11:30 A.M.	71
ST-7b[b]	Groove Masters Recording Studio Interior	Mechanical equipment within the studio building	07/15/09	11:30 A.M.	24

SOURCE: ATS Consulting, 2008; updated 2009.
a. All short-term measurements were for a minimum of 30 minutes.
b. Supplemental noise measurement.
Note that this table is no longer exclusively Institutional land uses due to the inclusion of ST-7a and ST-7b.

Supplementary Measurements

In response to comments on the DEIR and additional consultations, measurements and analysis were performed at the following locations:

- Overland Elementary School at the northeast corner of Overland Avenue and Northvale Road in Los Angeles

- Crossroads Elementary School on 17th Street between Olympic Boulevard and Colorado Boulevard in Santa Monica
- 18th Street Arts Center on 18th Street between Olympic Boulevard and Colorado Boulevard in Santa Monica, which includes residential apartments
- Groove Master recording studio at the northeast corner of 14th Street and Colorado Boulevard in Santa Monica
- Lantana Campus on Olympic Boulevard between Stewart Street and Centinela Avenue. The Lantana Campus has a number of tenants involved in different aspects of media production that are sensitive to both noise and vibration
- Metro Green Line maintenance yard at 33rd Street and Aviation Boulevard in El Segundo

Measurements taken at these sites are supplemental to previous measurements for the DEIR. For example, measurements taken at Overland Elementary School and Crossroads Elementary School for the FEIR where substantially more detailed than measurements taken previously as part of the DEIR. Further, the results of the Metro Green Line maintenance yard are supplemental to the earlier measurements taken on the Metro Gold Line maintenance yard to confirm and validate the original measurements and analysis. The overall noise monitoring results are summarized in Table 3.12-1 (Summary of Long-Term Measurement Results) and Table 3.12-2 (Summary of Short-Term Measurement Results). More information can be found in the *Noise and Vibration Technical Background Report*.

Existing Vibration

Existing vibration sources in the proposed project alignments primarily consist of vehicular traffic and intermittent construction activities. Vehicular traffic was the only permanent vibration source observed in the proposed project alignments. When vehicular traffic does cause perceptible vibration, the source can usually be traced to potholes, wide expansion joints, or other “bumps” in the roadway surface. Therefore, the FTA assessment procedures for vibration from rail transit projects do not require measurements of existing vibration levels.

Localized geologic conditions such as soil stiffness, soil layering, and depth to bedrock, have a strong impact on groundborne vibration. Unfortunately, it is difficult to obtain information on subsurface conditions in sufficient detail that computer models can be used to accurately predict groundborne vibration. As a result, most detailed predictions of groundborne vibration are largely based on empirical methods that involve measuring vibration propagation in the soil. The FTA defines three levels of vibration assessment (FTA 2006):

1. Screening: Generalized distances of potential impacts are used to quickly determine whether there is any potential for an impact.
2. General Assessment: The FTA provides a general curve of vibration level vs. distance that is used to estimate the vibration levels. The curve was developed by plotting measured vibration levels from a number of different rail transit systems against distance from the tracks and drawing a line through the top range of the data. The curve is intended to give a conservative (high) estimate of potential vibration impacts. Adjustments are made to the general curve to account for factors such as speed and special trackwork.
3. Detailed Assessment: The FTA recommends use of an impact test for measuring how vibration is transmitted from the light-rail tracks through the ground and then predicting

rail generated groundborne vibration (FTA 2006). The procedure basically consists of dropping a weight onto the ground and measuring the vibration waves that are created at several distances from the impact.

The vibration predictions for the Expo Phase 2 project follow the FTA Detailed Assessment approach for testing of vibration conditions in the project corridor. The assessment for the DEIR consisted of measuring vibration propagation at ten sites (refer to Figure 3.12-8 [Vibration Propagation Test Sites] [Revised]) using an impact vibration source and accelerometers. Accelerometers are vibration measurement devices. The DEIR measurements were supplemented with measurements at the Overland Elementary School, 18th Street Arts Center, Groove Masters Studio, and Lantana Campus. More detail on the vibration conditions testing procedures is contained in the *Noise and Vibration Technical Background Report*.

3.12.3 Regulatory Setting

This section summarizes the standards and regulations concerning noise and vibration limits that are applicable to this project. There are no state statutes that would apply to the proposed project; therefore, federal criteria are used.

FTA Noise Criteria

Federal noise impact criteria are defined in the FTA Guidance Manual (FTA 2006). The FTA criteria are based on the best available research on community response to noise. This research shows that characterizing the overall noise environment using measures of noise “exposure” provides the best correlation with human annoyance. Table 3.12-3 (FTA Land Use Categories and Noise Metrics) lists the three land-use categories that FTA uses and the applicable noise metric for each category.

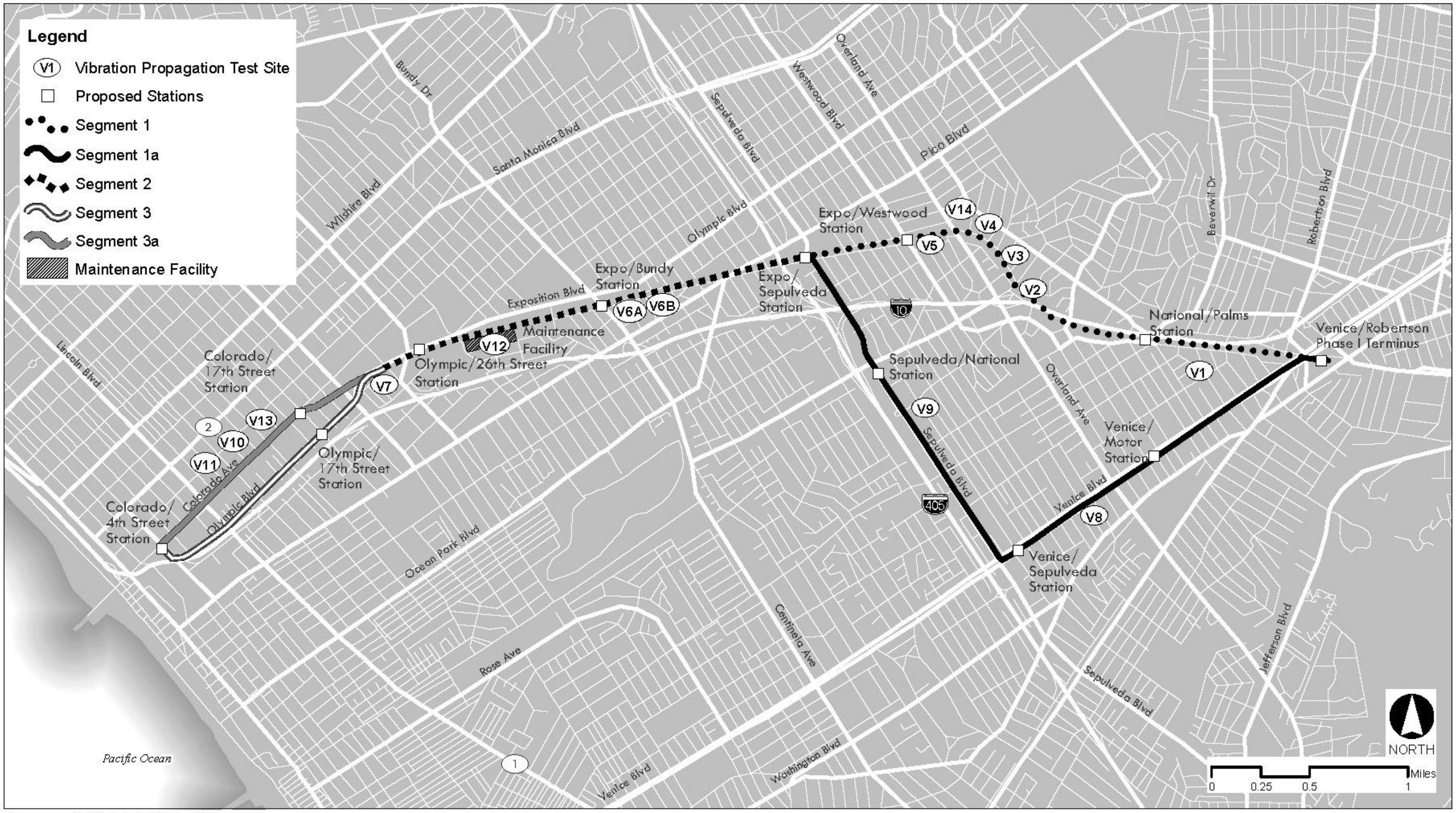
Table 3.12-3 FTA Land Use Categories and Noise Metrics

Land Use Category	Noise Metric (dBA)	Description of Land Use Category
1	Outdoor $L_{eq(h)}$[a]	Tracts of land where quiet are an essential element of their intended purpose. This category includes lands set aside for serenity and quiet, and such land uses as outdoor amphitheaters and concert pavilions, as well as National Historic Landmarks with significant outdoor use. Also included are recording studios and concert halls.
2	Outdoor L_{dn}	Residences and buildings where people normally sleep. This category includes homes, hospitals, and hotels where a nighttime sensitivity to noise is assumed to be of utmost importance.
3	Outdoor $L_{eq(h)}$[a]	Institutional land uses with primarily daytime and evening use. This category includes schools, libraries, and churches where it is important to avoid interference with such activities as speech, meditation, and concentration on reading material. Places for meditation or study associated with cemeteries, monuments, museums, campgrounds and recreational facilities can also be considered to be in this category. Certain historical sites and parks are also included.

SOURCE: FTA 2006.

L_{dn} is used for land uses where nighttime sensitivity is a factor; L_{eq} is used for land use involving only daytime activities.

a. $L_{eq(h)}$ is the L_{eq} for the noisiest hour of transit-related activity during hours of noise sensitivity.



Source: PBS&J, ESRI, 2008.

Figure 3.12-8 Vibration Propagation Test Sites [Revised]

For Category 2 land uses, noise exposure is measured using L_{dn}, while for Category 1 and Category 3 land uses, noise exposure is measured using L_{eq}. The basic concept of the FTA noise impact criteria is that more project noise is allowed in areas where existing noise is higher, but that the decibel increase in total noise exposure (the decibel sum of existing noise and project noise) decreases. ~~The Category 1 thresholds are not applicable because no Category 1 land uses were identified in the project corridor.~~

The FTA defines two levels of noise impact: moderate and severe. In accordance with the FTA Guidance Manual, noise mitigation to eliminate the impacts must be investigated for both degrees of effect. The Manual also states that for severe impacts "… there is a presumption by the FTA that mitigation will be incorporated in the project unless there are truly extenuating circumstances which prevent it." In considering mitigation for severe impacts in this study, the goal has been to reduce noise levels to below the moderate impact threshold. The FTA allows more discretion for mitigation of moderate impacts, based on consideration of factors that include cost, number of sensitive receptors affected, community views, the amount that the predicted levels exceed the impact threshold, and the sensitivity of the affected receptors.

The FTA noise impact criteria are given in tabular format in Table 3.12-4 (FTA Noise Impact Criteria in Tabular Form) with the thresholds rounded off to the nearest decibel. To use this table, first go to the existing noise exposure in column 1, and then read off the applicable impact threshold in the columns to the right. For example, consider a Category 3 land use, such as a school, where the existing daytime L_{eq} is 60 dBA. Go to the row for an existing noise exposure of 60 dBA, and then read off the impact thresholds in columns under Category 3 Sites. The impact threshold for moderate impact is 63 dBA and for severe impact is 68 dBA.

Table 3.12-4 FTA Noise Impact Criteria in Tabular Form

Existing Noise Exposure L_{eq} or L_{dn}	~~Project Noise Exposure~~ Impact Thresholds for Project Noise, L_{dn} or L_{eq} (dBA)			
	Category 1 or Category 2 Sites		Category 3 Sites	
	Moderate Impact	Severe Impact	Moderate Impact	Severe Impact
<43	Amb.+10	Amb.+15	Amb.+15	Amb.+20
43	52	58	57	63
44	52	58	57	63
45	52	58	57	63
46	53	59	58	64
47	53	59	58	64
48	53	59	58	64
49	54	59	59	64
50	54	59	59	64
51	54	60	59	65
52	55	60	60	65
53	54	60	60	65
54	55	61	60	66
55	56	61	61	66

Table 3.12-4 FTA Noise Impact Criteria in Tabular Form

Existing Noise Exposure L_{eq} or L_{dn}	~~Project Noise Exposure~~ Impact Thresholds for Project Noise, L_{dn} or L_{eq} (dBA)			
	Category 1 or Category 2 Sites		Category 3 Sites	
	Moderate Impact	Severe Impact	Moderate Impact	Severe Impact
56	56	62	61	67
57	57	62	62	67
58	57	62	62	67
59	58	63	63	68
60	58	63	63	68
61	59	64	64	69
62	59	64	64	69
63	60	65	65	70
64	61	65	66	70
65	61	66	66	71
66	62	67	67	72
67	63	67	68	72
68	63	68	68	73
69	64	69	69	74
70	65	69	70	74
71	65	70	71	75
72	66	71	71	76
73	66	71	71	76
74	66	72	71	77
75	66	73	71	78
76	66	74	71	79
77	66	74	71	79
>77	66	75	71	80

SOURCE: Federal Transit Administration, May 2006. For an explanation of these criteria, refer to Chapter 3 of Transit Noise and Vibration Assessment, Federal Transit Administration, at www.fta.dot.gov/documents/FTA_Noise_and_Vibration_Manual.pdf

L_{dn} is used for land uses where nighttime sensitivity is a factor; maximum 1-hour L_{eq} is used for land use involving only daytime activities.

