Exposition Metro Line Construction Authority

Exposition Corridor Transit Project Phase 2

Final Environmental Impact Report

Technical Background Report

FINAL

Noise and Vibration

December 2009

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Exposition Metro Line Construction Authority

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The Exposition Metro Line Construction Authority (Expo Authority) has determined that the bike path and Second Street Santa Monica Terminus are no longer under consideration as part of the Expo Phase 2 Light-Rail Transit project. This Technical Background Report was drafted prior to the final definition of the LRT Alternatives that was presented in the Draft Environmental Impact Report (DEIR). Accordingly, discussion of the bike path and Second Street Santa Monica Terminus still remain in this report but no longer apply and should be disregarded.

Contents

Figures

Tables

1. INTRODUCTION

This report presents the results of the noise and vibration analysis prepared by ATS Consulting for the proposed Exposition Transit Project Phase 2. The analysis has included measurements to document existing conditions, predictions of the noise and vibration levels during construction and once the proposed project is operational, and an evaluation of measures to minimize the noise and vibration impacts.

Data used to prepare this section were taken from various sources, including the *Transit Noise and Vibration Impact Assessment* guidelines (Ref. 1), *FHWA Roadway Construction Noise Model User's Guide* (Ref. 2), noise and vibration studies prepared for other light-rail transit (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), and from the City of Culver City, City of Los Angeles, City of Santa Monica, and Los Angeles County general plans and municipal codes. Existing noise and vibration measurements were taken at 20 sites along the proposed alignment from April 12 through December 6, 2007.

A brief introduction to noise and vibration fundamentals is provided in Appendix A, which also contains definitions of the key technical terms used in this report. The measurements to characterize the existing noise and vibration conditions are summarized in Section 2. Additional details on the noise and vibration measurements are contained in Appendices B and C. Section 3 presents the regulatory framework for the noise and vibration assessment including the criteria used to identify impacts and the locations where mitigation measures were evaluated. The methodology used to identify the impacts is presented in Section 4 along with the models used to predict future noise and vibration levels. The results of the analysis are presented in Section 5, with the potential mitigation measures discussed in Section 5.3. Appendix D shows the sensitive receptor clusters used in the analysis and shows the locations where noise and vibration impacts are predicted.

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 report. The supplementary measurements and analyses that have been performed in response to the comments received on the DEIR are summarized in Appendix E.

1.1 Project Summary

The proposed project would involve the implementation of new or upgraded corridor transit solutions within a western portion of Los Angeles County in the cities of Los Angeles, Culver City, and Santa Monica. Six alternatives are analyzed. The alternatives include the No Build, Transportation System Management (TSM), and four Light-Rail Transit (LRT) alternatives (see below). The LRT alternatives include two alternative alignments on the east end connecting to the Phase I terminus station and two alternatives on the west end connecting to the Santa Monica Terminus Station at approximately 4th Street and Colorado Avenue. A brief description of these alternatives and the alignment options is provided below.

1.1.1 No Build Alternative

The No Build Alternative includes only Metro service features that currently exist or have been explicitly committed for project buildout in the year 2030. As such, the No Build Alternative includes existing Metro rail services, Metro bus rapid transit (BRT) systems currently under operation, the Expo Phase 1 Light-Rail Transit Project (under construction), the full implementation of the Metro Rapid Bus program, represented as 28 routes across Los Angeles County, and planned peak-only rapid bus lanes along Wilshire Boulevard between Western Avenue and Bundy Drive. The rest of the bus network is based on June 2007 service patterns for Metro, Los Angeles Department of Transportation, Culver City, and Santa Monica Big Blue Bus, as well as committed enhancements to those services anticipated by 2030. Based on direction from Metro, their bus fleet will be assumed to include a mix of articulated and higher-capacity 45-foot buses in 2030.

1.1.2 Transportation System Management (TSM) Alternative

The TSM Alternative seeks to address the corridor transit needs without major capital investments and includes the improvements outlined in the No Build Alternative. The TSM Alternative includes three basic components: (1) addition of a rapid bus route connecting downtown Culver City with downtown Santa Monica; (2) associated service improvements on selected north/south routes to feed stations along the new rapid bus route; and (3) service improvements on selected routes, connecting Westside communities to the Phase 1 Terminus.

1.1.3 Light-Rail Transit (LRT) Alternatives

LRT is defined as a metropolitan electric railway system characterized by its ability to operate single cars or short trains along exclusive ROWs at ground level, on aerial structures, in subways, or, occasionally, in streets, and to board and discharge passengers at track or car-floor level. Light-rail vehicles are driven electrically with power drawn from an overhead electric line.

The LRT Alignments would extend rail from the current Phase I terminus station at Venice/Robertson to a terminus station in Santa Monica at approximately 4th Street and Colorado Avenue. As noted above, there are two alignment options on the eastern end of the corridor connecting to the Phase I Terminus Station at Venice/Robertson; a common middle segment between Sepulveda Boulevard and Cloverfield Boulevard; and two alignment options from Cloverfield Boulevard to the proposed terminus station at approximately 4th Street and Colorado Avenue.

1.2 Project Location

1.2.1 Geographic Segments

The proposed project traverses several jurisdictions, including the cities of Los Angeles, Culver City, and Santa Monica, and spans distinct communities within each jurisdiction. The alignment options have been divided into geographic segments for ease of analysis. For the area between the Phase I terminus and the Exposition/Sepulveda intersection, there are two alternative alignments: Segment 1 Expo ROW and Segment 1a Venice/Sepulveda. Segment 2 Sepulveda

to Cloverfield is common to all LRT Alternatives. For the area between the Cloverfield/Olympic intersection and a terminus in Santa Monica, there are also two alternative alignments: Segment 3 Olympic and Segment 3a Colorado. Thus, the segments are:

- *Segment 1 Expo ROW*—Runs from the Expo Phase 1 terminus station in Culver City, following the ROW to the Exposition/Sepulveda intersection.
- *Segment 1a Venice/Sepulveda*—Runs from the Expo Phase 1 terminus station in Culver City, west through the median in Venice Boulevard to the Venice/Sepulveda intersection. The alignment would become aerial at the intersection and continue aerial along Sepulveda Boulevard until the intersection of Charnock Road and Sepulveda Boulevard. The alignment would come down to grade at Charnock Road for a short stretch, and then become aerial again until north of National Boulevard, where it would return to grade to travel through the median in Sepulveda Boulevard and rejoin the ROW at the Exposition/Sepulveda intersection.
- *Segment 2 Sepulveda to Cloverfield*—Runs from the Exposition/Sepulveda intersection, following the ROW through to Cloverfield Boulevard and Olympic Boulevard.
- *Segment 3 Olympic*— Runs from the Cloverfield/Olympic intersection, following the median in Olympic Boulevard to the terminus at 4th Street and Colorado Avenue in Santa Monica.
- *Segment 3a Colorado*—Running from just west of Cloverfield Boulevard, the LRT alignment would continue in the ROW from 22nd Street to west of 19th Street; the alignment would then diverge from the ROW and enter onto Colorado Avenue east of 17th Street and continue along the center of Colorado Avenue to the terminus between 4th Street and Main Street in Santa Monica.

These segments combine to create four LRT Alternatives as described below:

- LRT Alternative 1: Expo ROW–Olympic Alternative (LRT 1: Expo ROW–Olympic Alternative) would utilize approximately 5 miles of the existing Exposition ROW from the Expo Phase 1 Terminus until reaching the intersection with Olympic Boulevard in Santa Monica. From that point, the alignment would follow Olympic Boulevard to the proposed terminus station. (Segments 1, 2 and 3)
- LRT Alternative 2: Expo ROW–Colorado Alternative (LRT 2: Expo ROW–Colorado Alternative) would also utilize the existing Exposition ROW from the Expo Phase 1 Terminus until reaching the intersection with Olympic Boulevard in Santa Monica. From that point, the alignment would continue within the Exposition ROW to west of 19th Street, then diverge from the ROW and enter onto Colorado Avenue east of 17th Street and follow the center of Colorado Avenue to the proposed terminus. (Segments 1, 2 and 3a)
- LRT Alternative 3: Venice/Sepulveda–Olympic Alternative (LRT 3: Venice/Sepulveda–Olympic Alternative) would divert from the Exposition ROW at the Expo Phase 1 Terminus and follow Venice Boulevard and Sepulveda Boulevard until reaching the intersection with the Exposition ROW. The alignment would then continue westward along the Exposition ROW and Olympic Boulevard identical to the LRT 1: ROW-Olympic Alternative. (Segments 1a, 2 and 3)
- LRT Alternative 4: Venice/Sepulveda–Colorado Alternative (LRT 4: Venice/Sepulveda–Colorado Alternative) would divert from the Exposition ROW at the Expo Phase 1

Terminus and follow Venice Boulevard and Sepulveda Boulevard until reaching the intersection with the Exposition ROW. The alignment would then continue westward along the Exposition ROW and Colorado Avenue identical to the LRT 2: ROW-Colorado Alternative. (Segments 1a, 2 and 3a)

This analysis addresses impacts at the segment level, which is then combined to reflect the Alternatives in the ~~DEIS/D~~FEIR.

In response to comments received on the DEIR and after further analysis and coordination with various stakeholders, five design options have been added in the FEIR for the LRT Alternatives:

- Sepulveda Grade Separation Design Option
- Expo/Westwood Station No Parking Design Option
- Maintenance Facility Buffer Design Option
- Colorado Parking Retention Design Option
- Colorado/4th Parallel Platform and South Side Parking Design Option

1.2.2 Stations

Table 1 (Station Locations) provides a description of the location of each station within the various segments, including the approximate location and whether the proposed station would be at grade or aerial in design.

Table 1 Station Locations

Name	Location	LRT—ROW Alignment	LRT—Venice/ Sepulveda Alignment	Number of Parking Spaces
Segment 1 Expo ROW				
National/Palms Station	Exposition between Clarington Avenue and Palms Boulevard	On Embankment	N/A	0
Expo\Westwood Station	Within Expo ROW, east of Westwood Boulevard ~~on Exposition Boulevard~~	At grade	N/A	170
Segment 1a Venice/Sepulveda				
Venice/Motor Station	Venice Boulevard, east of Motor Avenue	N/A	At grade	0
Venice/Sepulveda Station	On Venice Boulevard, east of Sepulveda Boulevard	N/A	Aerial	0
Sepulveda/National Station	National Boulevard and Sepulveda Boulevard	N/A	Aerial	252
Segment 2 Sepulveda to Cloverfield				
Expo/Sepulveda Station	East of Sepulveda Boulevard and Exposition Boulevard	At grade (aerial design option)	At grade (aerial design option)	260

Table 1 Station Locations

Name	Location	LRT—ROW Alignment	LRT—Venice/ Sepulveda Alignment	Number of Parking Spaces
Expo/Bundy Station	Bundy Drive and Exposition Boulevard	Aerial	Aerial	250
Olympic/26th Street Station	Cloverfield Boulevard, west of 26th Street	At grade	At grade	0
Segment 3 Olympic				
Olympic/17th Street Station	17th Street and Olympic Boulevard	At grade	At grade	0
Colorado/4th Street Station	On the existing commercial block bounded by 4th Street, ~~east of~~ 5th Street, and Colorado Avenue	Aerial	Aerial	~~225~~0
Segment 3a Colorado				
Colorado/17th Street Station	Between 16th Street and 17th Street on Colorado Avenue	At grade	At grade	70
Colorado/4th Street Station	~~Colorado Avenue, west of~~ On the existing commercial block bounded by 4th Street ~~or Colorado Avenue, east of 4th~~, 5th Street, and Colorado Avenue	At grade	At grade	~~225~~0

Source: DMJM Harris, 2008; updated 2009.

1.2.3 Maintenance Facilities

A maintenance facility would also be constructed along the alignment corridor in Santa Monica on a 6.9~~.17~~-acre area directly south of the ROW and east of Stewart Street, referred to as the Stewart Street Maintenance facility. The maintenance facility would store between 25 and 30 LRT vehicles during mid-day and in the evening. The facility would be equipped to provide vehicle cleaning, maintenance, wheel truing facilities, and light repairs. The maintenance facility would include crew quarters and would be staffed 24 hours per day. The maintenance facility would include a minimum 8- to 12-foot security wall per *Metro Design Criteria*.

Since the release of the DEIR and in response to comments, the Expo Authority has worked with the City of Santa Monica, Metro, and the community to identify alternative layouts for the Maintenance Facility. As a result of these collaborative efforts, a Maintenance Facility Buffer Design Option has been developed for evaluation in the FEIR. This design option would occupy only a portion of the Verizon site, with an extension of the facility into the existing Santa Monica City College parking lot to the west. Utilization of the adjacent parking lot on the west side of the Verizon site would create an approximate 100- to 110-foot buffer between the Maintenance Facility and the residential area on the south side of Exposition Boulevard. The Maintenance Facility Buffer Design Option would include much of the same facilities as the original Maintenance Facility concept, including a minimum 8- to 12-foot security wall per *Metro Design Criteria*.

1.2.4 Traction Power Substations

Traction Power Substations (TPSS) are electrical substations that redistribute the electrical current needed to power the LRT. A TPSS is typically a prefabricated structure approximately 15 feet wide by 43 feet long by 16 feet high. The TPSS site would also include space for utility power equipment, manholes, pull box, ground grid, perimeter fencing, and vehicle access. The entire TPSS site would be on the order of 80 feet by 45 feet.