FTA Vibration Criteria

The FTA vibration impact criteria are based on the maximum indoor vibration level as a train passes. There are no impact criteria for outdoor spaces such as parks. The FTA Guidance Manual (FTA 2006) provides two sets of criteria: one based on the overall vibration velocity level for use in General Vibration Impact Assessments and one based on the maximum vibration level in any ⅓-octave band for use with a Detailed Vibration Assessment, which was used for this project.

Table 3.12-5 (FTA Impact Thresholds for Groundborne Vibration, General Impact Assessment) shows the FTA General Assessment criteria for groundborne vibration from rail transit systems. For residential buildings (Category 2), the threshold applicable to this project is 72 VdB. The applicable threshold for institutional land use areas (Category 3) is 75 VdB. ~~The Category 1 thresholds are not applicable because no Category 1 land uses were identified in the project corridor.~~

Table 3.12-5 FTA Impact Thresholds for Groundborne Vibration, General Impact Assessment

Land Use Category[71]	Groundborne Vibration (VdB re 1 micro inch/sec)		
	Frequent Events[a]	Occasional Events[b]	Infrequent Events[c]
Category 1. Buildings where vibration would interfere with interior operations.	65 VdB	65 VdB	65 VdB
Category 2. Residences and buildings where people normally sleep.	72 VdB	75 VdB	80 VdB
Category 3. Institutional land uses with primarily daytime use.	75 VdB	78 VdB	83 VdB

SOURCE: FTA 2006

a. Frequent events are defined as more than 70 vibration events per day.

b. Occasional events are defined as between 30 and 70 events per day.

c. Infrequent events are defined as less than 30 events per day.

The FTA vibration thresholds do not specifically account for existing vibration. Although Venice, Sepulveda, Overland, Olympic and other arterials in the study area have substantial volumes of vehicular traffic including trucks and buses, rubber-tired vehicles rarely generate perceptible ground vibration unless there are irregularities in the roadway surface, such as potholes or wide expansion joints. As such, it is expected that there are few if any locations along the proposed Expo Phase 2 alignments where traffic-generated groundborne vibration is perceptible.

The refined criteria for use with Detailed Vibration Assessments are illustrated and further explained in the *Noise and Vibration Technical Background Report*.

3.12.4 Analytic Methodology

Data used to prepare this section were taken from various sources, including the *Transit Noise and Vibration Impact Assessment Guidelines* (FTA 2006), *FHWA Roadway Construction Noise Model User's Guide* (USDOT 2006), noise and vibration studies prepared for other LRT projects, and previous environmental studies prepared for the proposed project. Noise and vibration standards used in this section are from the Federal Transit Administration (FTA). Existing noise measurements were performed at twenty-one locations, while vibration

[71] Note that the FTA land use categories for vibration impacts are different than the land use categories for noise impacts. The primary difference applicable to this project is that noise Category 3 includes outdoor land uses, such as parks, and vibration Category 3 applies exclusively to indoor land uses. This is because vibration is an issue only for building occupants. Train vibration is rarely intrusive to observers who are outdoors.

measurements were taken at ten locations along the proposed alignment from April 12 through December 6, 2007.

Supplemental measurements were taken at five locations along the proposed alignment from May 20 through November 15, 2009. Refer to Table 3.12-1 (Summary of Long-Term Measurement Results), Table 3.12-2 (Summary of Short-Term Measurement Results), and the *Noise and Vibration Technical Background Report* for details on these measurements.

Noise Prediction Models

Different models are used to predict noise from light-rail vehicle operation, audible warnings at at-grade crossings, wheel squeal, ancillary equipment, and maintenance facilities. Each of these models is explained in detail in the *Noise and Vibration Technical Background Report*.

As is the case with all models, there is uncertainty in the noise predictions, and operational noise levels could be higher or lower than the predictions. To ensure greater accuracy with the noise modeling and results, the noise prediction models utilized the best available information on the different noise sources associated with light rail transit systems. Further, noise measurements have been performed of the existing Metro light rail system to validate and calibrate the model to reflect the most current information.

Vibration Prediction Models

The predictions of groundborne vibration for this study follow the Detailed Vibration Assessment procedure of the FTA Guidance Manual (FTA 2006). This is an entirely empirical method based on testing of the vibration propagation characteristics of the soil in the project corridor and measurements of the vibration characteristics of a light-rail vehicle similar to what would be used on the proposed project. As discussed in Section 3.12.2 (Existing Conditions), vibration propagation tests were performed at ~~ten~~fourteen locations along the proposed alignments for the Expo Phase 2 project. More detail on the analysis methodology utilized for the detailed assessment of operational vibration is provided in the *Noise and Vibration Technical Background Report*.

The vibration prediction models also include uncertainties relative to the vibration forces generated by the light rail vehicle/track system, how the local geologic conditions affect vibration propagation, and how building structures interact with ground vibration. As an example, it is possible that factors such as a particularly flexible floor in one building will occasionally result in vibration levels that exceed the predicted vibration levels. The vibration prediction models are designed to be conservative so that calculations tend to overestimate vibration impacts.

3.12.5 Criteria, Impact Evaluation, and Mitigation Measures

The noise and vibration impacts analyzed included operation noise levels, permanent and temporary noise levels and operation vibration levels. Construction noise and vibration impacts are reported in Chapter 4 (Construction Impacts).

Criterion	Would the project expose the public to, or generate, noise levels in excess of the Federal Transit Administration (FTA) noise impact criteria?

No-Build Alternative

There would be roadway and transit service improvements associated with the No-Build Alternative. However, the only improvement that would change the physical environment in the Expo Phase 2 ROW would be the I-405 Widening project. Mitigation of the noise impacts of increased traffic on I-405 within the Expo Phase 2 ROW are included in that project. There may be some noise increases as a result of the implementation of the various bus programs, but the increases would be minimal relative to existing and future traffic volumes. There would be no operational vibration associated with the No-Build Alternative. Noise impacts associated with the No-Build Alternative would be ***less than significant***.

Transportation Systems Management (TSM) Alternative

The TSM Alternative would include all of the improvements under the No-Build Alternative and new on-street bus services to directly serve the Expo Phase 2 community transit needs. Those additional improvements would include minor physical modifications such as upgraded bus stops and additional buses. The TSM Alternative would result in incremental changes in community noise levels. There would be no operational vibration associated with the TSM Alternative. Noise impacts associated with the TSM Alternative would be ***less than significant***.

LRT Alternatives

Light-Rail Vehicle Operation Impacts

The noise sensitive land uses for FTA Categories 1, 2, and 3 along the Expo Phase 2 LRT Alternatives have been grouped into clusters. The LRT tracks would be approximately the same distance from the sensitive buildings in each cluster and the clusters are small enough that train speeds and other operational parameters are the same for all land uses in the cluster. The *Noise and Vibration Technical Background Report* includes an appendix that shows the locations and buildings included in each cluster. The clusters typically include only the first row of residences. If impact is found for the first row of residences, the mitigation for the first row usually will benefit residences in the second row as well.

Noise predictions were developed for each cluster. The clusters where predicted noise levels exceed the FTA impact thresholds for moderate or severe impact for FTA Category 1 land uses (studios) are shown in Table 3.12-6 (Summary of Clusters with Noise Impacts for Studios, Category 1 Land Uses). The clusters where predicted noise levels exceed the FTA impact thresholds for moderate or severe impact for FTA Category 2 land uses (residential, hotels, and hospitals) are shown in Table 3.12-7 (Summary of Clusters with Noise Impacts ~~Assessment,~~ for Residential, Category 2 Land Uses) and for FTA Category 3 land uses (schools, churches, and other institutions) are shown in Table 3.12-8 (Summary of Clusters with Noise ~~Impact Assessment~~Impacts for Institutional, Category 3 Land Uses). The columns in the tables provide the following information:

- Civil Station: Defines the locations of the clusters. The civil stations can be found on the Plan and Profile drawings in Appendix E of this ~~D~~FEIR
- Desc: Description of the land use
- Cluster: Cluster number

- Near Track Dist: Distance in feet from the near track to the closest noise sensitive building in the cluster
- Train Speed: Maximum expected train speed on the track closest to the cluster
- Existing: Existing noise level at cluster based on the noise survey results summarized in Table 3.12-1 (Summary of Long-Term Measurement Results (Residential Land Uses)]) or Table 3.12-2 (Summary of Short-Term Measurement Results)
- Project: Predicted future L_{dn} from train noise
- Impact Threshold: The FTA impact thresholds for Moderate (Mod) and Severe impact
- Number of Impacts: The dwelling units where the predicted levels of LRT noise exceed the Moderate (Mod) and Severe impact thresholds

The predicted noise levels for all of the clusters are included in the *Noise and Vibration Technical Background Report*. Table 3.12-6 (Summary of Clusters with Noise Impacts for Studios, Category 1 Land Uses), Table 3.12-76 (Summary of Clusters with Noise Impacts for Residential, Category 2 Land Uses), and Table 3.12-87 (Summary of Clusters with Noise Impacts for Institutional, Category 3 Land Uses) only show the clusters where noise impact is predicted. As an example on how to interpret the tables, within Table 3.12-7 (Summary of Clusters with Noise Impacts for Residential, Category 2 Land Uses), consider Cluster 11, which is the first row under "Segment 1: Expo ROW (LRT Alternatives 1 and 2)." The existing L_{dn} is 698 dBA and the noise from the project is predicted to be L_{dn} 67 dBA. The FTA impact thresholds are L_{dn} 63 dBA for Moderate impact and L_{dn} 68 dBA for Severe impact. Therefore, because the project noise level is predicted to be more than the moderate impact threshold, moderate impact is predicted at the six residences encompassed by Cluster 11, but no severe impacts are predicted, as the project noise level is predicted to be less than the severe impact threshold. Bringing the predicted noise levels to below the FTA moderate impact threshold will require reducing train noise by at least 4 dBA, the difference between the project noise level and the impact threshold.

Lantana Campus Noise Impact

The land uses at the Lantana Campus that are considered noise sensitive include recording studios at Todd-AO and Gray Martin Studios, screening rooms in several of the Lantana buildings, and spaces that are used for audio/visual editing. Following FTA guidance, the studio spaces are considered a vibration Category 1 land use and the predictions for these Lantana spaces are included in Table 3.12-6 (Summary of Clusters with Noise Impacts for Studios, Category 1 Land Uses). The screening rooms and spaces used for audio/visual editing are considered Category 3 land uses and the predictions are included in Table 3.12-8 (Summary of Clusters with Noise Impacts Assessment for Institutional, Category 3 Land Uses). As indicated in the tables, the predicted noise levels at the building façades exceed the FTA impact thresholds and moderate to severe noise impact is predicted.

Table 3.12-6 Summary of Clusters with Noise Impacts for Studios, Category 1 Land Uses

Civil Station[a]	Desc[b]	Cluster	Near Track Dist (ft)	Train[c] Speed (mph)	L_{eq} (dBA)[d]				Impact
					Existing	Project	Impact Threshold		
							Mod	Severe	
Segment 2: Sepulveda to Cloverfield (All LRT Alternatives)									
743+00	Lantana Todd-AO[e]	Lan2	50	55	57	67	56	62	Severe[e, f]
743+00	Lantana Gray Martin[e]	Lan3	50	55	57	67	56	62	Severe[e]
Segment 3a: Colorado (LRT Alternatives 2 and 4)									
807+50	Groove Master Studio	2	40	35	75	67	65	73	Moderate[f]

SOURCE: ATS Consulting, 2009.
a. Civil Station refers to the locating system used on conceptual engineering drawings (Appendix E).
b. Desc. = Type of land use
c. Assumes operation of 2- and 3-car trains.
d. Maximum 1-hour L_{eq} during period of day when facility is in use.
e. Refer to the separate discussion below regarding noise impact at the Lantana Campus.
f. The impact identified is for outdoor noise levels, but tests concluded that indoor noise will not be affected by light rail operations so no noise mitigation is required to address the impact.