1.2.5 Other Related Facilities

The project will also include a variety of additional structures and equipment to accommodate the project. These generally include:

- **Overhead Contact System (OCS):** electrical wires and related support structure that carries power to the LRT system.
- **Communications and Signal Buildings (C&S):** structures generally 25 feet by 10 feet long and 12 feet high containing train controls and communications equipment for the LRT.
- **Radio Towers:** towers that are generally up to 70 feet in height providing two-way radio communications for the operations and maintenance of the LRT.
- **Crossing Gates:** provided at street and pedestrian crossings to facilitate safe interaction between the LRT trains and automobiles, trucks and pedestrians.
- **Fencing and Walls:** fencing and walls may be used along the project to control pedestrian access to the trackway and to mitigate noise impacts.

This list is not all inclusive, but does address the primary types of related structures.

1.3 Noise and Vibration Sources Associated with 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 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 dB change in sound levels. Therefore, a detailed assessment of noise effects 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. The existing shielding has been assumed to provide noise protection, ranging from 2 to 7 dB depending on the degree to which the structures currently block the view of traffic on Venice or Sepulveda. 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, Segment 3 (Olympic), and Segment 3a. 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 will 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 effects 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:** Transit power substations (TPSS) are the only ancillary equipment associated with the proposed project with potential for creating noise effect. 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. 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.

2. AFFECTED ENVIRONMENT

2.1 Existing Conditions—Noise

The existing noise conditions along the proposed Exposition Corridor Transit Project Phase 2 were documented through monitoring performed at representative noise sensitive sites along the proposed alignments. This section provides a summary of the measurement results; refer to Appendix B for detailed measurement results and descriptions of the measurement locations.

Noise-sensitive land uses were identified using preliminary alignment drawings, aerial photographs, and visual surveys. Noise measurements at ~~20~~twenty-one locations along the proposed alignments were taken during the period from April 12 through December 6, 2007. Supplemental noise measurements were taken between May 20, 2009 and November 15, 2009. Estimating existing noise exposure is an important step in the noise impact assessment because the thresholds for noise impact 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 ~~15~~seventeen sites 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 alignment. The general locations of the long-term measurement sites are shown in Figure 1 (Noise Measurement Sites, Segment 1) through Figure 5 (Noise Measurement Sites, Segment 3a). Table 2 (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 ~~six~~seven sites. The general locations of the short-term measurement sites are shown in Figure 1 through Figure 5. The short-term measurement sites were selected to be representative of ~~the institutional~~ land uses within the proposed segments ~~(e.g.,~~including schools, churches, temples, and recording studios~~)~~. Table 3 (Summary of Short-Term Measurement Results) gives the details of each individual short-term measurement.

Note that the results of the supplementary measurements that were taken at Groove Master Studios, 18th Street Arts Center, Overland Avenue Elementary School, Crossroads Elementary School, Lantana Campus, and the Green Line yard are provided in Appendix E.

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. The key measures of noise exposure used in this study are:

- **Equivalent Sound Level (L_{eq}):** L_{eq}, which is sometimes referred to as the energy average sound level, is the most common means of characterizing environmental noise. L_{eq} represents a constant sound that, over the specified period, has the same sound energy as the time-varying sound. Maximum 1-hour L_{eq} is used by the Federal Transit Administration (FTA) to evaluate noise impacts at institutional land uses such as schools, churches, and libraries from proposed transit projects (FTA Category 3, see Section 3.2).

Source: Metro, 2008; DMJM Harris, 2008

Figure 1 Noise Measurement Sites, Segment 1 [Revised]

Source: Metro, 2008; DMJM Harris, 2008

Figure 2 Noise Measurement Sites, Segment 1a

Source: Metro, 2008; DMJM Harris, 2008

Figure 3 Noise Measurement Sites, Segment 2 [Revised]

Source: Metro, 2008; DMJM Harris, 2008

Figure 4 Noise Measurement Sites, Segment 3

Source: Metro, 2008; DMJM Harris, 2008

Figure 5 Noise Measurement Sites, Segment 3a [Revised]

- **Day-Night Sound Level (L_{dn}):** L_{dn}, which is also abbreviated as DNL, is the most common measure of a 24-hour noise environment for residential land uses. It is basically a 24-hour L_{eq} with an adjustment added to noise that occurs during the nighttime hours when many people are more sensitive to environmental noise. Nighttime is defined as 10 PM to 7 AM. The adjustment has the effect of making an event that occurs during the nighttime hours equivalent to 10 of the same event during the daytime hours. That is, in calculating L_{dn}, one train between 10 PM and 7 AM is equivalent to 10 trains between 7 AM and 10 PM. L_{dn} is the metric used to evaluate noise impact for residential land uses (FTA Category 2, see Section 3.2). Note that L_{dn} is very similar to the Community Noise Equivalent Level (CNEL), which is used in the General Plans and noise guidelines of a number of California cities. The only difference between CNEL and L_{dn} is that CNEL adds a 5 decibel adjustment to evening noise (between 7 PM and 10 PM) in addition to the nighttime adjustment. In most cases, CNEL will be 0 to 0.5 decibels greater than L_{dn}.

See Appendix A for a brief introduction to noise fundamentals and the definitions of some of the other noise metrics that were calculated.

Both L_{dn} and L_{eq} are measures of *noise exposure* in that they measure the total noise environment 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 will increase L_{eq} and L_{dn} by an infinitesimal amount; a loud sound such as an emergency vehicle siren can end up dominating L_{eq} and L_{dn} even if the sound only occurs for a few minutes per day. Although a number of different measures of noise exposure have been considered 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 transportation noise.

The overall noise monitoring results are summarized in Table 2 (Summary of Long-Term Measurement Results) and Table 3 (Summary of Short-Term Measurement Results). Following are brief discussions of the noise measurement sites and the measurement results:

Long-Term Measurement Sites

LT-1: A long-term measurement was taken in the side yard of a multi-family residence located adjacent to Exposition Boulevard between Faris Drive and Watseka Avenue. The primary noise source in the area is vehicular traffic on I-10. The measurement position was 25 feet from Exposition Boulevard, 100 feet from the Expo ROW tracks that are still in place, and 180 feet from the nearest eastbound lane of I-10. The noise measurement was started at 8:38 AM on May 14, 2007 and completed at 4:00 AM on May 16, 2007. The measured L_{dn} was ~~67~~ 68 dBA and the maximum 1-hour L_{eq} was 71 dBA between 2 and 3 PM on May 15, 2007. Hourly L_{eq}s during daytime hours were consistently around 65 dBA.

LT-2: The measurement site was in the front yard of a single-family residence located at the southeast corner of Northvale Road and Dunleer Drive. The primary noise source in this area is vehicular traffic on I-10 and on the westbound on- and off-ramps for I-10. The measurement position was 35 feet from edge of Northvale Road, 140 feet from the tracks that are still in place in the Expo ROW and 210 feet from off-ramp of the westbound lane I-10. The noise measurement was performed for 10 hours on May 15, 2007, 24 hours on May 16, 2007, and 9 hours on May 17, 2007. The measured L_{dn} was 65 dBA.

Table 2 Summary of Long Term Measurement Results

Site No. and Segment	Location	Primary Noise Source	Measurement Start		Duration	Meas. L_{dn} (dBA)
			Date	Time		
Segment 1						
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 P~~2:00 A~~P~~.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~~[a]59[c]
LT-16.1[d]	Bungalow Classroom Exterior	Overland Avenue	08/17/09	10:21 A.M.	54 Hrs	64[e]
LT-16.2[d]	Bungalow Classroom Interior	HVAC System, Overland Avenue	8/17/09	11:30 A.M.	54 Hrs	39[e]
Segment 1a						
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						
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

Table 2 Summary of Long Term Measurement Results

Site No. and Segment	Location	Primary Noise Source	Measurement Start		Duration	Meas. L_{dn} (dBA)
			Date	Time		
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
Segment 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.	~~48~~24 Hrs	~~67~~71
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.	~~48~~24 Hrs	~~71~~67
Segment 3a						
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
LT-17[d]	Crossroads Elementary School	18th Street/Parking Lot, Olympic Blvd	05/20/09	8:00 A.M.	10 Hrs	57[e]
Green Line Maintenance Yard						
LT-18.1[d]	Entrance to Green Line Yard	Green Line Train activity	6/17/09	8.25 P.M.	24 Hrs	64
LT-18.2[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 Ldn 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 in the DEIR to have an existing noise level of 60 dBA Ldn based on the results at nearby measurement sites. This approach ensures that noise effects 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. The daytime L_{eq} is the noise metric for institutional land uses.

Table 3 Summary of Short-Term Measurement Results

Site No. and Segment	Location	Primary Noise Source	Measurement Start		Measured L_{eq} (dBA)
			Date	Time	
Segment 1					
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					
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 (no short-term measurements performed in Segment 2)					
Segment 3					
ST-1	Southeast corner of 21st St. and Olympic Blvd.	Olympic Blvd.	04/12/07	2:06 P.M.	66
Segment 3a ~~(no short-term measurements performed in Segment 3a)~~					
ST-7a[b]	Groove Masters Studio 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.

LT-3: Noise levels were measured for a 24-hour period in the backyard of a single-family residence located adjacent to the Expo ROW on Dunleer Place. The primary noise source in this area is vehicular traffic on I-10. The measurement position was 60 feet from the tracks that still are in place in the Expo ROW. The noise measurement was performed for 4 hours on May 8, 2007 and 20 hours on May 9, 2007. The measured L_{dn} was 59 dBA, 6 decibels lower than at LT-2, which is in the same general area but on the opposite side of the Expo ROW. The lower sound levels are because of the acoustical shielding of I-10 traffic provided by the terrain. A maximum 1 hour L_{eq} of 70 dBA was recorded at 10 a.m. on the second day of the measurement. As can be seen in Table 2 (Summary of Long Term Measurement Results), the L_{eq} for this hour was approximately 15 decibels higher than the L_{eq} for any other hour. The L_{dn} and L_{eq} (day) were 56 dBA and 51 dBA respectively when results from 10 a.m. are excluded from the calculation.

LT-4: Site LT-4 was at a single-family residence located on the northeast corner of Northvale Drive and Roundtree Road. The major noise sources in this area are vehicular on traffic I-10, arterials such as Overland, and local streets such as Northvale Drive. The microphone was

placed in the side yard of the residence 30 feet from Northvale Drive. The noise measurement was performed for 4 hours on May 8, 2007 and 20 hours on May 9, 2007. The measured L_{dn} was 59 dBA.

LT-5: Measurement Site LT-5 was in the backyard of a single-family residence located on Ashby Avenue between Overland Boulevard and Westwood Boulevard. The primary noise source in this area is vehicular traffic on Overland Boulevard plus the constant background noise of traffic on I-10. The measurement position was 100 feet from Ashby Avenue and 125 feet from the tracks that still are in place in the Expo ROW. The noise measurement was performed for 4 hours on May 8, 2007 and 20 hours on May 9, 2007. The measured L_{dn} was 58~~7~~ dBA, a relatively low noise level that shows that the measurement site was not directly exposed to major noise sources.

LT-6: Site LT-6 was in the side yard of a single-family residence located on the north side of Exposition Boulevard east of Military Avenue. Noise sources in this area include vehicular traffic on I-10 and I-405, which are both approximately 1/4 mile from the residence, traffic on local streets such as Military Avenue, and traffic on nearby arterials. The resident also mentioned noise from aircraft approaching Santa Monica Airport. The microphone was located 30 feet from Exposition Boulevard and 115 feet from the center of the Exposition alignment. The noise measurement was performed for 8 hours on May 16, 2007 and 12 hours on May 17, 2007. The measured L_{dn} was ~~67~~59 dBA~~, which represents a relatively high noise level for a residential community and is substantially higher than the measured at other locations in the same area (e.g., LT-5 and LT-7). To avoid understating the noise impacts, the results at this site have not been used to define existing noise levels for any areas along the Expo ROW~~.

LT-7: The measurement site was in the side yard of a multi-family residence on Exposition Boulevard two blocks west of the I-405. Vehicular traffic is the primary noise source in this area including traffic on local arterials (Exposition Boulevard and Sawtelle Boulevard) and traffic on I-10 and I-405. The measured L_{dn} was 63 dBA, which is lower than would be expected this close to a major freeway. This appears to be because the measurement site was partially shielded from I-405 noise. I-405 is elevated in this area and the roadway edge blocks the direct view of the roadway and acts as an acoustic shield.

LT-8: Site LT-8 was in the front yard of a multi-family residence located adjacent to Exposition Boulevard between Bundy Drive and Westgate Avenue. Traffic noise from Bundy, Exposition and I-10 is the dominant noise source at this location. The measurement position was 30 feet from Exposition Boulevard. The measured L_{dn} was ~~57~~59 dBA at this site.

LT-9: The monitor for this measurement was placed in the front yard of a multi-family residence on Exposition Boulevard between Dorchester Avenue and Centinela Avenue. The microphone was 25 ft from Exposition Boulevard. This is a relatively quiet residential area. The measured L_{dn} was ~~59~~60 dBA at this site.

LT-10: Site LT-10 was located in the parking lot of the Crossroads High School at a distance of 25 ft from the edge of Olympic Boulevard. Traffic on Olympic was the primary noise source. Olympic Boulevard is a heavily traveled arterial, which is reflected in the relatively high measured L_{dn} of 71~~0~~ dBA.

LT-11: Site LT-11 was located in the parking lot of the Crossroads Elementary School on the north side of Olympic between 17th and 18th Street. Traffic on Olympic was the main noise source with contributions from the children on the playground. The last hour of the

measurement was particularly loud because of a school event on the playground near the microphone. The measured L_{dn} excluding the last hour was ~~66~~67 dBA.

LT-12: Site LT-12 was located in the front yard of a single-family residence and catering business on Venice Boulevard. Vehicular traffic on Venice Boulevard was the primary noise source at this measurement location. The microphone was located at 30 feet from Venice Boulevard, which is the approximate set-back distance of the residence from Venice. The measured L_{dn} was 74 dBA.

LT-13: Site LT-13 was in the front yard of the UCLA residences located on the west side of Sepulveda Boulevard between Queensland Street and National Boulevard. The major noise source in this area is vehicular traffic on Sepulveda Boulevard. The measurement position was 25 feet from Sepulveda Boulevard. The measured L_{dn} was 71 dBA.

LT-14: A long-term measurement was taken in the front yard of a business located on the south side of Colorado Avenue between 5th Street and 6th Street. The primary noise source in this area is vehicular traffic on Colorado Avenue. The measurement position was 25 feet from the nearest lane of Colorado Avenue. The measured L_{dn} was 68 dBA.

LT-15: Site LT-15 was in the front yard of residences located on the south side of Exposition Boulevard just east of Stewart Street. The major noise sources in this area is vehicular traffic on I-10, Exposition Boulevard, and Olympic Boulevard. The measurement position was eight feet from Exposition Boulevard. The measured L_{dn} was 58 dBA. The site was chosen to record ambient noise levels at the closest residence to the proposed Stewart Street maintenance facility.

LT-16: A simultaneous indoor-outdoor measurement was taken at one of the classrooms at Overland Avenue Elementary School that is closest to the Exposition Right-of-Way. The measured daytime L_{eq} for the indoor measurement was 39 dBA while the outdoor daytime L_{eq} was measured at 64 dBA. See Appendix E for more details on the measurement location and results.

LT-17: Site LT-17 was located in the rear parking lot of Crossroads Elementary School. The microphone was placed 17 feet from the exterior wall of the auditorium and 84 feet from the edge of 18th Street. The measured daytime L_{eq} was 57 dBA. See Appendix E for more details on the measurement location and results.

LT-18: Two long-term measurements were performed at the Green Line Yard. The yard is located in West Hawthorne and has similar attributes to the proposed Stewart Street Yard. See Appendix E for more details on the measurement locations and results.

Short-Term Measurement Sites

ST-1: A measurement was taken at the intersection of Pennsylvania Avenue, 21st Street, and Olympic Boulevard, near the Crossroads High School. The primary noise source in this area is vehicular traffic on Olympic Boulevard. The microphone was placed 5 feet from the edge of 21st street and 50 feet from Olympic Boulevard. The noise measurement was performed for 30 minutes on April 12, 2007 at 2:06 pm. The measured L_{eq} was 66 dBA.

ST-2: The location for this measurement was at the intersection of Exposition Boulevard and Westwood Boulevard. Vehicular traffic on Westwood Boulevard is the primary noise source in

this area. The measurement position was 15 feet from the southeast corner of the intersection. The noise measurement was performed for 30 minutes on April 12, 2007 at 3:18 pm. The measured L_{eq} was 67 dBA.

ST-3: The measurement site was located outside the Overland Avenue Elementary School, on the east side of Overland Avenue. The primary noise source in this area is vehicular traffic on Overland Avenue. The measurement position was 15 feet from Overland Avenue. The measured L_{eq} was 67 dBA.

ST-4: Site ST-4 was located on the east side of Sepulveda Boulevard south of Palms Boulevard. The primary noise source in this area is vehicular traffic on Sepulveda Boulevard. The measurement position was 25 feet from the edge of Sepulveda Boulevard. The measured L_{eq} was 70 dBA.

ST-5: Site ST-5 was located on the south side of Venice Boulevard near Mentone Avenue. The primary noise source in this area is vehicular traffic on Venice Boulevard. The microphone was placed 25 feet from the edge of Venice Boulevard. The measured L_{eq} was 69 dBA.

ST-6: Site ST-6 was located in a parking lot on the north side of Venice Boulevard between Watseka Avenue and Delmas Terrace. The primary noise source in this area is vehicular traffic on Venice Boulevard. The measurement position was 12 feet from the edge of Venice Boulevard. The measured L_{dn} was 71 dBA.

ST-7: Simultaneous indoor-outdoor noise measurements were performed at Groove Masters Studio located at the corner of Colorado Avenue and 14th Street in Santa Monica. See Appendix E for more details on the measurement location and results.

The measured L_{dn} values varied from 57 to 74 dBA. Although the measured L_{dn} varied over a 17 decibel range, the measurements at all of the 24-hour sites show a similar diurnal variation in sound levels. The daytime levels are fairly constant and start to drop around 8 PM. The minimum sound levels occur between 2 and 4 AM and are 5 to 10 decibels lower than the daytime levels. The sound levels start to rise after 5 AM and reach the daytime levels by 7 AM. The measured L_{dn} was strongly dependent on the distance of the measurement site from major sources of traffic noise. These sources included the I-10 and I-405 freeways, major arterials such as Overland and Centinela, and intermittent local traffic. Although overflights from Santa Monica Airport were observed, they did not appear to have more than a minor influence on the measured L_{dn} at any of the sites.

Supplementary Measurements

In response to comments on the DEIR and additional consultations, measurements and analysis were performed at the following locations. Measurements taken at these sites are supplemental to previous measurements:

- 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
- The 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 example, measurements taken at Overland Elementary School and Crossroads Elementary School where substantially more detailed than measurements taken previously. 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 2 (Summary of Long-Term Measurement Results) and Table 3 (Summary of Short-Term Measurement Results). More information can be found in the Appendix E.

2.2 Existing Conditions—Vibration

2.2.1 Vibration Propagation Test Procedure

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 such soil stiffness, soil layering, and depth to bed rock, have a strong effect 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 ground vibration. As a result, most detailed predictions of ground vibration are largely based on empirical methods that involve measuring vibration propagation in the soil. The FTA defines three levels of vibration assessment (Ref. 1):

1. Screening: Generalized distances of potential effects are used to quickly determine whether there is any potential for an effect.
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 effects. 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 (Ref. 1). 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. This is illustrated in Figure 6 (Schematic of Vibration Propagation Test).

The vibration predictions for Expo Phase 2 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 using an impact vibration source and accelerometers as shown in Figure 6. As indicated in the figure, at most sites the impacts were performed at 11 positions along a line at the proposed track centerline (referred to in the figure as "line of impacts"). The DEIR measurements were supplemented with measurements at the Overland Elementary School, 18th Street Arts Center, Groove Masters Studio, and Lantana Campus.

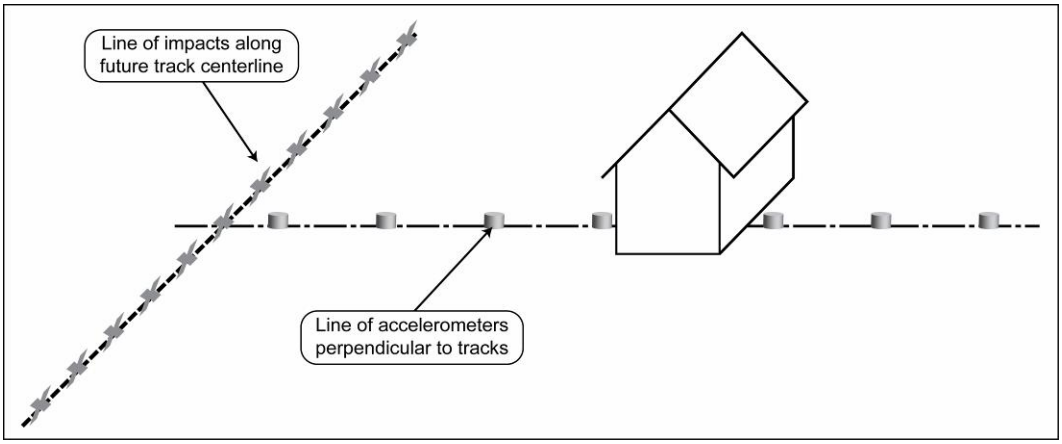


Figure 6 Schematic of Vibration Propagation Test

The effects of the soil conditions are characterized by the transfer function relationship between the impact force and the vibration created at each accelerometer by the impact. This function is referred to as the "transfer mobility." The transfer mobility indicates how easily vibration travels through the earth.

The measured transfer mobility functions for each accelerometer are combined using numerical integration to derive an equivalent line-source transfer mobility. The relationship between the line-source transfer mobility (LSTM) and the groundborne vibration created by a light-rail vehicle (L_v) is:

$L_v = FDL + LSTM$

where:

L_v = Train vibration velocity measured at the ground surface
FDL = Force density function that characterizes the vibration forces generated by the train and track
LSTM = Measured line source transfer mobility
(all quantities are in decibels assuming a consistent set of decibel reference values)

The FDL used for this project was developed from measurements on a ballast and tie track section just to the north of the Gold Line Chinatown Station. The results of the Gold Line measurements and the derived FDL functions for welded track and for crossovers are summarized in Appendix C. It is expected that the vehicle and track system used for the Expo

Phase 2 will be similar to that used on the Los Angeles to Pasadena section of the Gold Line; therefore the Gold Line measurement results are directly applicable to Expo Phase 2. The prediction curves developed from the propagation testing are presented in Section 4.3.

2.2.2 Vibration Propagation Test Sites

The ~~10~~ 14 sites for the vibration propagation tests were selected to represent the soil conditions of all sensitive receptors along the alternative alignments being evaluated for Expo Phase 2. Details on the measurement sites and the measurement results are presented in Appendix C. The general locations of the ~~10~~ 14 test sites are shown in Figure 7 (Vibration Propagation Test Sites) and are described below:

Note that supplementary measurements were taken at Groove Master Studios, 18th Street Arts Center, Overland Avenue Elementary School, and Lantana Campus. The results of these tests are provided in Appendix E.

V1—Exposition Boulevard/Watseka Avenue: The measurement site was located at the intersection of Exposition Boulevard and Watseka Ave, south of the Santa Monica Freeway (I-10). The impact line was along the edge of Exposition Boulevard and the transducers were installed on the sidewalk of Watseka Boulevard at distances of 25 ft, 50 ft, 75 ft, 100 ft, 150 ft, and 200 ft from the impact line.

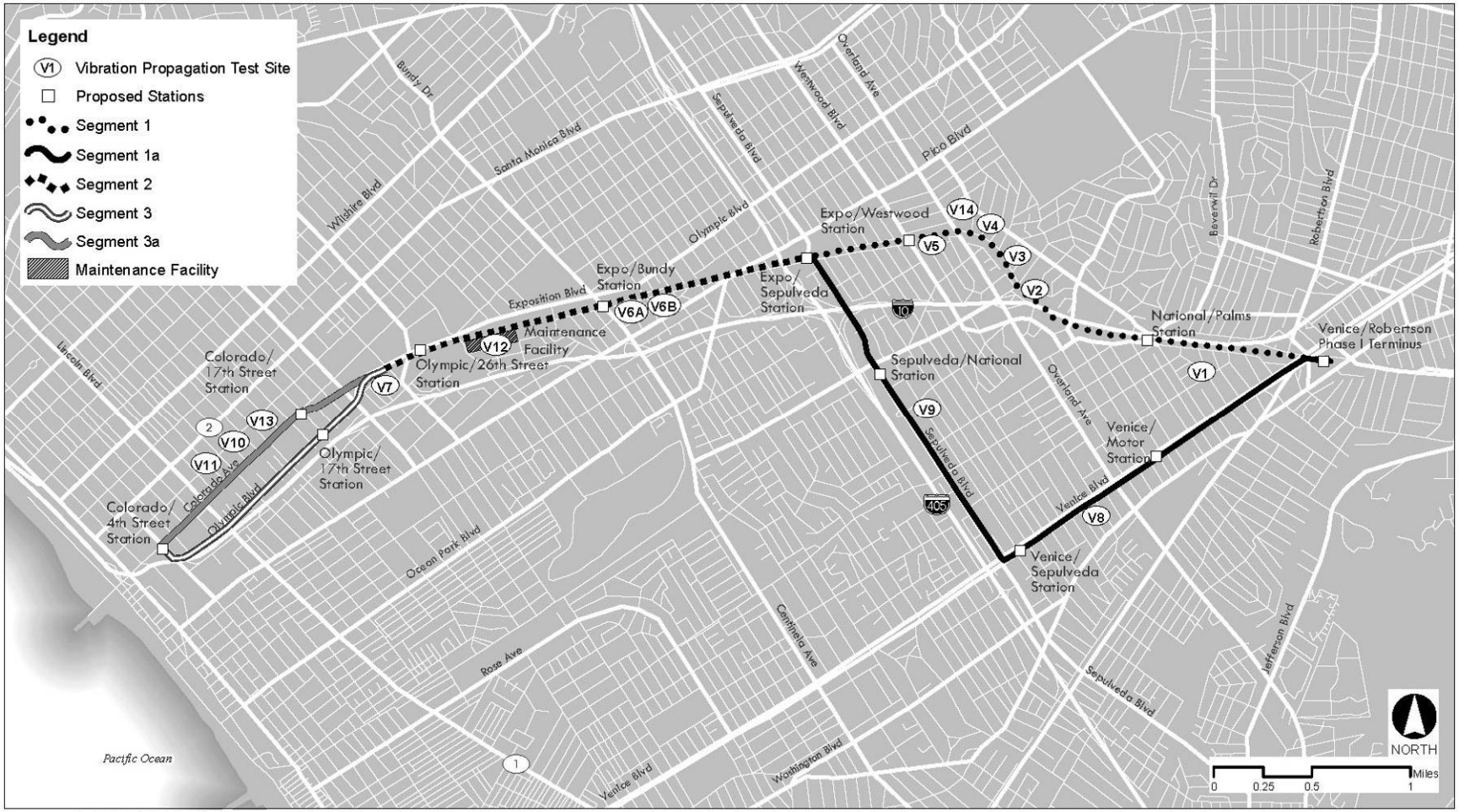
V2—Cheviot Hills/Northvale Road: This measurement was located north of the I-10 and west of Northvale Road where the Expo ROW is in a trench. The impact line was at the bottom of the trench parallel to the existing tracks. The transducers were located at distances of 25 ft, 37.5 ft, 50 ft, 62.5 ft, 75 ft, and 100 ft from the impact line. Two of the transducers were located on the slope, two were on the west side of Northvale at the top of the slope, and the other two were installed on the east side of Northvale Road.