Noise reduction measurements were performed at Lantana Center, Todd-AO, Gray Martin, and IMAX to determine how effective the building exterior walls and windows are at reducing the outdoor noise that is transmitted into the noise sensitive spaces. In all cases the loud speakers used for the noise reduction test generated noise levels that exceeded the predicted sound levels that will be generated by light rail operations. Therefore, it can be concluded that if the noise source was not audible inside a test space, then the noise from light rail operations also will not be audible and that there will not be any noise impacts. The test spaces where the noise source was inaudible were:

- All of the stages of Todd-AO
- All of the studios at Gray Martin except studios C and D and the vocal booth for studios C and D
- The IMAX screening room

Although noise mitigation is not needed for these spaces because of the effective sound insulation provided by the building structure, the conclusion from the supplemental noise testing at the Lantana Campus is that noise mitigation is required for noise sensitive facilities within Lantana West and Lantana Center. The predicted noise impacts at these buildings can be eliminated with a sound wall or berm that is 6 to 8 ft above the top of rail.

Kilroy Realty has seven buildings north of the Expo ROW that are east and west of Bundy Drive. Based on supplementary analysis conducted in response to comments on the DEIR, there may be noise impacts at one or more spaces within the Kilroy Realty properties that house filming and recording studios. Of the seven Kilroy Realty properties, the building at 12312 Olympic Boulevard, which houses three filming/recording studios, has the highest potential for noise impact. The potential for noise impacts to the sensitive uses at Kilroy Realty properties will be evaluated during final design. If impacts are identified over FTA thresholds, noise mitigation such as a sound wall will be implemented.

Table 3.12-7~~6~~ Summary of Clusters with Noise Impacts for ~~Assessment,~~ Residential, Category 2 Land Uses

Civil Station[a]	Desc[b]	Cluster	Near Track Dist (ft)	Train[c] Speed (mph)	L$_{dn}$ (dBA) Existing	Project	Impact Threshold Mod	Impact Threshold Severe	Number of Impacts[d ~~c~~] Mod[e]	Severe[~~d~~ e]
Segment 1: Expo ROW (LRT Alternatives 1 and 2)										
553+50	MFR	11	80	45	68	67	63	68	6	—
606+50	SFR	37	70	35	56	58	~~56~~57	~~61~~63	3	—
609+00	SFR	38	~~75~~70	35	56	57	~~56~~57	~~61~~63	3	—
613+00	SFR	39	115	35	58	58	57	63	5	—
614+00	SFR	25	115	35	58	58	57	63	4	—
617+00	SFR	26	115	35	58	58	57	63	6	—
617+00	SFR	40	115	35	58	58	57	63	7	—
626+50	SFR	43	115	35	58	~~58~~64	57	63	~~3~~—	~~—~~3
627+50	SFR	29	115	35	58	58	57	63	4	—
629+00	SFR	44	115	35	58	58	57	63	1	—
630+50	SFR	45	115	50	58	61	57	63	1	—
631+00	SFR	30	115	40	58	~~59~~65	57	63	~~5~~—	~~—~~5
633+00	SFR	46	115	55	58	61	57	63	6	—
634+00	SFR	31	115	50	59	61	57	63	6	—
636+50	SFR	47	115	55	59	61	57	63	6	—
637+00	SFR	32	115	55	59	~~61~~67	57	63	~~4~~—	~~—~~4
639+00	SFR	33	115	55	59	~~67~~61	57	63	~~0~~6	~~6~~—
640+00	SFR	48	115	55	59	67	57	63	~~0~~—	6
641+50	SFR	34	115	55	59	61	57	63	2	—
643+50	SFR	49	115	55	59	61	57	63	6	—
								Subtotal	*84*	*18*
Segment 1: Sepulveda At-Grade Option: (LRT Alternatives 1 and 2)										
646+50	SFR	50	115	50	59	61	57	63	6	—
648+00	SFR	51	115	40	59	59	57	63	5	—
650+00	SFR	52	115	30	59	67	57	63	~~1~~—	1
								Subtotal	*~~102~~11*	*~~13~~1*

Table 3.12-7~~6~~ Summary of Clusters with Noise Impacts for ~~Assessment,~~ Residential, Category 2 Land Uses

Civil Station[a]	Desc[b]	Cluster	Near Track Dist (ft)	Train[c] Speed (mph)	L$_{dn}$ (dBA) Existing	Project	Impact Threshold Mod	Severe	Number of Impacts[~~d~~e] Mod[e]	Severe[~~d~~ e]
Segment 1: Sepulveda Grade Separation Design Option: (LRT Alternatives 1 and 2)										
646+50	SFR	50	115	50	59	63	57	63	—	6
648+00	SFR	51	115	40	59	59	57	63	5	—
650+00	SFR	52	115	30	59	67	57	63	—	1
								Subtotal	*5*	*7*
Segment 1a: Venice/Sepulveda (LRT Alternatives 3 and 4)										
521+00	MFR	54	211	35	59	58	57	63	6	—
524+00	MFR	55	211	35	59	58	57	63	16	—
584+00	SFR	67	160	35	61	59	58	64	5	—
588+00	MFR	68	156	35	61	59	59	64	4	—
592+00	SFR	69	162	35	61	59	59	64	4	—
620+00	MFR	95	171	35	56	59	56	61	6	—
644+00	MFR	77	68	35	70	69	65	70	10	—
644+00	MFR	92	49	35	71	70	65	70	10	—
653+00	MFR	79	70	35	70	68	65	70	10	—
653+00	MFR	90	47	35	71	70	65	70	20	—
674+00	MFR	87	105	25	58	58	57	63	12	—
688+00	SFR	83	180	35	55	59	55	61	22	—
698+00	SFR	84	80	35	60	62	58	64	1	—
								Subtotal	*126*	*0*
Segment 2: Sepulveda to Cloverfield (All LRT Alternatives)[f]										
665+00	MFR	98	110	55	63	65	60	65	10	—
667+00	MFR	98a	110	55	63	65	60	65	10	—
669+00	MFR	99	115	55	63	65	60	65	12	—
680+00	MFR	99a	34	35	63	66	60	65	—	10
688+00	MFR	100	~~105~~90	55	59	~~62~~63	57	63	4	—
692+00	SFR	101	~~115~~100	55	59	~~61~~62	57	63	6	—
695+00	SFR	102	~~120~~105	55	59	~~61~~62	57	63	8	—
700+00	SFR	103	115	50	59	64	57	63	~~0~~—	8
704+00	SFR	104	110	45	59	63	57	63	6	—
707+00	SFR	105	110	35	59	60	57	63	6	—
710+50	MFR	106	110	25	59	58	57	63	4	—

Table 3.12-76 Summary of Clusters with Noise Impacts for Assessment, Residential, Category 2 Land Uses

Civil Station[a]	Desc[b]	Cluster	Near Track Dist (ft)	Train[c] Speed (mph)	L_{dn} (dBA) Existing	Project	Impact Threshold Mod	Severe	Number of Impacts[de] Mod[e]	Severe[de]
713+50	MFR	107	110	45	59	63	57	63	4	—
								Subtotal	*6070*	*818*
Segment 3: Olympic (LRT Alternatives 1 & 3)										
No noise impacts predicted for Segment 3										
Segment 3a: Colorado (LRT Alternatives 2 and 4)										
7770+00	MFR	114	20	55	71	71	65	70	0—	28
791+00	MFR	114d	75	35	57	59	56	62	3	—

SOURCE: ATS Consulting, 2008; updated 2009.

a. Civil Station refers to the locating system used on conceptual engineering drawings (Appendix E).

b. Desc. = Type of land use, SFR = single-family residence, MFR = multi-family residence.

c. Assumes operation of 2- and 3-car trains.

d. Number of impacts. This is a count of the number of single-family residences in the cluster plus the estimated number of residential units in multi-family buildings.

de. Mod = moderate impact, Severe = severe impact.

f. Includes grade separation for Centinela Avenue.

Note: A number of updates were made to the table because of updates to the project design.

Segment 1: Expo ROW (LRT Alternatives 1 and 2)

According to the FTA standards, 1089 single-family residences, 6 multi-family residences, 12 schools, and 1 building that is used by the Boy Scouts of America are predicted to be affected by noise generated by the proposed project within this segment. Severe impact is predicted at 193 single-family residences and the building used by the Boy Scouts.

Robertson to I-10 Freeway: Predicted noise levels at 6 multi-family residences, 1 building that houses the Boy Scouts of America, and the Lycée Françias School that is currently under construction exceed the noise impact threshold. All the predicted moderate impacts at multi-family residences are located on the south side of Exposition Boulevard. A severe impact is predicted at the Boy Scouts building on Exposition Boulevard between Clarington Avenue and Jasmine Avenue. The predicted severe impact at this location is due primarily to the close proximity of a crossover track to the Boy Scouts building. Moving the crossover farther from the Boy Scouts Building would reduce the impact from severe to moderate.

Table 3.12-87 Summary of Clusters with Noise Impacts Assessment for Institutional, Category 3 Land Uses

Civil Station[a]	Desc[b]	Cluster	Near Track Dist (ft)	Train[c] Speed (mph)	L_{eq} (dBA)[cd]				Impact
					Existing	Project	Impact Threshold Mod	Impact Threshold Severe	
Segment 1: Expo ROW (LRT Alternatives 1 and 2)									
555+00	Boy Scouts Building	2	25	50	66	74	67	72	Severe
564+00	Lycée Françias School	3	35	50	66	67	67	72	Moderate
610+00	Overland School	5	85	40	64	62	65	70	Moderate
Segment 2: Sepulveda to Cloverfield (All LRT Alternatives)									
746+00	Lantana West[e]	Lan1	80	55	57	65	61	67	Moderate[e]
740+00	Lantana Center[e]	Lan4	50	55	57	67	61	67	Severe[e]
732+00	IMAX[e]	Lan5	90	55	57	71	61	67	Severe[e]
Segment 3a: Colorado (LRT Alternatives 2 and 4)									
794+00	Crossroads Elementary School	17	100	35	57	62	61	67	Moderate

SOURCE: ATS Consulting, 2008; updated 2009.
a. Civil Station refers to the locating system used on conceptual engineering drawings (Appendix E).
b. Desc. = Type of land use
c. Assumes operation of 2- and 3-car trains.
d. Maximum 1-hour L_{eq} during period of day when facility is in use.
e. Refer to the separate discussion above regarding noise impact at the Lantana Campus.

I-10 Freeway to Overland Avenue: Moderate noise impact is predicted at 18 single-family residences on the southern side of the LRT Alternatives and at the Overland Avenue Elementary School.. The Expo ROW is in a trench for a distance of approximately 2,000 ft. after it passes under the I-10 Freeway. The trench would effectively shield adjacent properties by forming an acoustical barrier. However, after the terrain levels out, there is no longer an acoustic buffer between the residences and the LRT Alternatives. All of the predicted impacts are beyond the point where the trench levels out. Based on the site-specific analysis conducted in the FEIR with the supplemental measurements, the LRT Alternatives would not result in significant noise impacts to Overland Avenue Elementary School.

Overland Avenue to Sepulveda Boulevard: Noise impact is predicted at 90 single-family residences. The only portion of the segment where predicted noise levels are below the impact threshold is near the Expo/Westwood Station. The reason for this is that the train would enter and exit the station at low speeds, and thus, associated noise levels would be lower. Severe noise impact is predicted at 182 single-family residences adjacent to Segment 1 (Expo ROW) between Military Avenue and Veteran Avenue as a result of the residences' proximity to a crossover. Another severe noise impact is predicted for a single-family residence located in the southeast quadrant of Sepulveda Boulevard and Exposition Boulevard. This impact would be caused by the proposed partial removal of a building that currently acts as an acoustical shield between the receiver and vehicular traffic noise on Sepulveda Boulevard. The levels of traffic noise would increase at receptors currently shielded by the building after the building is removed.

Segment 1a: Venice/Sepulveda (LRT Alternatives 3 and 4)

Moderate noise impacts are predicted for 32 single-family residences and 94 multi-family residences. No severe impacts are predicted along Segment 1a.

Venice Boulevard: Noise impact is predicted at 9 single-family residences and 26 multi-family residences. All the predicted impacts in this area would be caused by the proposed removal of buildings that currently act as acoustical shields and the exposure of second-row properties to vehicular traffic on Venice Boulevard. If redevelopment were to take place between Venice Boulevard and the predicted impact sites, the new buildings would likely provide sufficient acoustic shielding to eliminate the predicted noise impact.