V3—Cheviot Hills/Palms Park: This measurement was performed in the right-of-way east of Palms Park. The impact line was parallel to the existing tracks in the Expo ROW. Two transducers were located on the slope west embankment and four transducers were installed in the park at the top of the slope. The transducers were located at distances of 10 ft, 20 ft, 55 ft, 75 ft, 100 ft, and 150 ft from the center of the impact line.

V4—Overland Avenue Elementary School: This measurement was performed south of Overland Avenue Elementary school. The impact line was parallel to the existing rail tracks. The transducers were located along Putney Road at distances of 25 ft, 50 ft, 60 ft, 105 ft, 150 ft, and 200 ft from the impact line.

V5—Exposition/Westwood: This measurement was located close to Westwood Boulevard and Exposition Boulevard. The impact line was along the edge of Exposition Boulevard just east of Westwood Boulevard. The transducers were located in an alley at distances of 25 ft, 50 ft, 75 ft, 90 ft, 140 ft, and 180 ft from the impact line.

V6A—Exposition/Westgate: This site was located between Bundy Drive and Barrington Avenue. The impact line was located on Exposition Boulevard and the transducers along Westgate Avenue at distances of 25 ft, 50 ft, 75 ft, 100 ft, 150 ft, and 200 ft from the center of the impact line.



Source: PBS&J, ESRI, 2008.

Figure 7 Vibration Propagation Test Sites [Revised]

V6B—Exposition/Granville: Site V6B was in the same general location as Site V6A and was performed to confirm the results obtained at Site V6A, which appeared to be anomalous. This site was at Exposition and Granville one block east of Site V6A. The impact line was on Exposition Boulevard and the transducers placed on Granville Avenue at distances of 25 ft, 50 ft, 75 ft, 100 ft, 125 ft, and 150 ft from the impact line.

V7—Crossroads Elementary School (Olympic Boulevard/18th Avenue): The impact line for this test was located on the south side of Olympic and the transducers located on 18th Avenue at distances of 25 ft, 50 ft, 75 ft, 100 ft, 150 ft, and 200 ft from the impact line.

V8A&B—Venice Boulevard/Spad Place: This measurement site was located on Venice Boulevard west of Overland Avenue. The impact line was located on Venice and the transducers were located on Spad Place at distances of 25 ft, 50 ft, 75 ft, 100 ft, 150 ft, and 200 ft from the impact line.

V9—Sepulveda Boulevard/Queensland Avenue: This measurement was performed at the intersection of Sepulveda Boulevard and Queensland Street. The impact line was located on Sepulveda Boulevard and the transducers were mounted on Queensland Street at 25 ft, 50 ft, 75 ft, 100 ft, 150 ft and 200 ft from the center of the impact line.

V10—Colorado Ave/12th Court: This measurement was near the intersection of Colorado Avenue and Euclid Avenue. The impact line was on Colorado Avenue and the transducers were located at distances of 25 ft, 50 ft, 75 ft, 100 ft, 125 ft and 150 ft from the center of the impact line.

V11—Colorado Ave. 14th St.: This measurement was located at Groove Master Studios at the corner of Colorado Avenue and 14th Street. The impact line was in the number 1 westbound lane of Colorado Avenue. Transducers were installed both inside and outside the building.

V12—Lantana Campus: The Lantana Campus consists of five buildings roughly bounded by Olympic Boulevard to the north, Exposition Boulevard to the south, Stewart Street to the west, and Centinela Avenue to the east. Six propagation tests were performed at the Lantana Campus. The measurements locations were Lantana West (2900 Olympic Boulevard), Lantana Center (3000 Olympic Boulevard), Todd-AO (western end of 3000 Olympic Boulevard), Gray Martin Studios (also at western end of 3000 Olympic Boulevard), Lantana South (3030 Exposition Boulevard), and in the Verizon parking lot along Exposition Boulevard that is adjacent to the Lantana Campus.

V13—18th Street Arts Center: This measurement was taken at the 18th Street Arts Center. The impact line was along the center of the existing tracks behind the Arts Center. Transducers were placed both inside and outside the Arts Center.

V14—Overland Avenue Elementary School: This measurement was taken at the Overland Elementary School located at Overland Avenue and Ashby Avenue. The impact line was at the centerline of the existing tracks in the Expo ROW. Transducers were placed both inside and outside of the buildings.

Refer to Appendix E for further details on measurement sites V11 through V14.

2.2.3 Results of Vibration Propagation Tests

Detailed results of the vibration propagation tests along with maps showing the location of each site and the coefficients for the best-fit lines of LSTM vs. distance are given in Appendix C. Figure 8 (Measured Line-Source Transfer Mobilities) shows the measured LSTM for the 10 test sites at distances of 25, 50, 75, and 100 ft. The use of these results to develop prediction curves for vibration from light-rail operations is discussed in Section 4.3. A few observations from Figure 8 are:

- The large variation in the measured transfer mobility indicates that there is likely to be a large variation in the vibration levels along the proposed project alignment.
- The vibration levels at Site V6A near Bundy Drive are likely to be higher than at any of the other sites. There is no clear reason for this; a follow-up test was performed at Site V6B, one block east of Site V6A. The results at Site V6B are consistent with the other measurements in the project corridor. Therefore, it is clear that a very localized condition was responsible for the high transfer mobility measured at Site V6A.
- The measured transfer mobilities at Site V9 at Sepulveda and Queensland and Site V10 at Colorado and 12th in Santa Monica are consistently lower than at the other sites. This indicates that vibration levels at these sites would be lower than in the remainder of the project corridor.
- The measured transfer mobilities at most of the sites peak in the 25-to-50 Hz range, with the peak frequency dropping with increasing distance. Site V7 at Olympic and 18th Avenue is the only one that stands out as having a noticeably different frequency characteristic.
- The shape and magnitude of the transfer mobility curves at Sites V1, V2, V4, V5, V6B, and V9 are relatively consistent. Site V1, V2, V4, and V5 are along Segment 1 (Expo ROW), Site V6B is along Segment 2 (Sepulveda to Cloverfield) only one block from the Site V6A where the measured transfer mobility was substantially higher than any of the other sites, and Site V9 is along Sepulveda.
- The transfer mobility measured at Site V3 in Palms Park off of Overland Avenue was substantially lower than measured at the other sites including the three other sites in the same general area (V2, V4, and V5). To avoid underestimating vibration levels in this area, Site V3 was not used for the predictions.

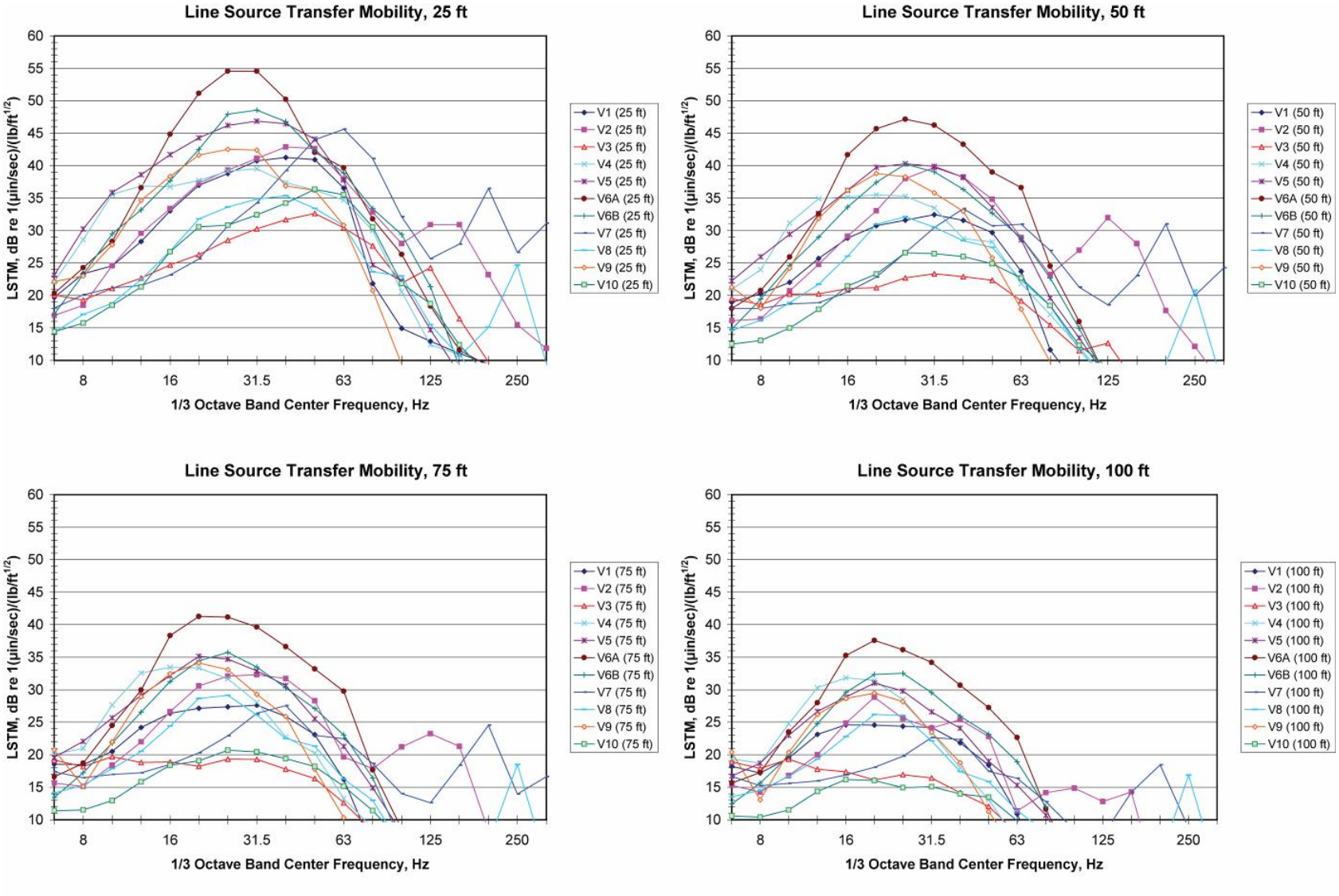


Figure 8 Measured Line-Source Transfer Mobilities

3. REGULATORY FRAMEWORK

3.1 State and Local Noise and Vibration Limits

There are no state statutes related to noise criteria that would apply to the proposed project. Even though the Expo Authority will not be seeking federal funding for the project the FTA Noise and Vibration guidelines have been used for this evaluation. The FTA guidelines, analysis methods, and criteria reflect the best available research on the topic.

The Expo Authority is not subject to compliance with local land use plans and regulations, including general plans and zoning, when constructing projects within Metro-owned rights-of-way. However, the Expo Authority seeks to cooperate with local jurisdictions to reduce any physical consequences of construction and operation to the extent feasible to do so. The City of Culver City, City of Los Angeles, City of Santa Monica, and Los Angeles County all have ordinances that place limits on construction noise and vibration.

3.2 Noise

The noise impact criteria to be used on federally financed transit projects are defined in the FTA Guidance Manual (Ref. 1). 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 4 (FTA Land Use Categories and Noise Metrics) lists the three land-use categories that FTA uses and the applicable noise metric for each category.

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 effect: moderate and severe. In accordance with the FTA Guidance Manual, noise mitigation to eliminate the effects must be investigated for both degrees of effect. The Manual also states that for severe effects "…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 effects in this study, the goal has been to reduce noise levels to below the moderate effect threshold. The FTA allows more discretion for mitigation of moderate effects, based on consideration of factors that include cost, number of sensitive receptors affected, community views, the amount that the predicted levels exceed the effect threshold, and the sensitivity of the affected receptors. The FTA noise impact criteria are given in tabular format in Table 5 (FTA Noise Impact Criteria) with the thresholds rounded off to the nearest decibel.

Table 4 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 is 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.

a. L_{eq} for the noisiest hour of transit related activity during hours of noise sensitivity

The criteria are shown graphically in Figure 9 (FTA Noise Impact Criteria) for the three different categories of land use along with an example of how the criteria are applied. The top two graphs are for nonresidential land uses where $L_{eq(h)}$ is used as the noise exposure metric, and the bottom left graph is for residential land uses where L_{dn} is used as the noise exposure metric. As seen in Figure 9, the impact threshold is a sliding scale. The existing noise is shown on the horizontal axis, and the amount of new noise that can be created by the project is on the vertical axis. The lower curve (blue) defines the threshold for Moderate Impact and the upper curve (red) defines the threshold for Severe Impact.

The concept of a sliding scale for noise impact is difficult to grasp and may be clarified by the example illustrated in the bottom right graph in Figure 9. Assume that the existing noise has been measured to be 60 dBA L_{dn}. This is the total noise from all existing noise sources over a 24-hour period: traffic, aircraft, lawn mowers, children playing, birds chirping, etc. Starting at 60 dBA on the horizontal axis, follow the vertical line up to where it intersects the moderate and severe impact curves. Then refer to the left axis to read off the impact thresholds. As shown in the example, an existing noise of 60 dBA L_{dn} gives thresholds of 57.8 dBA L_{dn} for moderate impact and 63.4 dBA L_{dn} for severe Impact. Note that the values are given in tenths of a decibel to avoid confusion from rounding off; in reality it is not possible to perceive a tenth of a decibel change in sound level.

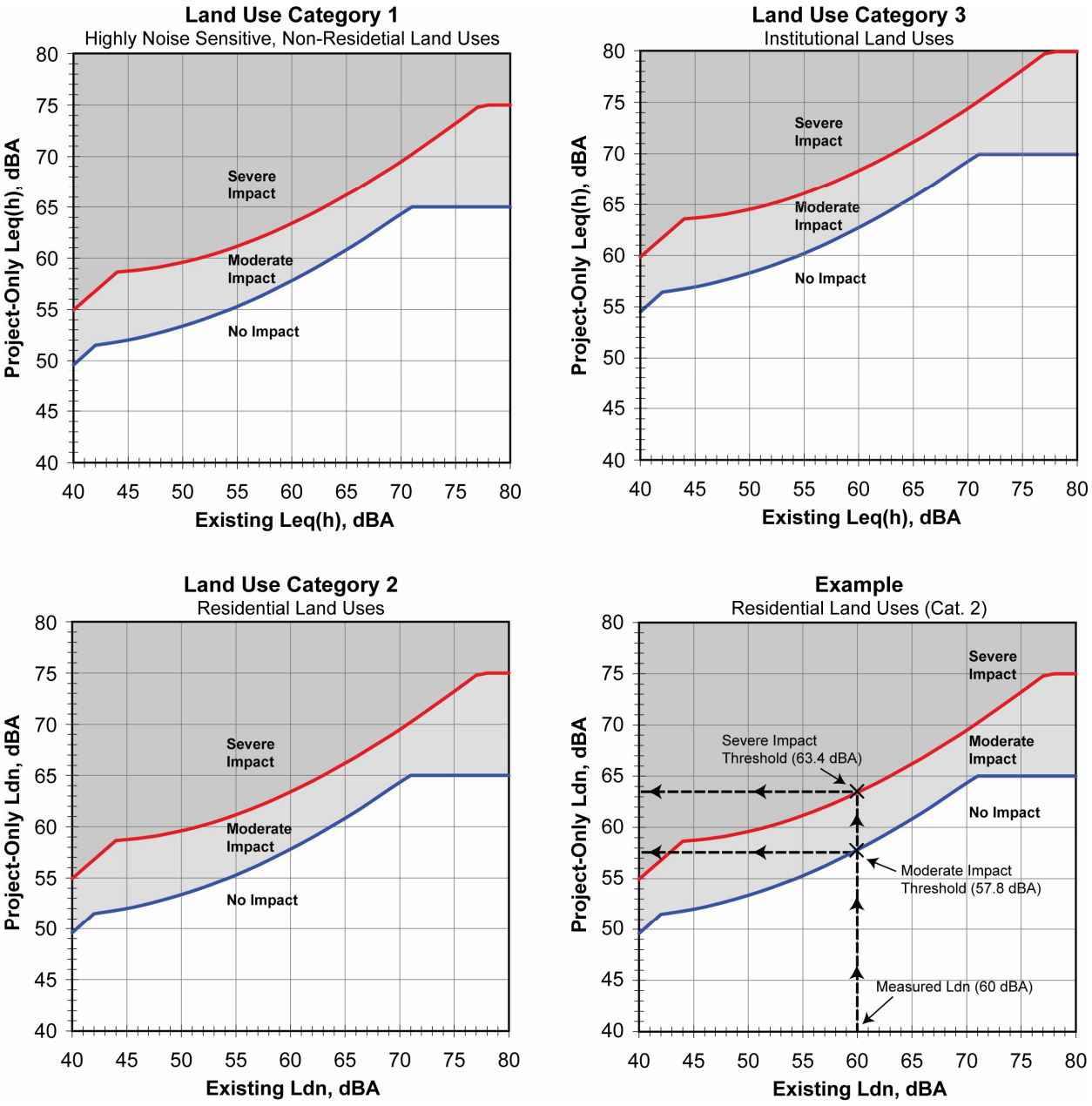


Figure 9 FTA Noise Impact Criteria

The thresholds of 57.8 dBA and 63.4 dBA are for the project noise. If the predicted project noise is greater than 57.8 dBA L_{dn}, then there is moderate impact and noise mitigation must be considered. If the predicted project noise exceeds 63.4 dBA L_{dn}, then there is severe impact and, as discussed above, noise mitigation must be included in the project unless there are compelling reasons why mitigation is unfeasible.

The FTA noise impact criteria are given in tabular format in Table 5 (FTA Noise Impact Criteria) with all the values 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 5 FTA Noise Impact Criteria

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 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
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

Table 5 FTA Noise Impact Criteria

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 2 Sites		Category 3 Sites	
	Moderate Impact	Severe Impact	Moderate Impact	Severe Impact
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.

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

3.3 Vibration

The potential adverse effects of rail transit ground vibration are:

- Perceptible building vibration. This is when building occupants feel the vibration of the floor or other building surfaces. Experience is 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 several different rattle effects. These include rattling of items on shelves and hanging walls, and various different rattle and buzzing noises from windows and doors.
- Reradiated noise. The vibration of room surfaces will radiate sound waves that may be audible to humans. This is referred to as *groundborne noise*. When audible groundborne noise occurs, it usually sounds like a low-frequency rumble. For a surface rail system such as the proposed project, the groundborne noise is usually masked by the normal airborne noise radiated from the transit vehicle.
- Damage to building structures. Although it is conceivable that vibration from a light-rail system could cause damage to fragile buildings, the vibration from rail transit systems is usually one to two orders of magnitude below the most restrictive thresholds for preventing building damage. Therefore the vibration impact criteria focus on human annoyance, which occurs at much lower amplitudes that does building damage.

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 (Ref. 1) 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 1/3-octave band for use with a Detailed Vibration Assessment, which was used for this project.

Table 6 (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 6 FTA Impact Thresholds for Groundborne Vibration, General Impact Assessment

Land Use Category	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.

Notes:

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

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

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

d. Vibration sensitive equipment is not sensitive to groundborne noise.

Unlike the FTA noise criteria, the vibration criteria do not incorporate any factor to account for the number of trains per day with one exception. The exception is that for occasional service, the FTA impact thresholds are 3 VdB higher than for frequent service and for infrequent service, the FTA impact thresholds are 8 VdB higher than for frequent service. FTA defines “occasional” service to be between 30 and 70 trains per day and “infrequent” service to be less than 30 trains per day. The frequent criteria are applicable to the Northwest Corridor Light-Rail Extension as there would be more than 70 trains 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 vehicular traffic including trucks and buses, it is relatively rare that rubber-tired vehicles will 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 current conditions along the proposed Expo Phase 2 corridors do not include more than isolated cases where traffic generated groundborne vibration is perceptible.

The refined criteria for use with Detailed Vibration Assessments are shown in Figure 10 (FTA Criteria for Detailed Vibration Analysis). For the Detailed Assessment, the predicted vibration levels in terms of the 1/3 octave band spectra are compared to the curves shown in Figure 10 to determine whether there is impact and the frequency range over which vibration mitigation is required. Impact occurs when any spectral values exceed the applicable curve. The VC-A

through VC-E curves are used to specify acceptable vibration limits for sensitive equipment such as electron microscopes.

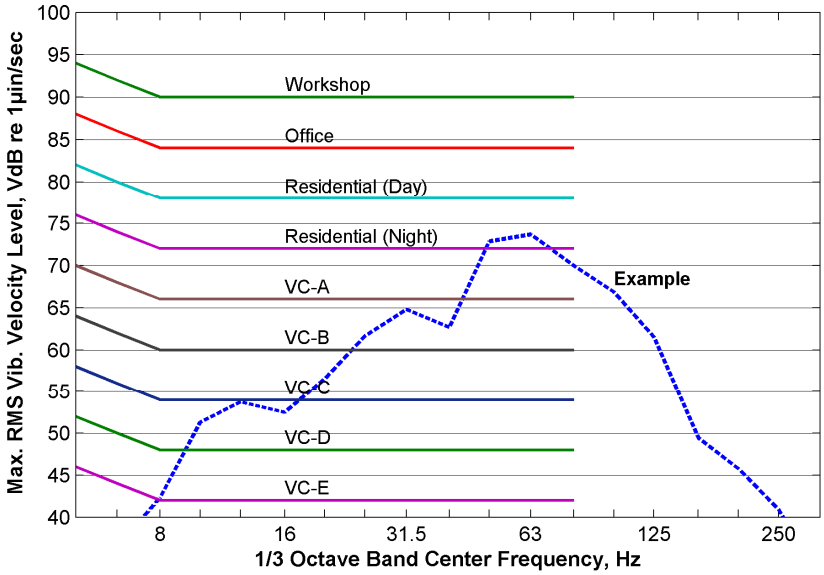


Figure 10 FTA Criteria for Detailed Vibration Analysis

The “Residential Night” curve would normally be applied to residential land uses. When this curve is used, impact occurs when at least one 1/3 octave band level between 8 and 80 Hz exceeds 72 VdB. In general, the use of the curves in Figure 10 will lead to 3- to 5-dB higher vibration levels before there is impact than will the use of the overall vibration level thresholds given in Table 6.

The use of the criteria is illustrated by the example vibration spectrum (the blue dashed line) shown in Figure 10. The maximum level of the spectrum exceeds the “Residential (Night)” curve in the 50 and 63 Hz 1/3-octave bands and all of the 1/3-octave band levels are below the “Residential (Day)” curve. For this example, impact would be predicted for residential land uses and vibration mitigation would need to be evaluated.

The approach used for this project is that the General Assessment criteria of Table 6 were used to identify potential vibration impacts. Then the Detailed Assessment criteria were applied to determine whether vibration mitigation would be warranted.

There are some buildings, such as concert halls, recording studios and theaters, which can be very sensitive to vibration but do not fit into any of the three categories listed in Table 6 (FTA Impact Thresholds for Groundborne Vibration, General Impact Assessment) or associated with the curves in Figure 10 (FTA Criteria for Detailed Vibration Analysis). Due to the sensitivity of these buildings, they usually warrant special attention during the environmental evaluation of a transit project. Table 7 (Groundborne Vibration and Noise Impact Criteria for Special Buildings) gives the FTA criteria for acceptable levels of groundborne vibration for various types of special buildings.

Table 7 Groundborne Vibration and Noise Impact Criteria for Special Buildings

Type of Building or Room	Groundborne Vibration Impact Levels (VdB re 1 micro-inch/sec)		Groundborne Noise Impact Levels (dB re 20 micro Pascals)	
	Frequent Events[a]	Occasional or Infrequent Events[b]	Frequent Events[a]	Occasional or Infrequent Events[b]
Concert Halls	65 VdB	65 VdB	25 dBA	25 dBA
TV Studios	65 VdB	65 VdB	25 dBA	25 dBA
Recording Studios	65 VdB	65 VdB	25 dBA	25 dBA
Auditoriums	72 VdB	80 VdB	30 dBA	38 dBA
Theaters	72 VdB	80 VdB	35 dBA	43 dBA

Source: FTA, 2006.

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

b. "Occasional or Infrequent Events" is defined as fewer than 70 vibration events per day.

c. If the building will rarely be occupied when the trains are operating, there is no need to consider impact.

4. NOISE AND VIBRATION METHODOLOGY

4.1 Noise Assessment Approach

Following is an outline of the approach used to identify potential noise impacts that would occur from operation of the proposed project. This section covers noise associated with train operations. The noise from audible warning devices, traction power substations, and construction are covered independently. In general, the approach follows the Detailed Noise Assessment guidelines outlined in the FTA Guidance Manual. The steps are:

1. Identify noise-sensitive receptors. Noise- and vibration-sensitive land uses along the corridor were identified first using aerial photography. Field visits were then conducted to confirm land uses and gather additional relevant information, such as the presence of second stories, sound walls, or intervening structures. Sensitive receivers were then grouped together based on their location relative to the tracks and operational factors such as train speed that affect noise and vibration levels. The predictions for each cluster were based on the distance from the proposed project to the closest sensitive receptor. The clusters used for the assessment are shown in Appendix D.
2. Determine existing noise levels. As discussed in Section 2, measurements of existing noise levels were taken at 20 locations along the corridor. The measurements were used to estimate the existing L_{dn} at all of the sensitive receptor clusters.
3. Develop noise prediction models. The noise predictions models are based on formulas provided in the FTA Guidance Manual (Ref. 1), equipment specifications, and noise measurements of similar equipment on existing LA Metro light-rail lines. The predictions of train noise are based on the forecast future number of daily trains and the distribution of these trains throughout the day (early morning, daytime, and nighttime), the distance from the tracks, the train speed, the presence of walls, berms, or other structures that could reduce noise levels, and other site-specific conditions.
4. Estimate future noise levels at the representative receivers. The predicted noise levels were compared to the applicable FTA impact thresholds to identify potential noise and vibration impacts. See Section 5.1 for a discussion of predicted noise impacts.
5. Recommend noise mitigation measures. Noise mitigation options were evaluated for all locations where predicted noise levels exceed the Severe or Moderate impact thresholds.