Sepulveda Boulevard: Noise impact is predicted at 23 single-family residences and 68 multi-family residences. Fifty of the predicted impacts would be due to the proximity of a crossover track to multi-family housing on both the east and west side of Sepulveda Boulevard just north of the Sepulveda Channel. All the remaining predicted impacts in this area would result from proposed removal of buildings that currently act as acoustical shields and the exposure of second-row properties to vehicular traffic on Sepulveda Boulevard. If redevelopment were to take place between Sepulveda Boulevard and the impact sites, the new buildings would likely provide sufficient acoustic shielding to eliminate the predicted noise impact.

Segment 2: Sepulveda to Cloverfield (All LRT Alternatives)

Noise impact is predicted for 34 single-family residences~~ and 34~~, 54 multi-family residences, and the Lantana Campus. Of these impacts, 19~~eight~~ are predicted to be severe impacts. Proximity to the track, a relatively high-speed profile, and low ambient noise levels in the area are the primary reasons for predicted impact in this area. In addition, the noise levels would be approximately 3 dB higher where the tracks would be on aerial structures for the Bundy,~~ and~~ Pico, and Centinela grade separations~~ overpasses~~. The addition of a grade separation at Centinela Avenue did not change the results of the noise impact assessment.

Segment 3: Olympic (LRT Alternatives 1 and 3)

There is no predicted noise impact for Segment 3 (Olympic).

Segment 3a: Colorado (LRT Alternatives 2 and 4)

~~Moderate n~~Noise impact is predicted for 31~~28~~ multi-family residences~~. All of the~~, and 1 school. Note that because the 18th Street Arts Studio is a residence, it has been categorized as a multi-family residence. The Groove Masters recording studio does show moderate impact outdoors, but tests show that noise from light rail operations will be at or below existing ambient noise levels indoors, so there will not be any noise impacts for the studio. The predicted residential impacts are at an eight-story multi-family residential building located on the north side of the Expo ROW near 22nd Street and Colorado Boulevard the 18th Street Arts Studio.~~ No severe noise impact is predicted along Segment 3a.~~

Impact Summary by Alternative

Table 3.12-9~~8~~ (Summary of Operational Noise Impacts by Alternative Prior to Mitigation) provides a summary of the anticipated number of receptors impacted by operational noise for each alternative.

Table 3.12-9~~8~~ Summary of Operational Noise Impacts by Alternative Prior to Mitigation

Alternative	Moderate Impact	Severe Impact
No-Build	0	0
TSM	0	0
LRT 1: Expo ROW–Olympic Alternative	~~162~~166	~~21~~39
LRT 2: Expo ROW–Colorado Alternative	~~162~~171	~~49~~67
LRT 3: Venice/Sepulveda–Olympic Alternative	~~186~~196	~~8~~19
LRT 4: Venice Sepulveda–Colorado Alternative	~~186~~201	~~36~~47

SOURCE: ATS Consulting, 2008; updated 2009.

FEIR Design Options

Further analysis was performed to identify the potential noise impacts associated with the Sepulveda Grade Separation Design Option. As shown in Table 3.12-7 (Summary of Clusters with Noise Impacts for Residential, Category 2 Land Uses), the only significant change to noise impacts caused by the proposed grade separation design option at Sepulveda Boulevard is an increase in future noise levels of up to 2 dBA at Clusters 50 and 51 (adjacent to the Sepulveda Boulevard grade separation). Although this is a relatively small change in overall noise levels, the predicted increase is sufficient to change the noise impact at Cluster 50 (six single-family residences) from moderate to severe.

Operational Mitigation Measures

Mitigation measure MM NOI-1 is applicable to the locations in Table 3.12-6 (Summary of Clusters with Noise Impacts for Studios, Category 1 Land Uses), Table 3.12-7~~6~~ (Summary of Clusters with Noise Impacts for ~~Assessment,~~ Residential, Category 2 Land Uses), and Table 3.12-8~~7~~ (Summary of Clusters with Noise Impacts ~~Assessment~~ for Institutional, Category 3 Land Uses), where the predicted noise levels exceed the applicable moderate or severe impact threshold. The specific locations where noise mitigations are expected to be required are listed in Table 3.12-10~~9~~ (Noise Mitigation Options and Locations). Final type, location, and extent of noise mitigations will be completed in Final Design. Proposed noise mitigation locations are shown on the Plan and Profile drawings included in Appendix E. The implementation of the proposed mitigation measures at locations identified will reduce operational noise levels below the FTA moderate impact criteria for all identified receptors.

Table 3.12-109 Noise Mitigation Options and Locations

Civil Stations	Side of Alignment	Mitigation Options[a]
Segment 1: Expo ROW (LRT Alternatives 1 and 2)		
552+00 to 556+00 (between Palms Boulevard and Jasmine Avenue)	South	Sound Wall[c], Low-Impact Frog
562+50 to 565+50 (between Jasmine Avenue and Motor Avenue)	South	Sound Wall
597+50 to 611+00 (between Cheviot Drive and Overland Avenue)	South	Sound Wall
612+00 to 619+00 (between Overland Avenue and Glendon Avenue)	North	Sound Wall
612+00 to 619+00 (between Overland Avenue and Westwood Boulevard)	South	Sound Wall
626+00 to 642+50 (between Westwood Boulevard and Military Avenue)	North	Sound Wall[c], Low-Impact Frog
626+00 to 651+00643+50 (between Westwood Boulevard and Sepulveda BoulevardMilitary Avenue)	South	Sound Wall[c], Low-Impact Frog
Segment 1: Sepulveda At-Grade Option (LRT Alternatives 1 and 2)		
643+50 to 651+00 (between Military Avenue and Sepulveda Boulevard)	South	Sound Wall
Segment 1: Sepulveda Grade Separation Design Option (LRT Alternatives 1 and 2)		
643+50 to 651+00 (between Military Avenue and Sepulveda Boulevard)	South	Sound Wall
Segment 1a: Venice/Sepulveda (LRT Alternatives 3 and 4)		
520+00 to 527+00 (between Canfield Avenue and Cardiff Avenue)	North	Sound Wall
579+00 to 594+00 (between Westwood Boulevard and Military Avenue)	South	Sound Wall
619+50 to 621+50 (between Charnock Road and Westminster Avenue)	West	Sound Wall
643+00 to 645+50 (north of the Sepulveda Channel)	East	Sound Wall or Low-Impact Frog[c]
642+50 to 645+50 (north of the Sepulveda Channel)	West	Sound Wall or Low-Impact Frog[c]
651+00 to 654+50 (north of Queensland Street)	East	Sound Wall or Low-Impact Frog[c]
651+00 to 654+50 (north of Queensland Street)	West	Sound Wall or Low-Impact Frog[c]
672+00 to 675+00 (between National Boulevard and Sardis Avenue)	West	Sound Wall
685+00 to 699+00 (between the I-10 Freeway and Richland Avenue)	East	Sound Wall

Table 3.12-109 Noise Mitigation Options and Locations

Civil Stations	Side of Alignment	Mitigation Options[a]
Segment 2: Sepulveda to Cloverfield (All LRT Alternatives)		
663664+00 to 665670+50 (between the I-405 Freeway and Purdue Avenue)	South	Sound Wall
667675+00 to 670+50678+00 (between SawtelleWest Pico Boulevard and PurdueFederal Avenue)	SouthNorth	Sound Wall
686+00 to 715+50 (between Barry Avenue and Westgate Avenue)	South	Sound Wall
735+00 to 747+50 (between Dorchester Avenue and Stewart Street)	North	Sound Wall
Segment 3: Olympic (LRT Alternatives 1 and 3)		
—	—	—
Segment 3a: Colorado (LRT Alternatives 2 and 4)		
776+00 to 779+00 (between 22nd Street and 20th Court)	North	Sound Wall[b] and/or Improved Sound Insulation
789+50 to 795+00 (between 17th Street and 20th Street)	South	Sound Wall

SOURCE: ATS Consulting, 2008; updated 2009.

a. Final type, location, and extent of noise mitigations will be completed in Final Design; options could include sound wall, berm or equivalent; low impact frog at crossover; and/or improved sound insulation.

b. A sound wall to mitigate this predicted impact may not be feasible. If that is the case, improved sound insulation is an optional noise mitigation measure.

c. Low impact frogs may be necessary for vibration mitigation where crossovers are located.

Note: Table and results changed due to updated design information.

MM NOI-1 *Solid, impervious objects that block the direct path between the sound source and the receiver shall be installed at the proposed locations indicated in Table 3.12-10 to reduce the sound level at the receiver, with sound walls being the preferred option. Sound walls are a common noise mitigation measure and have been widely used on highways and on rail transit lines. Alternatively, the Expo Authority may construct a landscaped berm parallel to the rail line or use low berms with a low wall along the top. As long as the wall, berm, or berm/wall combination reaches the same elevation, the acoustical performance will be equivalent. Except where noise impacts are due to special trackwork at crossovers and turnouts, the predicted noise impact can be eliminated with sound walls or berms that extend to heights of:*

- *6 to 8 ft above the top of rail for ballast and tie track sections*
- *3.5 to 4 ft above the top of rail on aerial structures*

The wall heights can be reduced by 6 to 12 inches if an acoustically absorbent surface treatment is used on the track side of the wall.

A 7 to 9 dB reduction in operational noise can be expected in all locations where sound walls block direct lines of sight between the sound source and the receiver. This excludes receivers located in high-rise apartment buildings.

Additionally, in areas where crossovers would be located near sensitive receptors, low-impact frogs may be either an alternative to sound walls or supplemental measure to sound walls. There are several different types of low-impact frogs that could be used.

If during Final Engineering or Operations it is determined that measures described above are not practicable or do not provide sufficient noise mitigation, the Expo Authority or Metro, as appropriate, shall provide for sound insulation of residences and other noise-sensitive facilities as ~~a~~ another alternative that could be used. Sound insulation involves upgrading or replacing existing windows and doors, and weather stripping windows and doors. Installing a mechanical ventilation system may be needed so that windows do not need to be opened for ventilation.

The mitigation measures will ensure that noise levels will be below the applicable FTA impact threshold for moderate noise impact.

Audible Warnings Impacts

It is assumed that the audible warnings at gate-protected at-grade crossings will consist of ringing bells on the masts of the crossing gates and sounding the low-volume horn (the quacker) on the vehicle. Light-rail vehicles will be equipped with quackers. Because the noise from the quacker adds only a marginal amount to the noise exposure at speeds of 35 mph and greater and because train speeds greater than 35 mph have been assumed for all gate-protected crossings where the quacker would be sounded, the quacker has not been included as a separate source in the noise analysis. The emergency horn, which is 10 dB louder than the quacker, will be used infrequently and also has not been included in the noise analysis. Impacts from the audible warnings will be mitigated by working with the CPUC staff and will incorporate lessons learned from previous rail projects such as Phase 1 of the Metro Gold Line. The noise mitigation measures implemented on the Gold Line include reducing the volume of the crossing bells, using the quacker in place of the high horn at gate-protected grade crossings, placing shrouds on the crossing bells to direct the sound away from residences, and applying for gate-down-bell-stop variances for some crossings.

The predicted L_{dn} from bell noise at the FTA Category 1, Category 2 and Category 3 land uses closest to the crossings are shown in Table 3.12-11~~10~~ (Predicted Levels of Crossing Bell Noise). Shown in the table are the predicted noise levels for only the impacted areas:

- No Mitigation (column “No Mitig”): Bells installed as typically delivered from the suppliers.
- Reduced Bell Volume (column “Lower Vol”): The bell sound level is reduced to ~~near~~within 5 dBA of the minimum required by the CPUC. Bells as supplied usually are set to a sound level of 85 dBA at 10 ft. and the minimum sound level required by the CPUC for crossing bells is 75 dBA. ~~Simply adjusting the bell volume reduces noise levels by 10 dB.~~ As seen in Table 3.12-11~~10~~ (Predicted Levels of Crossing Bell Noise),

thissimply adjusting the bell volume to a maximum of 80 dBA at 10 ft is sufficient to eliminate all of the predicted noise impact from crossing bells.

Table 3.12-110 Predicted Levels of Crossing Bell Noise

Segment	Street	Quad.	Cluster[e]	L_{dn}[a] (dBA) Exist	Impact Thresh[b]	No Mitig[c]	Lower Vol[d]
Segment 1: Expo ROW (LRT Alternatives 1 and 2)	Bagley	SE	3	68	63	**64**	594
		SW	4	68	63	60	550
Segment 1: Expo ROW (LRT Alternatives 1 and 2)	Overland	NE	School	5964[e]	652[e]	59[e]	549[e]
		SE	38	56	56	56	4651
		SW	39	58	57	**60**	550
		NW	25	59	57	57	4752
Segment 1: Expo ROW (LRT Alternatives 1 and 2)	Westwood	NE	28	59	57	**60**	550
		SE	42	59	57	**59**	549
		SW	43	59	57	**61**	561
		NW	29	59	57	**58**	4853
Segment 1: Expo ROW (LRT Alternatives 1 and 2)	Military	NE	34	59	57	**61**	561
		SE	48	59	57	**59**	549
		SW	49	59	57	**61**	561
Segment 1: Expo ROW (LRT Alternatives 1 and 2)	Sepulveda	SE	52	60	58	**59**	549
Segment 1a: Venice/Sepulveda LRT Alternatives 3 and 4)	No gate-protected crossings						
Segment 2: Sepulveda to Cloverfield (All LRT Alternatives)	Barrington	SE	100	59	57	**61**	561
		SW	101	59	57	**59**	549
	Stewart	NE	Lantana	59	62	58	53
Segment 3: Olympic (LRT Alternatives 1 and 3)	No gate-protected crossings						
Segment 3a: Colorado (LRT Alternatives 2 and 4)	17th Street	No noise sensitive receptors at crossing					
	20th Street	SF	114c	71	65	61	56
	17th Street	SE	15	57	56	54	49

SOURCE: ATS Consulting, 2008; updated 2009.

Numbers in shaded cells exceed the FTA moderate impact threshold.

a. L_{dn} from bell noise only.

b. FTA threshold for moderate noise impact.

c. Bell noise at closest receivers using bells as delivered from suppliers.

d. Bell noise at closest receivers with bell sound level adjusted to be just above the minimum required by the CPUC.

e. Closest group of sensitive receptors. Refer to *Noise and Vibration Technical Background Report* for drawings showing the locations and properties included in each cluster.

Note: Table and results changed due to updated design information. The results of the lowered volume have increased by 5 dB based on consultations with Metro.

Impact Summary by Alternative

Table 3.12-12~~1~~ (Summary of Audible Warnings Impacts by Alternative Prior to Mitigation) provides a summary of the anticipated number of receptors impacted by audible warnings for each alternative.

Table 3.12-12~~1~~ Summary of Audible Warnings Impacts by Alternative Prior to Mitigation

Alternative	Number of At-Grade Crossings with Impacts
No-Build	0
TSM	0
LRT 1: Expo ROW–Olympic Alternative	12
LRT 2: Expo ROW–Colorado Alternative	12
LRT 3: Venice/Sepulveda–Olympic Alternative	~~2~~0
LRT 4: Venice Sepulveda–Colorado Alternative	~~2~~0

SOURCE: ATS Consulting, 2008; updated 2009.

FEIR Design Options

The Sepulveda Grade Separation Design Option would eliminate the at-grade crossing and associated audible warning devices at Sepulveda Boulevard. As such, there would be ***no impact*** at this crossing. There would be no change with any of the other design options.

Audible Warnings Mitigation Measures

Mitigation measure MM NOI-2 would reduce crossing bell noise levels below the FTA's moderate impact thresholds.

MM NOI-2 *The volume of crossing bells shall be reduced to within 5 dBA of the bottom of the CPUC-approved range. This step is sufficient to reduce the bell noise to below the applicable FTA impact thresholds.*

Wheel Squeal Impacts

Wheel squeal noise is generated by the slip-stick interaction of the wheels and rails as light-rail vehicles negotiate tight-radius curves. Wheel squeal can usually be controlled through (1) application of friction modifier to the railhead or the wheel tread, (2) application of lubricant to the gage face of the rail or the wheel flange, or (3) optimization of the wheel and rail profiles. Steps would be taken in the design and maintenance of the tracks to minimize or eliminate wheel squeal. These steps include use of resilient wheels, which are now standard on Metro light-rail systems, and a maintenance program of periodically truing wheels that eliminates wheel flats and maintains an optimum profile. In addition, lubrication using either onboard or wayside lubrication systems would be considered.

The LRT Alternatives have relatively few tight radius curves. For this analysis it has been assumed that squeal could occur at any curve with a radius of less than 600 ft. Table 3.12-13~~2~~

(Predicted Levels of Wheel Squeal Noise) shows the predicted levels of wheel squeal at FTA land use Category 1 (studios), Category 2 (residential), and Category 3 (institutional) land uses

Table 3.12-13~~2~~ Predicted Levels of Wheel Squeal Noise

Curve Locations	Cluster[a]	Dist. (ft)	L_{dn}[b] (dBA) Exist	Impact Threshold[c] Mod	Impact Threshold[c] Severe	Worst Case[d]	Impact
Segment 1: Expo ROW (LRT Alternatives 1 and 2)							
East Entrance to I-10 underpass	13 14	40 140	68 68	63	68	69 64	Severe Mod
Segment 1a: Venice/Sepulveda (LRT Alternatives 3 and 4)							
Turn onto Venice from Expo Phase 1 Venice/Robertson Station	No sensitive receptors near curve						
Venice to Sepulveda	73 97	48 80	72 60	65 58	71 64	71 72	Severe Severe
Sepulveda to Expo ROW	84	60	71	65	70	73	Severe
Segment 2: Sepulveda to Cloverfield, no tight radius curves (All LRT Alternatives)							
Segment 3: Olympic (LRT Alternatives 1 and 3)							
Turn onto Olympic at 22nd St.	113 Crossroads High School~~1~~4	88 90	71 66[e]	65 67[e]	70 72[e]	69 71[e]	Mod Mod
20th Street	No sensitive receptors near curve						
5th Street	No sensitive receptors near curve						
4th Street	No sensitive receptors near curve						
Segment 3a: Colorado (LRT Alternatives 2 and 4)							
~~18th Street~~	~~No sensitive receptors near curve~~						
17th Street	~~No sensitive receptors near curve~~Crossroads Elementary School	180	55[e]	60[e]	66[e]	70[e]	Severe
4th Street	~~No sensitive receptors near curve~~115	90	71	65	70	69	Mod

SOURCE: ATS Consulting, 2008; updated 2009.

a. Closest group of sensitive receptors. Refer to *Noise and Vibration Technical Background Report* for drawings showing the locations and properties included in each cluster.

b. Ldn from train operations including wheel squeal only.

c. FTA moderate/severe impact thresholds.

d. Worst case consists of substantial wheel squeal plus normal train noise.

e. The FTA impact thresholds and the predicted noise levels are hourly L_{eq} during rush hour.

Note: 18th Street replaced with 17th Street because the radius of the curve at 18th Street was greater than 600 ft, while the radius of the curve at 17th Street was 400 ft; 4th Street added due to curve at terminus.

assuming that no measures are taken to control squeal. The clusters of sensitive receptors are the same as used in assessing the noise from Light-Rail Vehicle Operations discussed above. Aerial photographs showing buildings considered to be sensitive receptors in each cluster are included in the *Noise and Vibration Technical Background Report*. Table 3.12-132 (Predicted Levels of Wheel Squeal Noise) shows that potential noise impact from wheel squeal could occur at two clusters in Segment 1, three in Segment 1a, two in Segment 3, and two in Segment 3a. The clusters are residential land uses except for Cluster 14 in Segment 3 that is a schooland Cluster 15 in Segment 3a that are both schools. For two of the clusters in Segment 1a, noise impact is also predicted without wheel squealdue to light-rail vehicles (Table 3.12-8 [Summary of Clusters with Noise Impacts for Institutional, Category 3 Land Uses]). For the remaining clusters, eliminating wheel squeal would eliminate the predicted noise impact.

Impact Summary by Alternative

Table 3.12-143 (Summary of Wheel Squeal Impacts by Alternative Prior to Mitigation) provides a summary of the anticipated number of receptors impacted by wheel squeal noise for each alternative.

Table 3.12-143 Summary of Wheel Squeal Impacts by Alternative Prior to Mitigation

Alternative	Number of Clusters Impacted by Wheel Squeal
No-Build	0
TSM	0
LRT 1: Expo ROW–Olympic Alternative	4
LRT 2: Expo ROW–Colorado Alternative	24
LRT 3: Venice/Sepulveda–Olympic Alternative	5
LRT 4: Venice Sepulveda–Colorado Alternative	35

SOURCE: ATS Consulting, 2008; updated 2009.

FEIR Design Options

Implementation of the Colorado Parking Retention, Sepulveda Grade Separation, Colorado/4th Parallel Platform and South Side Parking, Maintenance Facility Buffer, or Expo/Westwood Station No Parking design options would not result in changes to the radius of any tight curves along the LRT Alternative alignments and would not change the wheel squeal impacts associated with the LRT Alternatives.

Wheel Squeal Mitigation Measures

Mitigation measure MM NOI-3 would reduce wheel squeal noise levels below the FTA's moderate impact thresholds for all receptors except those in Clusters 97 and 84. MM NOI-3 includes eliminating wheel squeal through means such as vehicle mounted or wayside applicators of friction modifier. Since wheel squeal noise levels would still exceed the FTA moderate impact threshold for receptors in Clusters 97 and 84, the mitigation measures discussed above for LRT noise (MM NOI-1) will be required in addition to taking measures to eliminate wheel squeal noise.

MM NOI-3 *If wheel squeal occurs that is sufficient to cause community noise levels that exceed the applicable FTA moderate impact thresholds, measures to reduce wheel squeal, such as rail or wheel lubrication, will be considered by Metro. If, by the end of the first year of service, noise from wheel squeal cannot be reduced to below the FTA moderate noise impact thresholds, the noise mitigation measures discussed in measure MM NOI-1 would be applied to further reduce levels of wheel squeal so that the levels are below the FTA moderate impact thresholds. No additional mitigation is required.*

Ancillary Equipment Impacts

TPSS units are the only ancillary equipment associated with the proposed project with the potential for causing noise impacts. There would be approximately 8 to 912 TPSS units distributed along the proposed project, including one in the Maintenance Facility site. The number of TPSS units varies depending upon the LRT Alternative. An additional 4 to 5 sites have been identified and studied to provide optional locations. Several of the selected sites are adjacent to residential land uses. As is standard in purchase contracts for TPSS units, maximum noise limits for bothpotential noise generators, such as the transformer hum and any cooling systems, would be included in the contract specifications to minimize the potential for noise impacts.

For Expo Phase 1 the specifications limit noise to a maximum of 50 dBA at a distance of 50 ft from any part of a TPSS unit. The cooling fans are the major noise source. The Metro Design Criteria includes a design goal that noise from continuous sources, such as TPSS units, should not exceed the ambient noise level. The ambient for residential land uses is defined as the nighttime L_{eq}., while the ambient for institutional land uses is defined as the daytime L_{eq}. For noise sources that have a noticeable tonal component, which will sometimes happen with TPSS units, the design goal is to reduce TPSS noise to 5 dB below the ambient. The evaluation of the TPSS at the Maintenance Facility is addressed separately as part of the overall assessment of noise sources at that facility.

Table 3.12-154 (Predicted TPSS Noise) shows the predicted levels of TPSS noise for each of the sites being considered, which has been revised in the FEIR to reflect changes to the locations of various TPSS sites. Where any uncertainty existed regarding the location of TPSS sites, the predictions are for the worst-case with the TPSS unit located at the property line closest to the residences. The measured nighttime L_{eq} at the long-term noise monitoring position closest to each site is also shown. The measured daytime L_{eq} at the noise monitoring position closest to each site was used when the TPSS was considerably closer to an institutional land use (such as a school). Considering that the TPSS noise could have a tonal component, mitigation needs to be considered even if the predicted TPSS noise is equal to below, but within 5 decibels of the existing nighttime ambient (Units 1 through 11, 14, and 17), or daytime ambient (Unit 12, 13, 15, and 16).