4.2 Noise Prediction Models

Different models are used to predict noise from operational noise, wheel squeal, audible warnings at at-grade crossings, TPSS units, and construction noise.

4.2.1 Prediction Model, Noise from Light-Rail Vehicle Operations

The following noise emissions and operating conditions from the most recent specifications for the Expo Phase 1 vehicle and measurements of the Metro Gold Line vehicles are the basis for the predictions of the light-rail vehicle (LRV) noise for the Expo Phase 2 project:

- Maximum sound level (L_{max}), two car train operating at 40 mph on ballast and tie track at a distance of 50 ft: 77 dBA
- Maximum sound level, vehicle stationary on ballast and tie track at distance of 50 ft: 65 dBA
- Train speed: based on predicted maximum train speeds
- Train schedule: see Table ~~7~~8 (LRT Operating Schedule Used for Noise Predictions)

Table ~~7~~8 LRT Operating Schedule Used for Noise Predictions

Time	Peak/Off-Peak	Headway (Minutes)	Train Length
04:00–06:00	Off-Peak	15	2
06:00–09:00	Peak	5	3
9:00–15:00	Off-Peak	10	2
15:00–18:00	Peak	5	3
18:00–19:00	Off-Peak	8	2
19:00–20:00	Off-Peak	10	2
20:00–00:00	Off-Peak	20	2
00:00–01:00	Off-Peak	30	2

These values are used to predict the levels of train noise using formulas included in the FTA Guidance Manual (Ref. 1). The principal formulas are:

Relationship between L_{max} and SEL:

$$SEL = L_{\max} - 10 \times \log\left[\frac{speed}{length}\left(2\alpha + \sin(2\alpha)\right)\right] + 3.3$$

where:

speed = Velocity in mph
length = length of train in feet (e.g. 3 car LRT = 270 ft)
y = distance from receiver to track centerline
α= $\tan^{-1}$(length/2y)

Change in sound level with speed:

$$\Delta SEL = 20\log\left(speed_2 / speed_1\right)$$

where:

$speed_1$ = Initial speed
$speed_2$ = New speed
ΔSEL = Change in SEL for speed change from $speed_1$ to $speed_2$

Calculation of L_{dn} and hourly L_{eq} from SEL:

$$L_{DN} = SEL + 10 \times \log\left(NTrain_{DAY} + 10 \times NTrain_{NIGHT}\right) + 49.4$$

$$L_{EQ}(Hour) = SEL + 10 \times \log\left(NTrain_{HOUR}\right) + 35.6$$

where:

$NTrain_{DAY}$ = Number of trains during daytime hours
$NTrain_{NIGHT}$ = Number of trains during nighttime hours
$NTrain_{HOUR}$ = Number of trains during one hour

Figure 11 (Light-Rail Operational Sound Level vs. Distance, 40 mph) is a graph showing the predicted LRV sound level vs. distance from the near track centerline in terms of L_{dn} and the maximum sound level during the passing of a three vehicle train at 40 mph. A separation distance of 18 feet between the near and far track was used to generate the curve in Figure 11.

There are several locations along the project corridor where existing structures would be taken due to the realignment of roads for the proposed project. In some cases, removing these structures would substantially increase future noise levels by removing the acoustic shielding that is currently being provided by the structures. The existing shielding has been assumed to range from 2 to 7 dB depending on the degree to which the structures that would be removed currently block the view of the traffic on Venice or Sepulveda.

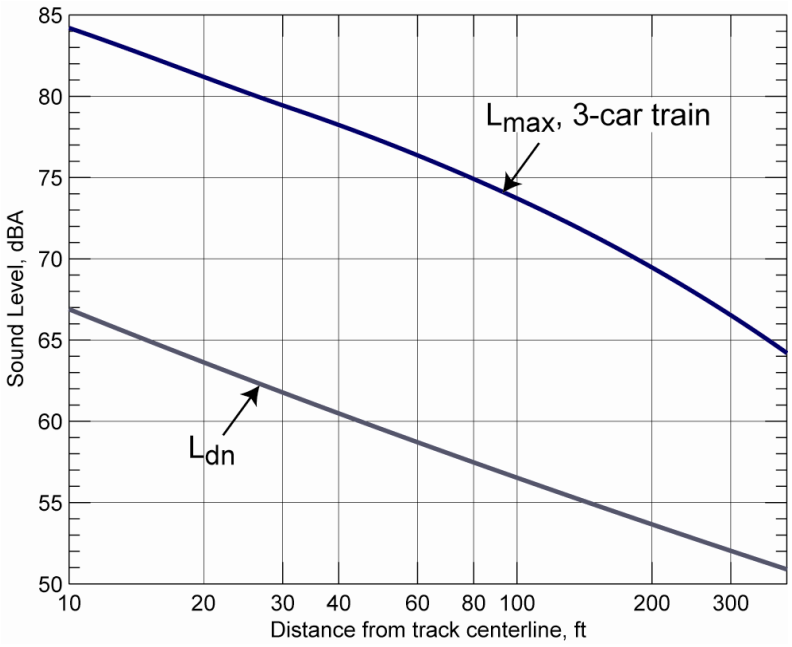


Figure 11 Light-Rail Operational Sound Level vs. Distance, 40 mph

4.2.2 Prediction Model, Noise from Wheel Squeal

Because noise impacts from wheel squeal are generally limited to localized areas near tight radius curves, the potential for noise impacts from wheel squeal have been evaluated independently from the normal noise from light-rail train operations discussed in the previous section. Wheel squeal is generated by the slip-stick interaction of the wheels and rails and is generally limited to curves with radii less than 600 ft.

The light-rail vehicles used on the Expo line will be equipped with what is referred to as resilient wheels instead of solid steel wheels such as those used on freight rail systems. There are several different types of resilient wheels used on light-rail vehicles; the most common resilient wheels have small rubber blocks that separate the wheel tread from the hub. Both the tread and hub are made of steel. The use of resilient wheels substantially reduces the occurrence and amplitudes of wheel squeal, but do not always eliminate wheel squeal.

For the noise impact assessment, it has been assumed that if wheel squeal occurs on a curve, the squeal noise will increase train noise by approximately 10 decibels. That is, if the predicted L_{dn} from train operations is 60 dBA at a residence near a curve, the L_{dn} if there is squeal on the curve is estimated to be 70 dBA. This amount of sound level increase is consistent with measurements that have been performed at other light-rail systems.

4.2.3 Prediction Model, Noise from Maintenance Facility

The Maintenance Facility would include a 6.9~~.17~~-acre area directly south of the ROW and east of Stewart Street. Between 25 and 30 vehicles would be stored at the Maintenance Facility during mid-day and in the evening. The facility would be used for vehicle cleaning and maintenance. The shop would be used for light repairs 24 hours a day and would be equipped with ~~a~~ wheel truing facilities. There are currently two options for the Maintenance Facility layout: the original DEIR concept with slight modifications and the Buffer Design Option.

The noise modeling software CadnaA was used for predicting noise from the maintenance facility for both layout options. The key assumptions used for building the computer models are:

- The car wash will be enclosed. If blowers are used to strip water off the vehicles, the blowers would be located inside the east end of the building.
- The car wash will be used for a total of ~~50~~110 minutes per day. This is based on the wash cycle for a ~~2~~3-car ~~Gold~~Blue Line train taking ~~4~~5 minutes and a maximum of ~~15~~ ~~2~~223-car trains washed each day. As a worst case, all car washing is assumed to occur during nighttime hours.
- The noise sources associated with the blowdown facility would include a vacuum system and an air compressor. Based on measurements of the Gold Line blowdown facility, the sound level at a distance of 50 ft from the facility is assumed to be 61 dBA. It is assumed that the blowdown facility will be in operation an average of 2 hours during the day and 2 hours during the night.
- Metro would perform limited outdoor testing of horns and only during the daytime.
- ~~Wheel squeal on the curves into and out of the storage tracks would be resolved with lubrication or other means.~~ Wheel squeal was not included in the noise model for the

maintenance facility. There are no curves in the facility that have a radius of less than 600 feet. Any wheel squeal within the facility will be able to be controlled with lubrication.

- Noise from general maintenance activities inside the shop building would include use of hand tools, continuous operation of compressors and other mechanical equipment, and intermittent operation of equipment such as overhead cranes, vehicle lifts, and the wheel truer. The equipment would all be located inside the maintenance shop. The predictions of the noise that would be emitted from the shop are based on measurements at the Green Line Yard. It is assumed that the noise coming from the shop will be continuous.
- The original layout does not specify the location of different activities within the shop. It was assumed that most noise leaving the building would come from entrances on the west and east side of the building.
- The Buffer Design Option layout specifies the location of service and inspection, wheel truing, heavy repair, the body shop, and the paint shop. It was assumed that the most noise would leave the building from a main entrance where the service and inspection area is designated on the west side. A lower noise source was used at the location of all the other activities to account for smaller entrances or windows at those locations.
- Some equipment in the shop, such as the vehicle lifts and overhead cranes, may be equipped with alarms to alert workers before they are used. In the design of the shop facility, the alarms will be placed such that they provide appropriate warning for shop personnel, but the noise will not be directed out of doors. The alarms are not expected to cause noise impact beyond the Maintenance Facility property line.
- There would be limited vehicle movements inside the yard. Once trains enter a storage yard and are parked, they will usually stay in place until they go back into revenue service. Movements within the yard would include shuttling vehicles to the shop and through the car wash, blowdown, and cleaning station.
- The noise from the traction power substations (TPSS) in the Maintenance Facility will be a maximum of 50 dBA at 50 feet. This is based on measurements of a TPSS unit on the Metro Gold Line in South Pasadena. It is assumed the TPSS units will be in operation continuously.
- The noise sources associated with the blowdown facility would include a vacuum system and an air compressor. Based on measurements of the Metro Gold Line blowdown facility, the sound level at a distance of 200 ft from the facility is assumed to be 60 dBA. It is assumed that the blowdown facility will be in operation an average of 2 hours per night.
- Activities at the cleaning station would include vacuuming and hand cleaning of the vehicle interior. This is assumed to be an insignificant noise source.
- A minimum 8- to 12-foot security wall and combination fence per *Metro Design Criteria*.

The noise levels for each source and the key parameters used to calculate L_{dn} are given in Table ~~8~~9 (Noise Levels Assumed for Maintenance Facility Activities). The columns in the table are:

- **Sound Level (L_{eq}):** The energy average measured or assumed sound level at the reference distance (Ref Dist) of 50 ft.
- **SEL:** The sound exposure level. For the fixed noise sources, the following formula is used to calculate SEL where *Duration* is the duration of the event in seconds:.

$$SEL = SoundLevel + 10 \times \log[Duration]$$

- **Duration/Number:** This is the total number of events per day or the total number of minutes that the noise source is active in a 24-hour period. This number has been adjusted to account for the nighttime events using one of the following relationships:

$$AdjustedDuration = DaytimeDuration + 10 \times NighttimeDuration$$
$$AdjustedNumber = DaytimeNumber + 10 \times NighttimeNumber$$

- **Partial L_{dn}:** L_{dn} at the reference distance due to the noise source, which is calculated using one of the following relationships:

$$L_{dnPartial} = L_{eq} + 10 \times \log(AdjustedDuration) - 49.4$$
$$L_{dnPartial} = SEL + 10 \times \log(AdjustedNumber) - 49.4$$

Once the noise level for each source was calculated, each source was modeled independently in CadnaA with a receiver 50 feet away to ensure receiver reported the same value as the empirically determined sound levels. The design drawings of both facility options were then used to create models in CadnaA including each of the noise sources identified in Table 9 (Noise Levels Assumed for Maintenance Facility Activities), as well as seven receivers at residences nearest to the proposed maintenance facility and a receiver on the Lantana Campus.

Table 9 Noise Levels Assumed for Maintenance Facility Activities

Noise Sources	Sound Level (dBA)	Duration (equivalent minutes)[a]	Partial L_{dn}[b] (dBA)	Comments
Trains entering yard	61	785	58	Based on measurements of trains entering and exiting the Green Line Yard.
Trains exiting yard	61	560	57	
Car wash	61[c]	1100	60	Based on measurement of Blue Line car wash adjusted to account for the blowers being located inside the car wash enclosure
Blowdown	61[d]	1320	61	Based on measurement of Gold Line blowdown facility
Shop noise - high	58	Continuous	65	Noise coming out of shop doors based on measurements of Green Line maintenance shop.
Shop noise - low	53	Continuous	60	
TPSS	50	Continuous	56	Based on a measurement of a TPSS unit on Gold Line in South Pasadena.

SOURCE: ATS Consulting, 2008; updated 2009.

a. The duration of the activity in equivalent minutes per day. The "equivalent minutes" have been adjusted to account for nighttime events, which are counted as the equivalent of 10 daytime events in the calculation of L_{dn}.

b. The L_{dn} due to only the specific noise source at the reference distance.

c. Supplementary measurements were taken at the Green Line Maintenance Yard in West Hawthorne; see Appendix E for detailed measurement results.