Table 3.12-15 Predicted TPSS Noise

TPSS Unit Site	Seg.	Location	Closest Resid.[a]	Existing Nighttime, L_{eq}[b] (dBA)	Max TPSS Noise[c,d] (dBA)
1	1	SE of Exposition Blvd. and Hughes Ave. (Alt. to 2)	20 ft	61 (LT-1)	58
2	1	SE of Exposition Blvd. and Clarington (Alt. to 1)	20 ft	61 (LT-1)	58
3	1	NE of Exposition Blvd. and Overland Ave. (Alt. to 4)	60 ft	52 (LT-4)	48
4	1	SW Exposition Blvd. and Overland Ave. (Alt. to 3)	50 ft	52 (LT-4)	50
5	1/1a	NE. corner of Exposition Blvd. and Sepulveda Blvd. (Alt. to 6)	135 ft	51 (LT-6)	41
6	2	SW of Exposition Blvd. and Sepulveda Blvd. Near I-405 (Alt. to 5)	285 ft	51 (LT-6)	35
7	1a	NW. corner of Venice Blvd. and Motor Ave.	175 ft	67 (LT-12)	39
8	1a	NE. corner of Venice Blvd. and Sepulveda Blvd.	50 ft	67 (LT-12)	50
9	1a	NW. corner of Sepulveda Blvd. and Clover Ave.	300 ft	62 (LT-13)	34
10	2	NE of Exposition Blvd. and Barrington Ave.	75 ft	56 (LT-7)	46
11	2	West of Cloverfield Blvd. near Olympic/26th St. Station	380 ft	63 (LT-10)	32
12	3	South of Olympic Blvd. and west of 17th Street (Alt. to 13)	300 ft	64 (LT-11[e]	34
13	3	Near Olympic/17th Street Station (Alt. to 12)	260 ft	64 (LT-11)[e]	36
14	3/3a	Colorado/4th Street Station	250 ft	60 (LT-14)	40
15	3a	SE. corner of Colorado Avenue and 17th Street north of LRT (Alt to 16)	130 ft	57 (LT-16)[e]	42
16	3a	SE. corner of Colorado Avenue and 17th Street south of LRT (Alt to 15)	200 ft	57 (LT-16)[e]	38
17	2	Within Maintenance Facility	225 ft	52 (LT-15)	37

SOURCE: ATS Consulting, 2008; updated 2009.

a. Assuming worst case of TPSS being located at property line closest to residence with fan directed towards residences.

b. Measured L_{eq} over nighttime hours of 10:00 P.M. to 7:00 A.M. The measurement sites used to characterize the nighttime L_{eq} are shown in parentheses.

c. Maximum noise based on standard specification used for Phase 1 TPSS units. The noise limit is a maximum noise level of 50 dBA at 50 ft from any part of the TPSS.

d. Shaded cells indicate sites where there is an impact for TPSS noise based upon that the predicted noise would be equal to or within 5 dB below the existing nighttime L_{eq}.

e. Measured L_{eq} over daytime hours of 7:00 A.M. to 10:00 P.M. when school where the closest receiver to TPSS.

Note: A number of the potential TPSS sites have shifted since the DEIR analysis. Due to the large amount of edits, the table was completely replaced.

Table 3.12-14 Predicted TPSS Noise

TPSS Unit Site	Seg.	Location	Closest Resid.[a]	Existing Nighttime, L_{eq}[b] (dBA)	Max TPSS Noise[c,d] (dBA)
1	1	SE of Exposition Blvd and Clarington Ave.	10 ft	61 (LT-1)	**63**
2	1	SE. of Exposition Blvd. and Hughes Ave.	10 ft	61 (LT-1)	**63**
3	1	Exposition Blvd. and Overland Ave.	40 ft	52 (LT-4)	**51**
4	1a	NW. corner of Venice Blvd. and Motor Ave.	—	—	—
5	1a	NE. corner of Venice Blvd. and Sepulveda Blvd.	100 ft	59 (LT-6)	43
6	1a	NW. corner of Sepulveda Blvd. and Clover Ave.	—	—	—
7	2	Exposition Blvd. and Sepulveda Blvd.	60 ft	59 (LT-6)	47
8	2	NE of Exposition Blvd. and Barrington Ave.	40 ft	51 (LT-8)	**51**
9	2	West of Cloverfield Blvd. near Olympic/26th St. Station	—	—	—
10	3	South of Olympic Blvd. and west of 17th Street	20 ft	59 (LT-11)	**57**
11	3	Colorado/4th Street Station	—	—	—
12	3	West of 16th Street between Olympic and I-10	20 ft	59 (LT-11)	**57**
13	3	Near Olympic/17th Street Station	20 ft	59 (LT-11)	**57**
14	3a	SE. corner of Colorado Avenue and 17th Street	—	—	—
15	3a	Colorado/4th Street Station	—	—	—

SOURCE: ATS Consulting, 2008

a. Assuming worst case of TPSS being located at property line closest to residence with fan directed towards residences.

b. Measured Leq over nighttime hours of 10:00 P.M. to 7:00 A.M. The measurement sites used to characterize the nighttime L_{eq} are shown in parentheses.

c. Maximum noise based on standard specification used for Phase 1 TPSS units. The noise limit is a maximum noise level of 50 dBA at 50 ft from any part of the TPSS.

d. Shaded cells indicate sites where TPSS noise would be equal to or within 5 dB below the existing nighttime L_{eq}.

Impact Summary by Alternative

Table 3.12-165 (Summary of TPSS Impacts by Alternative Prior to Mitigation) provides a summary of the anticipated number of impacted locations associated with the placement of traction power substations for each alternative, revised to reflect changes in the locations of various TPSS sites.

Table 3.12-165 Summary of TPSS Impacts by Alternative Prior to Mitigation

Alternative	Number of Locations Impacted by TPSS Noise
No-Build	0
TSM	0
LRT 1: Expo ROW–Olympic Alternative	74
LRT 2: Expo ROW–Colorado Alternative	4
LRT 3: Venice/Sepulveda–Olympic Alternative	04
LRT 4: Venice Sepulveda–Colorado Alternative	01

SOURCE: ATS Consulting, 2008; updated 2009.

FEIR Design Options

Implementation of the Colorado Parking Retention, Sepulveda Grade Separation, Colorado/4th Parallel Platform and South Side Parking, Maintenance Facility Buffer, or Expo/Westwood Station No Parking design options would not alter the proposed locations of any TPSS sites and would not change the noise impacts associated with the LRT Alternatives.

Ancillary Equipment Mitigation Measures

Mitigation measure MM NOI-4 would reduce impacts associated with TPSS locations.

MM NOI-4 *Noise levels would be sufficient to warrant mitigation at 74 of the 15 proposed TPSS sites; see Table 3.12-15. All noise impacts can be eliminated by (1) specifying a noise limit of 44 dBA at 50 ft from any part of the TPSS units that would be used at sites 1, 2, 3, and 4 8, 10, 12, and 13, and (2) locating the TPSS units at sites 1 and 2 at a minimum of 20 ft from the closest residential land use.*

Maintenance Facility

Table 3.12-176 (Predicted Maintenance Facility Noise) shows the predicted noise levels from activities at the residences along Exposition Boulevard south of the proposed Stewart Street site for the Maintenance Facility. The noise predictions for the Maintenance Facility have been changed since the DEIR because of modifications to the noise predictions model and changes to the Maintenance Facility design. The changes are due to improved information on the noise sources at maintenance facilities that resulted from the measurements that were performed at the Metro Green Line yard. Short-term measurements were taken at the TPSS, blowdown facility, maintenance shops, and carwash. Previous measurements taken at the Gold Line Yard were also taken into consideration when predicting future noise levels for the Expo Phase 2 Maintenance Facility. Where measurements were performed of a specific class of equipment, such as a car wash, at both the Gold Line and Green Line Yards, the higher of the two sets of measurements were then used for the Expo Phase 2 Maintenance Facility predictions to ensure that the noise predictions would be on the conservative (high) side.

The noise modeling software CadnaA was used to predict the noise at the residences directly south of the proposed facility and at the Lantana campus north of the proposed facility. The model included noise sources for the blowdown facility, car wash, train movement on the yard entry and exit tracks, the TPSS, and maintenance shops. Activities associated with the maintenance shops such as compressors, fans, vehicle-lift alarms and various hand tools were included as part of the maintenance shop noise levels. Wheel squeal is not expected at the facility because there are no tight radius turns less than 600 feet in radius in the yard. Any wheel squeal will be avoided with proper lubrication. The noise models assumed a minimum 8- to 12-foot security wall and combination fence at the perimeter of the facility per *Metro Design Criteria*.

The measurements at the Green Line and Gold Line Maintenance Facilities showed that the reference noise levels assumed for some of the noise sources were on the conservative (high) side in the DEIR. In addition, with the minimum 8- to 12-foot security wall and combination fence, none of the predicted noise levels exceed the FTA moderate impact threshold. As such, no noise impacts are predicted at sensitive receivers near the Maintenance Facility, and mitigation measure MM NOI-5 is no longer required at 21 residences. At 8 of the 21 residences

~~the predicted noise levels exceed the FTA severe impact threshold. The dominant noise sources at all of the residences are the car wash and the blowdown facility~~.

FEIR Design Options

Table 3.12-18 (Predicted Maintenance Facility Buffer Design Option Noise) shows the predicted noise levels from activities at the proposed Maintenance Facility Buffer Design Option. None of the predicted noise levels exceed the FTA impact threshold. The noise models also assumed a minimum 8- to 12-foot security wall and combination fence at the perimeter of the Maintenance Facility Buffer Design Option per *Metro Design Criteria*. As such, no mitigation is required.

Table 3.12-176 Predicted Maintenance Facility Noise

Civil Station[a]	Cluster[b]	Existing L_{dn} (dBA)	Maintenance Facility L_{dn} (dBA)			Number of Impacts	
			Impact Threshold		Maint. Facility Noise[c]		
			Moderate	Severe		Moderate	Severe
553746+50	M1	58	57	63	524	—	—
614744+00	M2	58	57	63	559	—	—4
617742+00	M3	58	57	63	5063	—	—4
627740+50	M4	58	57	63	4661	—4	—
631737+00	M5	58	57	63	5261	—4	—
634735+00	M6	58	57	63	5659	—5	—
732+00	M7	59	57	63	53	—	—
740+00	M8	57[d]	56[d]	62[d]	54[d]	—	—

SOURCE: ATS Consulting, 2008; updated 2009.

a. Civil Station refers to the locating system used on design drawings.

b. Groups of residences along south side of Exposition Blvd. south of Stewart Street site. Refer to the *Noise and Vibration Technical Background Report* for drawing showing the residences in each cluster.

c. Predicted noise levels from all activities expected to occur at Maintenance Facility.

d. Value is daytime Leq because it corresponds to an institutional land use, not a residence.

Table 3.12-18 Predicted Maintenance Facility Buffer Design Option Noise

Civil Station[a]	Cluster[b]	Existing L_{dn} (dBA)	Maintenance Facility L_{dn} (dBA)			Number of Impacts	
			Impact Threshold		Maint. Facility Noise[c]		
			Moderate	Severe		Moderate	Severe
746.50	M1	58	57	63	54	—	—
744+00	M2	58	57	63	57	—	—
742+00	M3	58	57	63	55	—	—
740+50	M4	58	57	63	53	—	—
737+00	M5	58	57	63	51	—	—
735+00	M6	58	57	63	50	—	—
732+00	M7	59	57	63	47	—	—
740+00	M8	57[d]	56[d]	62[d]	56[d]	—	—

SOURCE: ATS Consulting, 2009.

a. Civil Station refers to the locating system used on design drawings.

b. Groups of residences along south side of Exposition Blvd. east of Stewart Street. Refer to the *Noise and Vibration Technical Background Report* for drawing showing the residences in each cluster.

c. Predicted noise levels from all activities expected to occur at Maintenance Facility.

d. Value is daytime Leq because it corresponds to an institutional land use, not a residence.

~~Maintenance Facility Mitigation Measures~~

~~The predicted levels of noise from the Maintenance Facility exceed the applicable FTA noise impact thresholds at most of the residences immediately south of the proposed site for the Maintenance Facility. Mitigation measure MM NOI-5 would reduce the predicted noise levels to below the FTA moderate impact threshold.~~

~~*MM NOI-5*~~ ~~*An 8- to 10-foot-high sound wall shall be installed along the southern property line of the Maintenance Facility. The wall height can be reduced to 6 to 8 feet high if the car wash and blowdown facilities are designed to generate lower noise levels than standard facilities. This can be achieved through the use of silencers on compressors and fans, minimizing openings on the south side of the blowdown and car wash buildings, and constructing the south walls of the facilities of masonry, brick, or wood studs with insulation in the cavities instead of sheet metal.*~~

Implementation of mitigation measures MM NOI-1 through MM NOI-4~~5~~ would reduce operational noise impacts to ***less than significant***.

Criterion	**Would the project expose the public to, or generate, excessive groundborne vibration, groundborne noise levels, or vibration levels in buildings exceeding the FTA vibration impact criteria?**

No-Build Alternative

There would be roadway and transit service improvements associated with the No-Build Alternative. However, the only improvement that would change the physical environment in the Expo Phase 2 ROW would be the I-405 Widening project. The I-405 Widening project would increase lanes of travel in elevated sections over the corridor and would not increase vibration impacts. The No-Build Alternative also assumes full implementation of the various bus programs, with continued bus operation along city streets. There would be no operational vibration associated with the aerial roadway or the on-street bus operations associated with No-Build Alternative. The No-Build Alternative would result in ***no impact*** relative to groundborne vibration, groundborne noise levels, or vibration levels in buildings.

Transportation Systems Management (TSM) Alternative

The TSM Alternative would include all of the improvements under the No-Build Alternative and new on-street bus services to directly serve the Expo Phase 2 community transit needs. Those additional improvements would include minor physical modifications such as upgraded bus stops and additional buses. Because there would be no operational vibration associated with the TSM Alternative, there would be ***no impact***.

LRT Alternatives

As discussed in Section 3.12.3 (Regulatory Setting), the FTA guidelines provide two criteria for assessing vibration impacts. The first criterion is based on the overall vibration velocity level and is intended for use with a General Assessment. The key thresholds applicable to the Expo Phase 2 project are a maximum vibration level of 65 VdB for Category 1 (studios) land uses, 72 VdB for Category 2 (residential) land uses and 75 VdB for Category 3 (institutional) land uses. The second FTA criterion is based on the spectrum of the predicted vibration. Impacts would occur if any 1/3-octave band level of the predicted vibration spectrum exceeds the impact threshold. The threshold for residential land uses is 72 VdB over the frequency range of 8 to 80 Hz. This means that an impact would occur if any ⅓-octave band level between 8 and 80 Hz is predicted to exceed 72 VdB. FTA indicates that the second criterion is intended for use with a Detailed Assessment when vibration propagation testing has been performed and the predictions include the vibration spectrum. As discussed in Section 3.12.2 (Existing Conditions), vibration propagation tests were performed at 10 locations in the project corridor. Therefore, it is appropriate to apply the Detailed Assessment criteria to more accurately identify potential vibration impacts.

After applying the General Assessment criteria, the potential for vibration impact was identified at a number of residential land uses in the project corridors and at several ~~institutional land uses.~~ recording studios, quiet office spaces, and spaces used for audio/visual editing. The vibration sensitive commercial spaces were at the buildings on the Lantana Campus and at Groove Masters Studio. The number of potential impacts was reduced considerably after applying the Detailed Assessment criteria. ~~The remaining potential impacts are summarized in Table 3.12-17 (Summary of Vibration Impact Assessment, Residential [Category 2] Land Uses)~~

~~for residential land uses and in Table 3.12-18 (Summary of Vibration Impact Assessment for Institutional [Category 3] Land Uses) for institutional land uses~~

The FTA vibration impact thresholds applicable to the Lantana Campus and Groove Masters Studio are:

- Institutional spaces (FTA vibration Category 3), which includes office spaces: applied to offices and spaces used for audio/video editing
- Concert halls, TV studios, and recording studios: applied to the studios where audio recording is performed
- Theaters: applied to screening rooms

Details on how the FTA vibration impact criteria were applied to Groove Masters and the Lantana Campus are given in the *Noise and Vibration Technical Background Report*. The vibration assessment for Groove Masters Studio is given in Table 3.12-19 (Predicted Ground-Borne Vibration and Groundborne Noise at Groove Master's Studio with and without Mitigation) and the assessment for the Lantana Campus is presented in Table 3.12-20 (Predicted Groundborne Vibration and Groundborne Noise in Sensitive Lantana Spaces). The conclusion is that the predicted groundborne vibration and groundborne noise levels inside some spaces exceed the impact thresholds. Shown in Table 3.12-19 (Predicted Groundborne Vibration and Groundborne Noise at Groove Master's Studio with and without Mitigation) and Table 3.12-20 (Predicted Groundborne Vibration and Groundborne Noise in Sensitive Lantana Spaces) are the predicted levels with no mitigation and with several alternative vibration mitigation measures.

Kilroy Realty has seven buildings north of the Expo ROW that are east and west of Bundy Drive. Based on supplementary analysis conducted in response to comments on the DEIR, there may be vibration impacts at one or more spaces within the Kilroy Realty properties that house filming and recording studios. Of the seven Kilroy Realty properties, the building at 12312 Olympic Boulevard, which houses three filming/recording studios, has the highest potential for vibration impact. The potential for vibration impacts to the sensitive uses of Kilroy Realty properties will be evaluated during final design. If impacts are identified over FTA thresholds, vibration mitigation such as ballasted mat or floating slab will be implemented.

Table 3.12-19 Predicted Groundborne Vibration and Groundborne Noise at Groove Master's Studio with and without Mitigation

Location and Track Design	Groundborne Vibration[a]		Groundborne Noise[b]	
	Predicted (VdB)	Exceed Thresh[c] (dB)	Predicted (dBA)	Exceed Thresh[c] (dB)
Main Studio South				
No Mitigation	**67[d]**	2	**35[d]**	10
HRDF	64	—	**26[d]**	1
Floating Floors	63	—	**28[d]**	3
HRDF+Floating Floors	62	—	20	—
Floating Slab	57	—	14	—
Main Studio North				

Table 3.12-19 Predicted Groundborne Vibration and Groundborne Noise at Groove Master's Studio with and without Mitigation

Location and Track Design	Groundborne Vibration[a]		Groundborne Noise[b]	
	Predicted (VdB)	Exceed Thresh[c] (dB)	Predicted (dBA)	Exceed Thresh[c] (dB)
No Mitigation	64	—	**33**[d]	8
HRDF	62	—	23	—
Floating Floors	60	—	**26**[d]	1
HRDF+Floating Floors	59	—	18	—
Floating Slab	55	—	11	—
Control Room				
No Mitigation	65	—	**34**[d]	9
HRDF	62	—	24	—
Floating Floors	61	—	**27**[d]	2
HRDF+Floating Floors	59	—	19	—
Floating Slab	55	—	16	—
Vocal Booth				
No Mitigation	**73**[d]	8	**44**[d]	19
HRDF	**66**[d]	1	**34**[d]	9
Floating Floors	**68**[d]	3	**37**[d]	12
HRDF+Floating Floors	63	—	**28**[d]	3
Floating Slab	58	—	22	—

SOURCE: ATS Consulting, 2009.

a. Predicted groundborne vibration at measurement positions in studio. FTA impact threshold is 65 VdB.

b. Predicted groundborne noise at measurement positions in studio. FTA impact threshold is 25 dBA.

c. Amount that predicted levels exceed the FTA impact threshold.

d. Values in **bold** exceed the applicable FTA impact threshold.

HRDF=High resilience direct fixation track fasteners; Floating floors=concrete floor inside sensitive space that is "floated" on a resilient element; Floating Slab=track support system consisting of a concrete slab supported by rubber or coil springs.

Table 3.12-20 Predicted Groundborne Vibration and Groundborne Noise in Sensitive Lantana Spaces

Location	Predicted Groundborne Vibration, VdB				Predicted Groundborne Noise, dBA			
	Thres-hold[a]	No Mitig.	Ballast Mat	Floating Slab	Thres-hold[a]	No Mitig.	Ballast Mat	Floating Slab
Lantana West								
102 Screening Room	72	70	64	59	35	**42**	34	21
Office 1st Floor	75	67	64	62	40	**40**	31	18
Office 2nd Floor	75	61	59	59	40	**41**	33	19

Table 3.12-20 Predicted Groundborne Vibration and Groundborne Noise in Sensitive Lantana Spaces

Location	Predicted Groundborne Vibration, VdB				Predicted Groundborne Noise, dBA			
	Threshold[a]	No Mitig.	Ballast Mat	Floating Slab	Threshold[a]	No Mitig.	Ballast Mat	Floating Slab
Middle, 2nd Floor	75	62	61	61	40	37	28	15
Lantana Center								
Suite 1370	75	74	74	69	40	29	25	15
Suite 1369B	75	75	74	70	40	37	30	18
Suite 2371	75	76[b]	77[b]	73	40	30	27	17
Suite 2370	75	80[b]	80[b]	75	40	38	34	22
Lantana South								
1st Floor North	75	70	70	68	40	24	20	10
1st Floor South	75	67	67	66	40	20	16	6
2nd Floor North	75	70	70	69	40	21	19	10
2nd Floor South	75	68	68	66	40	18	16	7
Todd-AO								
Small Stage	65	**66**	**66**	60	25	**28**	21	9
Large Stage	65	**69**	**69**	62	25	**35**	**27**	15
ADR Stage	65	**71**	**68**	61	25	**38**	**30**	17
Foley Stage	65	59	59	56	25	14	10	-1
Gray Martin								
Studio C/D Booth	65	**75**	**74**	61[c]	25	**33**	**27**	10[c]
Studio D	65	**74**	**73**	58[c]	25	**34**	**28**	11[c]
Studio B	65	**72**	**72**	59[c]	25	23	18	-1[c]
Studio A Booth	65	63	63	50[c]	25	20	15	-3[c]
Studio A	65	64	65	55[c]	25	15	11	-7[c]
IMAX								
Screening Room[d]	72	**79**	69[e]	--	35	35	25	--

Source: ATS Consulting, 2009.

a. Impact threshold for the overall vibration level. Refer to text for a discussion of the impact thresholds.

b. The predicted vibration levels exceed the impact threshold for a General Vibration Analysis but do not exceed the threshold for a Detailed Vibration Analysis.

c. The floating slab for mitigation at Gray Martin Studios is assumed to be a coil spring system with a resonance frequency of 3 to 5 Hz.

d. The vibration predictions for IMAX assume a 10 decibel increase in vibration levels due to the switch for the Maintenance Facility lead track that would be located near the northeast corner of the building.

e. Vibration mitigation for the IMAX building is assumed to be use of a low-impact frog. Ballast mats or other vibration mitigation measures in addition to the low-impact frog would not be necessary.

A bold font and shaded cell indicates that predicted levels exceed impact applicable threshold.

The impacts for residential land uses are shown in Table 3.12-21 (Summary of Vibration Impact Assessment, Residential [Category 2] Land Uses) and for institutional land are shown in Table 3.12-22 (Summary of Vibration Impact Assessment for Institutional [Category 3] Land

Uses). As shown in Table 3.12-2117 (Summary of Vibration Impact Assessment, Residential [Category 2] Land Uses), potential for vibration impact in Category 2 land uses is predicted at 2418 residences in Segment 1; 50 residences in Segment 1a; and 28 residences in Segment 3a. No vibration impact at residences is predicted for Segment 2 or Segment 3. The 28 potential vibration impacts for Segment 3a would all be in the same building, an eight-story apartment building located a few feet from the right-of-way where the tracks would cross Olympic Boulevard. As shown in Table 3.12-2218 (Summary of Vibration Impact Assessment for Institutional [Category 3] Land Uses), potential for vibration impact in Category 3 land uses is predicted at the building on National Boulevard used by the Boy Scouts of America. This building is on Segment 1. Overall, the majority of the vibration impacts are at locations where there would be special trackwork for crossovers. This is because the banging as the wheels pass through the rail gaps in frogs causes vibration levels that are up to 10 dB higher than for normal track.

Table 3.12-2117 Summary of Vibration Impact Assessment, Residential (Category 2) Land Uses

Civil Station	Land Use	Cluster[a]	Number of Dwelling Units	Near Track Dist (ft)	Speed (mph)	Cross-over[b]	Aerial Struc.[c]	Max Spectral Level[d] (VdB)	Impact Thresh.[e] (VdB)	Amount Exceeded (dB)
Segment 1: Expo ROW (LRT Alternatives 1 and 2)										
553+50	MFR	11	6	80	45	Yes	No	78	72	6
639+00	SFR	303	56	115	4055	Yes	No	8076	72	64
637+00	SFR	32	4	115	55	Yes	No	76	72	4
626+50	SFR	43	3	115	35	Yes	No	73	72	1
640+00	SFR	48	6	115	55	Yes	No	76	72	4
Segment 1a: Venice/Sepulveda (LRT Alternatives 3 and 4)										
644+00	MFR	77	10	68	35	Yes	Yes	73	72	1
653+00	MFR	79	10	70	35	Yes	Yes	73	72	1
653+00	MFR	90	20	47	35	Yes	Yes	76	72	4
644+00	MFR	92	10	49	35	Yes	Yes	76	72	4
Segment 3a: Colorado (LRT Alternatives 2 and 4)										
777+00	MFR	114	28	20	55	No	Yes	75	72	3

SOURCE: ATS Consulting, 2008; updated 2009.

SFR = single-family residence; MFR = multi-family residence

a. The clusters of sensitive receptors are the same as used for the noise analysis. The *Noise and Vibration Technical Background Report* includes an appendix that shows the locations and buildings included in each cluster.

b. Identifies whether special trackwork for a crossover is located near the cluster.

c. The vibration path through the aerial structure is assumed to reduce vibration levels by 5 decibels relative to standard at-grade track.

d. Maximum predicted vibration level in any 1/3-octave band.

e. FTA impact threshold for a Detailed Assessment. The “Residential Night” curve has been used for residential land uses. Refer to the *Noise and Vibration Technical Background Report*.