Table 8:
Noise Levels Assumed for Maintenance Facility Activities

Noise Sources	Ref Dist	Sound Level (dBA)	SEL (dBA)	Duration/ Number[a]	Partial L_{dn}[b] (dBA)	Comments
Trains entering yard	50	77[c]	85	157	57	Train speed assumed to be 20 to 25 mph. Wheel impacts at special trackwork assumed.
Trains exiting yard	50	77[c]	85	122	56	
Car wash	100	77[c]	95	480	72	Based on measurement of Blue Line car wash adjusted to account for the blowers being located inside the car wash enclosure
Blowdown	200	60[d]	78	120	59	Based on measurement of Gold Line blowdown facility
Shop noise	50	80	98	20	61	Noise coming out of shop doors. Noise levels assumed to last for one minute per event.

SOURCE: ATS Consulting, 2008

a. The duration of the activity in minutes per day or the number of events per day. The values have been adjusted to account for nighttime events, which are counted as the equivalent of 10 daytime events in the calculation of L_{dn}.

b. The L_{dn} due to only the specific noise source at the reference distance.

c. The train noise is based on a speed of 25 mph plus noise from wheel impacts at the Maintenance Facility special trackwork.

To calculate the L_{dn} at each receptor, first the partial L_{dn}'s are adjusted to the receptor location using the formula:

$$L_{dnPartial}(Receptor) = L_{dnPartial}(RefDistance) + 20 \times \log\left(\frac{RefDistance}{ReceptorDistance}\right)$$

Once the partial L_{dn}s at each receptor have been calculated for each noise source, decibel addition is used to calculate the combined noise level at the receptor from all of the noise sources.

4.2.4 Prediction Model, Audible Warnings

The California Public Utilities Commission (CPUC) requires that audible warnings be sounded as light-rail trains approach all gate protected crossings. The specific requirements are as follows:

1. Every LRV must be equipped with a bell or horn that generates a sound level of 75 dBA at a distance of 100 ft from the vehicle (CPUC General Order 143B).
2. Every LRV operating on separate right-of-way over motor vehicle at-grade crossings must be equipped with a horn or whistle that generates a sound level of at least 85 dBA at a distance of 100 ft from the LRV (CPUC General Order 143B). Most automobile

horns generate a sound level of 80 to 85 dBA at a distance of 100 ft, so the loud horn is slightly louder than most automobile horns.

3. The light-rail vehicle operator must sound an audible warning when approaching at-grade crossings protected by automatic crossing signals. As is the standard operating procedure on the Metro Gold Line, Metro would sound the low-volume horn (75 dBA at 100 ft) before at-grade crossings unless there is a potential emergency and then the louder emergency horn would be used.
4. Bells must be included in all automatic crossing gate assemblies. The bells are operated in conjunction with the flashing light signals and must conform to the guidelines of the American Railway Engineering and Maintenance of Way Association's (AREMA) "Communications and Signals (C&S) Manual of Recommended Practices" (CPUC General Order 75D). The current AREMA C&S Manual states that crossing bells should generate a sound level of at least 75 dBA (L_{max}) at a distance of 10 ft from the bell.
5. The automatic warnings at at-grade crossings, including the bells, must be activated at least 20 seconds before the light-rail train reaches the at-grade crossing and must continue until the trailing car of the train is completely through the crossing (CPUC General Order 75D).

Metro's operating procedure on the Gold Line is that train operators sound the 75 dBA warning device (referred to as the quacker) prior to all gate-protected crossings starting approximately 300 ft prior to the crossing. At speeds greater than 35 mph, the noise from the quacker adds less than 1 dB to the noise exposure caused by light-rail train operations. 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 CPUC regulations and standard practices require that a bell be placed on the mast of each crossing gate and that the bells ring for the entire time that the gates are activated. That is, the default condition is that the bells start to ring just before the gates start to drop and continue to ring until the train has passed through the crossing and the gates have returned to the vertical position. Where four-quadrant gates would be used on the proposed project, a bell is required only on the masts on the right-hand sides of the road.

The formulas below were used to predict the bell noise levels at the closest receptors.

Calculation of Sound Exposure Level (SEL)[†] for an individual at-grade crossing bell:

$$SEL_{Bell} = 10 \times \log\left[E \times 10^{\left(L\max/10\right)}\right] - 20\log\left(D/D_{ref}\right)$$

where:

E = Crossing bell duration

L_{max} = 85 dBA at a reference distance of 10 ft, which is 10 dB higher than the CPUC minimum and is the sound level generated by most bells as delivered by suppliers

D = Distance of receiver from crossing bell

[†] SEL is defined in Section 5.6.1

D_{ref} = Reference distance of 10 ft, which is the distance CPUC uses to specify acceptable sound levels for crossing bells.

Calculation of L_{dn} for an individual at-grade crossing bell:

$$Ldn_{Bell} = SEL_{Bell} + 10 \times \log\left(N_{day} + 10 \times N_{night}\right) - 49.4$$

where:

N_{day} = Number of trains in **both** directions during daytime hours
N_{night} = Number of trains in **both** directions during nighttime hours

The L_{dn} for the two crossing bells is then the decibel sum of the two bell L_{dn}s:

$$Ldn_{Bells\_1\&2} = 10 \times \log\left[10^{\left(Ldn(Bell\ 1)/10\right)} + 10^{\left(Ldn(Bell\ 2)/10\right)}\right]$$

4.2.5 Prediction Model, Ancillary Equipment

The primary noise sources on TPSS units are the transformer hum and noise from cooling systems. The cooling fans are the primary noise source on the TPSS units used on the Metro Gold Line. The noise level at a distance of 40 ft from the cooling fan of a Gold Line TPSS unit in South Pasadena was measured to be 51 dBA, which is equivalent to 49 dBA at a distance of 50 ft (the measurement was not done at 50 ft because of obstructions). The audible noise from the TPSS unit in South Pasadena was caused by a ventilation fan. The measured noise level is consistent with the specifications used for the purchase of the TPSS units for the Metro Gold Line Phase 1 and the East Side extension to the Gold Line The specifications limit TPSS noise to a maximum of 50 dBA at 50 ft from any side of the TPSS.

The following formula has been use to predict TPSS noise for this project:

$$Lp = Lp_{ref} = 20 \times \log\left(D/Dref\right)$$

where:

D = Distance to receiver from the TPSS unit cooling fan
D_{ref} = Reference distance from the TPSS unit cooling fan (50 ft)
Lp = Level of TPSS noise at receiver
Lp_{ref} = TPSS sound level at reference distance (50 dBA)

4.2.6 Prediction Model, Construction Noise

Construction noise levels depend on the number of pieces and type of equipment, their general condition, the amount of time each piece operates per day, the presence or lack of noise attenuating features such as walls and berms, and the location of the construction activities relative to the sensitive receptors. The majority of these variables are left to the discretion of the contractor so that assessment of construction noise is a professional judgment of the likely means and methods that would be used by the contractor.

The construction of LRT guideway requires use of heavy earth-moving equipment, pneumatic tools, generators, concrete pumps, and similar equipment. Table ~~9~~10 (Typical Noise Emissions

of Construction Equipment) shows categories of equipment that are likely to be used and the typical noise generated by this equipment when it is operating at full load. The typical noise levels, along with estimates of what equipment would be used during the loudest phases of the project and the usage factors for each category of equipment, have been used to estimate construction noise levels. The following formula was used to estimate the contribution to workshift L_{eq} of each category of equipment.

$L_{eqPartial}$ = Equipment$_{SP}$L + 10 log(Usage)

where:

Usage = percent of workshift that equipment is used at or near full power
Equipment$_{SP}$L = sound level at 50 ft when equipment is operating a full power
$L_{eqPartial}$ = contribution to workshift L_{eq} of this category of equipment

The predicted workshift L_{eq}s for all equipment categories are then combined to estimate the total workshift L_{eq} at an equivalent distance of 50 ft from the centroid of the construction site and the L_{eq} at sensitive receptors was estimated using the following formula.

$L_{eqReceptor} = L_{eq50ft} + 20*\log(50/Dist)$

where

L_{eq50ft} = calculated L_{eq} at an equivalent distance of 50 ft from the centroid of the construction activity
Dist = distance of receptor from the centroid of the construction site in feet
$L_{eqReceptor}$ = workshift L_{eq} at receptor location

The average noise emissions of the different categories of construction equipment are based on the levels used in the Federal Highway Administration computer program “Roadway Construction Noise Model” (USDOT 2006).

Table ~~9~~10 Typical Noise Emissions of Construction Equipment

Equipment	Sound Level at 50 ft under Load
Earthmover (bulldozer, front-end loader, etc.)	82 dBA
Mobile Crane	81 dBA
Dump Truck	76 dBA
Pneumatic Tools	85 dBA
Generator	78 dBA
Compressor	81 dBA

SOURCE: USDOT 2006, ATS Consulting

4.3 Vibration Prediction Models

4.3.1 Operational Vibration

The predictions of groundborne vibration for this study follow the Detailed Vibration Assessment procedure of the FTA Guidance Manual (Ref. 1). 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 similar light-rail vehicle. As discussed in

Section 2.2, vibration propagation tests were performed at ~~10~~14 locations in the proposed corridors for Expo Phase 2. The quantity derived from the propagation tests is referred to as the Line Source Transfer Mobility (LSTM). The results of propagation tests are discussed in Section 2.2 and detailed results are presented in Appendix C for the tests performed for the DEIR and Appendix E for the supplementary tests performed for the FEIR.

The basic relationship used for the vibration predictions is:

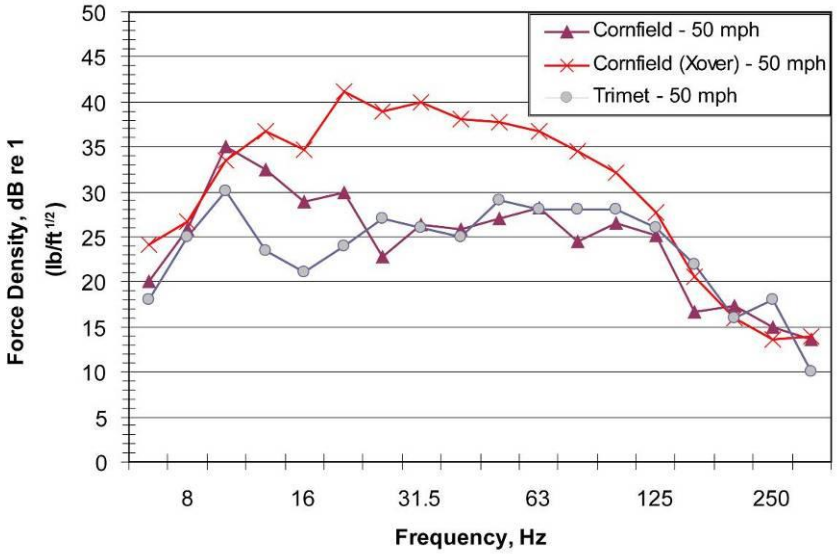
$$Lv = FDL + LSTM$$

where:

Lv = Train vibration velocity measured at the ground surface
LSTM = Measured line source transfer mobility
FDL = Force density function that characterizes the vibration forces generated by the train and track
(All quantities are expressed in decibels using a consistent set of decibel reference values)

FDL is derived by measuring Lv and LSTM at a site where there are train operations. For this project, the FDL was measured on the Gold Line at the historic Cornfield, which is just north of the Chinatown Station. The track at the Cornfield measurement site is ballast and tie. There are several switches in this area, so it was possible to measure FDL values for both standard welded track and for crossovers. The results of the Cornfield FDL measurements are shown in Figure 12 (Measured Force Density Levels) for train speeds of 50 mph. Included in Figure 12 is an FDL function from measurements on the Tri-met light-rail system in Portland, OR (Ref. 3). The measured levels for Portland and the Cornfield are quite close except at frequencies of 20 Hz and below where the Cornfield FDL is approximately 5 decibels higher than the Portland FDL. The FDL results below 20 Hz must be used with caution because of the low coherence in the measurement results below 20 Hz.

The Cornfield crossover FDL is 10 to 15 decibels higher than the FDL for welded track. This is consistent with the common rule of thumb that crossovers will increase the overall vibration velocity level by approximately 10 decibels. Overall vibration velocity levels predicted using the crossover FDL are close to 10 decibels higher than levels predicted using the FDL for standard track. Therefore, the vibration from crossovers was accounted for by adding 10 decibels to the predictions without a crossover.