Table 3.12-2218 Summary of Vibration Impact Assessment for Institutional (Category 3) Land Uses

Civil Station	Desc.	Cluster[a]	Near Track Dist. (ft)	Speed (mph)	Cross-over[b]	Aerial	Max Spectral Level[c] (VdB)	Impact Thresh.[d] (VdB)	Amt. Exceeded (dB)
Segment 1: Expo ROW (LRT Alternatives 1 and 2)									
555+00	Boy Scouts Building	2	25	50	Yes	No	89	75	14

SOURCE: ATS Consulting, 2008.

a. The clusters of sensitive receptors are the same as used for the noise analysis. The *Noise and Vibration Technical Background Report* includes an appendix that shows the locations and buildings included in each cluster.

b. Indentifies whether special trackwork for a crossover is located near the cluster.

c. Maximum predicted vibration level in any 1/3-octave band.

d. FTA impact threshold for a Detailed Assessment. The “Residential Day” curve has been used for institutional land uses.

Several of the buildings where vibration impact is predicted are larger buildings of the type that tend to have lower vibration levels because of attenuation at the soil/foundation interface. Because this attenuation varies widely from building to building, it has not been accounted for in the predictions, which means that the vibration inside some of the buildings where impact is predicted may be substantially overestimated. Site-specific vibration propagation testing, including measurements inside the vibration sensitive spaces of the buildings, should be performed at these buildings during the design phase to more accurately define the vibration mitigation requirements.

Impact Summary by Alternative

Table 3.12-2319 (Summary of Operational Vibration Impacts by Alternative Prior to Mitigation) provides a summary of the anticipated number of impacted locations associated with operational vibration for each alternative.

Table 3.12-2319 Summary of Operational Vibration Impacts by Alternative Prior to Mitigation

Alternative	Number of Locations Impacted by Operational Vibration
No-Build	0
TSM	0
LRT 1: Expo ROW–Olympic Alternative	2519
LRT 2: Expo ROW–Colorado Alternative	5347
LRT 3: Venice/Sepulveda–Olympic Alternative	50
LRT 4: Venice Sepulveda–Colorado Alternative	78

SOURCE: ATS Consulting, 2008, 2009.

FEIR Design Options

Implementation of the Colorado Parking Retention, Sepulveda Grade Separation, Colorado/4th Parallel Platform and South Side Parking, Maintenance Facility Buffer, or Expo/Westwood Station No Parking design options would have no effect on the previous vibration analysis. The predicted vibration levels are below the FTA impact threshold at all vibration sensitive land uses in the vicinity of the design options.

Operational Vibration Mitigation Measures

Implementation of the LRT Alternatives has the potential to create vibration impact at residences and institutional buildings. Compliance with existing regulations and implementation of mitigation measure MM NOI-6 would ensure that this impact is reduced below the FTA impact criteria.

MM NOI-6 *Further site-specific testing shall be performed during the ~~Preliminary Engineering~~Final Design where potential for vibration impact has been identified. Where vibration impact is still predicted, the vibration energy transmitted into the ground shall be decreased by (1) use of low impact frogs to reduce the banging at special trackwork, and/or (2) installation of a resilient layer between the tracks and the ground. There are a number of different approaches to installing resilient elements in track to reduce vibration. Vibration-reducing design specifications for the track sections shall be determined in consultation with a qualified vibration scientist or engineer during the design phase.*

The specific locations where vibration mitigations are expected to be required are listed in Table 3.12-24~~0~~ (Anticipated Vibration Mitigation Locations). Final type, location, and extent of such mitigations will be determined in Final Design. The mitigation measures will be designed to ensure that vibration levels will be below the FTA impact threshold that is applicable to Detailed Vibration Assessments. The threshold for FTA Category 2 (residential) land uses is a band-maximum vibration level of 72 VdB at frequencies greater than 8 Hz.

Table 3.12-24~~0~~ Anticipated Vibration Mitigation Locations

Segment	Location of Impacts	Mitigation Locations (Civil Stations)[a]
Segment 1: Expo ROW (LRT Alternatives 1 and 2)	~~North and~~ South of tracks	~~551~~552+00 to ~~561~~556+00
	South of tracks	626+50 to 627+50
	North of tracks	630+50 to 631+50
	North of tracks	636+~~00~~50 to ~~642+00~~637+50
	South of tracks	~~635+50~~640+00 to 641+~~50~~00
Segment 1a: Venice/Sepulveda (LRT Alternatives 3 and 4)	~~North~~East and ~~south~~west of tracks	~~642~~643+00 to 645+00

Table 3.12-240 Anticipated Vibration Mitigation Locations

Segment	Location of Impacts	Mitigation Locations (Civil Stations)[a]
	~~North~~East and west of tracks	~~651~~652+00 to ~~655~~654+50
Segment 2: Sepulveda to Cloverfield (All LRT Alternatives)	~~None~~South of tracks	~~—~~732+00 to 733+00
	North of tracks	741+00 to 745+00
	North of tracks	745+00 to 747+50
Segment 3: Olympic (LRT Alternatives 1 and 3)	None	—
Segment 3a: Colorado (LRT Alternatives 2 and 4)	North of tracks	~~775+00~~776+50 to 780+00
	North of tracks	807+00 to 808+50

SOURCE: ATS Consulting, 2008; updated 2009.
a. Civil Station refers to the locating system used on design drawings.
Note: Table and results changed due to updated design information.

Implementation of mitigation measure MM NOI-6 would reduce operational vibration impacts to ***less than significant***.

Criterion	**Would the project cause a substantial permanent increase in ambient noise levels in the project vicinity above levels existing without the project?**

No-Build Alternative

There would be roadway and transit service improvements associated with the No-Build Alternative. The No-Build Alternative assumes full implementation of the Metro Rapid Bus program, with continued operation along city streets and widening of the I-405. As discussed previously, the No-Build Alternative would not result in any increase in noise associated with light-rail vehicle operation, audible warnings, wheel squeal, ancillary equipment, or other sources from the proposed project. Traffic increases on the I-405 will result in increased noise levels that are mitigated by proposed sound walls. The No-Build Alternative would result in a ***less-than-significant*** impact relative to permanent ambient noise.

Transportation Systems Management (TSM) Alternative

The TSM Alternative would include all of the improvements under the No-Build Alternative and new on-street bus services to directly serve the Expo Phase 2 community transit needs. Those additional improvements would include minor physical modifications such as upgraded bus stops and additional buses. The additional buses included in the TSM Alternative would not result in a substantial increase in ambient noise levels above those of the No-Build Alternative. Therefore, the TSM Alternative would result in a ***less-than-significant*** impact.

LRT Alternatives

As discussed previously, permanent sources of ambient noise associated with the LRT Alternatives include light-rail vehicle operation, vehicular traffic, audible warnings, wheel squeal, ancillary equipment, and other sources. Compliance with existing regulations and implementation of mitigation measures MM NOI-1 through MM NOI-45 would ensure that impacts would remain ***less than significant***.

FEIR Design Options

As discussed previously, implementation of the Colorado Parking Retention, Sepulveda Grade Separation, Colorado/4th Parallel Platform and South Side Parking, Maintenance Facility Buffer, or Expo/Westwood Station No Parking design options would not alter the impacts associated with the LRT Alternatives. Compliance with existing regulations and implementation of mitigation measures MM NOI-1 through MM NOI-4 would ensure that impacts would remain ***less than significant***.

Criterion	Would the project cause a substantial temporary or periodic increase in ambient noise levels in the project vicinity above levels existing without the project?

No-Build Alternative

There would be roadway and transit service improvements associated with the No-Build Alternative. The No-Build Alternative assumes full implementation of the Metro Rapid Bus program, with continued operation along city streets. The I-405 Widening involves the addition of lanes to the existing freeway on elevated structure above the Expo Phase 2 ROW. Those projects would not result in periodic or temporary sources of noise associated with operations. The No-Build Alternative would result in ***no impact*** relative to temporary or periodic increases in ambient noise.

Transportation Systems Management (TSM) Alternative

The TSM Alternative would include all of the improvements under the No-Build Alternative and new on-street bus services to directly serve the Expo Phase 2 community transit needs. Those additional improvements would include minor physical modifications such as upgraded bus stops and additional buses. The TSM Alternative bus operations would not involve periodic or temporary sources of noise. The TSM Alternative would result in ***no impact***.

LRT Alternatives

As discussed previously, periodic sources of noise associated with the LRT Alternatives include light-rail vehicle operation, vehicular traffic, audible warnings, and other sources. Compliance with existing regulations and implementation of mitigation measures MM NOI-1 through MM NOI-46 would ensure that impacts would remain ***less than significant***.

FEIR Design Options

As discussed previously, implementation of the Colorado Parking Retention, Sepulveda Grade Separation, Colorado/4th Parallel Platform and South Side Parking, Maintenance Facility Buffer, or Expo/Westwood Station No Parking design options would not alter the impacts associated with the LRT Alternatives. Compliance with existing regulations and implementation of mitigation measures MM NOI-1 through MM NOI-4 would ensure that impacts would remain ***less than significant***.

Criterion	Would the project expose people residing or working in the project site to excessive noise levels from a project located within an airport land use plan or, where such a plan has not been adopted, within 2 miles of a public airport or public use airport?

No-Build Alternative

There would be roadway and transit service improvements associated with the No-Build Alternative. The No-Build Alternative would not substantially increase residential population or employment in the project area, and employees would not be exposed to substantial airport noise because they would generally be indoors (within automobiles or the cabin of buses) or would be exposed to airport noise for only short, temporary periods. The No-Build Alternative would result in ***no impact***.

Transportation Systems Management (TSM) Alternative

The TSM Alternative would include all of the improvements under the No-Build Alternative and new on-street bus services to directly serve the Expo Phase 2 community transit needs. Those additional improvements would include minor physical modifications such as upgraded bus stops and additional buses. The TSM Alternative would not substantially increase employment, and employees hired for the TSM Alternative would not be exposed to substantial airport noise because they would generally be indoors (within automobiles or the cabin of buses) or would be exposed to airport noise for only short, temporary periods. The TSM Alternative would result in ***no impact***.

LRT Alternatives

Much of the LRT Alternatives are within 2 miles of Santa Monica Municipal Airport. None of the proposed LRT Alternatives involves the construction of residential or other habitable uses within the bounds of the applicable airport land use plan for Los Angeles County and the Santa Monica Municipal Airport. Therefore, the LRT Alternatives would not expose residents to excessive noise levels from a public airport. The LRT Alternatives would not substantially increase employment, and employees hired for the LRT Alternatives would not be exposed to substantial airport noise because they would generally be indoors (within the cabin of LRT vehicles) or would be exposed to airport noise for only short, temporary periods. Therefore, noise exposures would not be excessive, and ***no impact*** would occur.

FEIR Design Options

Implementation of the Colorado Parking Retention, Sepulveda Grade Separation, Colorado/4th Parallel Platform and South Side Parking, Maintenance Facility Buffer, or Expo/Westwood Station No Parking design options would not involve the construction of residential or other habitable uses within the bounds of the applicable airport land use plan for Los Angeles County and the Santa Monica Municipal Airport. Therefore, the design options would not expose residents to excessive noise levels from a public airport. The design options would not substantially increase employment, and employees would not be exposed to substantial airport noise because they would generally be indoors (within the cabin of LRT vehicles) or would be exposed to airport noise for only short, temporary periods. Therefore, noise exposures would not be excessive, and ***no impact*** would occur.

Criterion	**Would the project expose people residing or working in the project site to excessive noise levels from a project located within the vicinity of a private airstrip?**

No-Build Alternative

The No-Build Alternative is not within the vicinity of a private airstrip. Therefore, there would be ***no impact***.

Transportation Systems Management (TSM) Alternative

The TSM Alternative is not within the vicinity of a private airstrip. Therefore, there would be ***no impact***.

LRT Alternatives

The LRT Alternatives are not within the vicinity of a private airstrip. Therefore, none of the LRT Alternatives would expose people to excessive noise levels associated with a private airstrip. ***No impact*** would occur.

FEIR Design Options

The Colorado Parking Retention, Sepulveda Grade Separation, Colorado/4th Parallel Platform and South Side Parking, Maintenance Facility Buffer, or Expo/Westwood Station No Parking are not within the vicinity of a private airstrip. Therefore, none of the design options would expose people to excessive noise levels associated with a private airstrip. ***No impact*** would occur.