(The curve for the Portland LRT is from Ref. 3)

Figure 12 Measured Force Density Levels

The procedure used to develop vibration prediction curves was:

1. Combine sites with similar results into groups. After inspection of the test results, the sites were combined into three groups as follows:
   Group 1: V1-V5, V6B, V8 and V9.
   Group 2: V7 and V10
   Group 3: V6A
2. The majority of the LSTM results were combined into Group 1. The LSTM results for all the Group 1 sites were generally within a 5 dB range.
3. The average LSTM curves were combined with the FDL curve in Figure 12 to develop predicted vibration level spectra. The FDL curves in Figure 12 were derived from the root mean square (RMS) average of the train vibration using 3-decibels down from the maximum as the RMS cutoff points. The FTA impact thresholds are based on the maximum 1-second RMS average (L_{max}). L_{max} for the train passbys averaged 1 dB higher than the RMS average and, to account for this difference, an adjustment factor of 1 dB was added to the FDL spectrum in Figure 12.
4. The vibration spectra for the three groups are shown in Figure 13 (Predicted Vibration Velocity, Spectra, 50 mph Train Speed) for distances of 25, 50, 75, and 100 ft from the near track centerline.
5. Figure 14 (Predicted Vibration Velocity versus Distance Curves, 50 mph Train Speed) shows the predicted overall vibration velocity level as a function of distance. These curves were used for the General Vibration Assessment, which was basically a screening for potential impact. When potential for vibration impact was found, the spectra curves in Figure 13 were used for a more accurate assessment of potential impact:

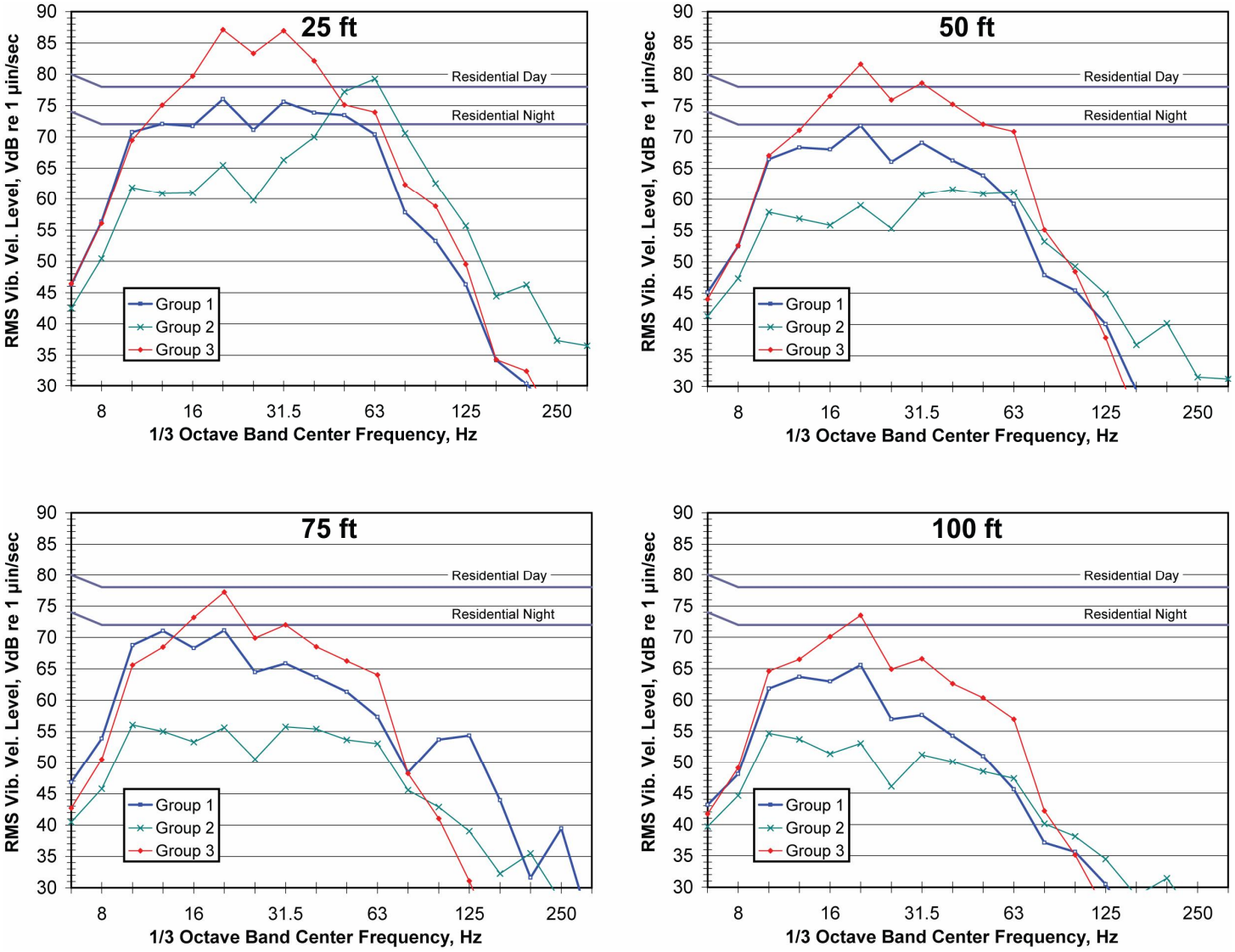


Figure 13 Predicted Vibration Velocity, Spectra, 50 mph Train Speed

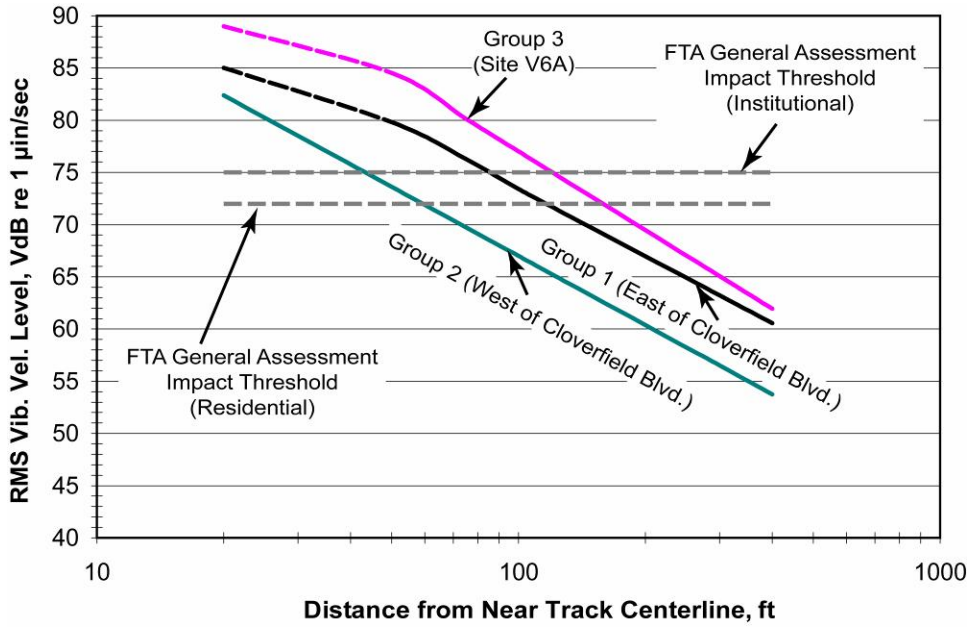


Figure 14 Predicted Vibration Velocity versus Distance Curves, 50 mph Train Speed

- Group 1 was used as the prediction curve for all sensitive receptors located east of Cloverfield Boulevard, except for receivers on Exposition Boulevard between Westgate Avenue and Bundy Drive, for which Group 3 was used.
- Group 2 was used for all the receivers west of Cloverfield Boulevard.
- Group 3 was used for the receivers on Exposition Boulevard between Westgate Avenue and Bundy Drive, which is the immediate vicinity of vibration test site V6A.

Additional details on how the measurement results were used to derive the prediction curves are provided in Appendix C. Note that supplementary vibration measurements were taken at Groove Master Studios, 18th Street Arts Center, Overland School, and the Lantana Campus between Centinela Avenue and Stewart Street. The results of these tests are provided in Appendix E.

After the curves in Figure 13 and Figure 14 were used for the base vibration predictions, the following adjustments were applied to estimate vibration levels at occupied spaces of the buildings:

- A speed adjustment of 15log(Speed/50) was applied. The FTA Manual recommends using a speed adjustment of 20log(Speed). The 15log(Speed) function was used because some recent data suggests that the 20log function may overestimate the effects of speed. This tends to be a conservative approach because it will lead to higher predicted vibration levels at speeds less than 50 mph and a marginally lower predicted level at the maximum speed of 55 mph.

- The additional vibration at special trackwork was accounted for by adding 10 VdB to the predicted vibration levels for sensitive receptors located within 100 ft from a crossover frog.
- A 5 decibel attenuation factor was assumed for locations where the tracks would be on an aerial structure. This is to account for the vibration attenuation as it travels from the tracks, through the aerial structure to the ground.
- A 5 decibel factor was added to the predicted vibration levels to account for amplification by the building structure and to include a small "safety" factor into the predictions. Two things happen as vibration is transmitted from the ground, through the building foundation and into occupied spaces. First, the interaction at the foundation/soil interface tends to reduce the vibration amplitudes transmitted into the building foundation. Second, when the vibration reaches occupied spaces of the building, various resonances in the building components will tend to amplify the vibration. Both of these effects can be substantial and are difficult to predict. Experience is that the average effect is close to zero for wood frame residential structures, although it is not uncommon for the combined effect to result in indoor vibration being as much as 10 decibels higher than the outdoor vibration. It appears that this amplification is most common in buildings that have very flexible floors. For larger buildings with more massive foundations, the net effect is more likely to be a 5 to 10 decibel reduction in the vibration levels. The specific adjustments used are:
  - Wood frame residential buildings: The net effect was assumed to be a 5 decibel amplification. This basically represents a "safety factor" to ensure that in the majority of cases the predicted vibration levels will be higher than what will occur after the proposed project is operational.
  - Large buildings: The net effect was assumed to be 0 decibels. That is, the indoor vibration is assumed to equal the outdoor vibration. Again, this is a conservative assumption and in most cases will result in an over prediction of the vibration levels.

4.3.2 Construction Vibration

Some activities, such as pile driving, pavement breaking, and the use of tracked vehicles (e.g., bulldozers), could result in perceptible levels of groundborne vibration. However, these activities would be limited in duration and vibration levels are likely to be well below thresholds for minor cosmetic building damage. The approach used to estimate the vibration levels that would be generated during construction of the proposed project is as follows:

1. Use the vibration source levels for construction equipment from the FTA manual (Ref. 1).
2. Make the propagation adjustment according to the following formula:

$$PPV_{equip} = PPV_{ref} \times (25/D)^{1.5}$$

where:

PPV_{equip} = peak particle velocity in in/sec of the equipment adjusted for distance
PPV_{ref} = reference vibration level in in/sec at 25 ft
D = distance from the equipment to the receiver

5. NOISE AND VIBRATION IMPACT ASSESSMENT

5.1 LRT Related Noise

5.1.1 Operational Noise

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 locations of the clusters and buildings included in each cluster are shown in Appendix D. 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 11 (Summary of Noise Impact Assessment Highly Sensitive [Category 1] Land Uses). A detailed account of the predicted levels of LRT operational noise impact for Category 2 land uses is shown in Table ~~10~~12 (Summary of Noise Impact Assessment, Residential, Land Uses) and for Category 3 land uses is shown in Table ~~11~~13 (Summary of Noise Impact Assessment for Category 3 [Institutional Land Uses]). Category 2 land uses include residential, hotels, and hospitals and Category 3 land use include schools, libraries, medical facilities, and parks that are not sensitive to noise during nighttime hours. Two highly noise sensitive land uses were identified subsequent to the DEIR noise assessment. The predicted noise impact for these land uses is shown in Table 13 (Summary of Noise Impact Assessment for Category 3 [Institutional Land Uses]). The columns in the tables provide the following information:

- Cluster: Cluster number
- Desc: Description of the land use
- Civil Station: Defines the locations of the clusters. The civil stations can be found on the Conceptual Engineering drawings within Appendix E of ~~this DEIS/DEIR~~the FEIR.
- 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 (L_{dn} or L_{eq}) at cluster based on the noise survey results summarized in Table 2 (Summary of Long-Term Measurement Results) and Table 3 (Summary of Short-Term Measurement Results).
- Project: Predicted future L_{dn} from train noise
- Impact Threshold: The FTA impact thresholds for moderate and severe impact
- Number of Impacts: The dwelling units where the predicted levels of LRT noise exceed the Moderate (Mod) and Severe impact thresholds

As an example on how to interpret the tables, consider Cluster 11 in Table 12 (Summary of Noise Impact Assessment, Residential Land Uses), which is the first row under Segment 1 where noise impact is predicted. The existing L_{dn} is 68 dBA and the noise from the train operations 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 decibels, the difference between the project noise level and the impact threshold.

Table 11 Summary of Noise Impact Assessment for Highly Sensitive (Category 1) Land Uses

Cluster	Desc.[a]	Civil Stn.[b]	Near Track Dist (ft)	Speed[e] (mph)	L_{eq} (dBA)[c]				Impact
					Existing	Project[d]	Impact Threshold		
							Mod	Severe	
SEGMENT 2									
Lan2	Lantana Todd-AO[g]	743.00	50	55	57	67	56	62	Severe[e, f]
Lan3	Lantana Gray Martin[g]	743.00	50	55	57	67	56	62	Severe[e]
SEGMENT 3a									
2	Groove Masters Studio	807.50	40	35	75	67	65	73	Moderate[f]

Source: ATS Consulting, 2009.
Refer to Appendix E for detailed impact analysis at the Lantana Campus and Groove Masters Studio.
a. Desc. = Type of land use.
b. Civil Stn refers to the locating system used on design drawings.
c. Maximum 1-hour Leq during period of day when facility is in use.
d. Project Leq is the additional noise that would be created by the LRT operations.
e. Assumes operation of 2- and 3-car trains.
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.
g. Refer to Appendix E (Section E.5) for discussion of the noise impact assessment for the Lantana Campus.

Table ~~10~~12 Summary of Noise Impact Assessment, Residential Land Uses

Cluster	Desc.[a]	Civil Stn.[b]	Near Track Dist (ft)	Speed[e] (mph)	L_{dn}, (dBA)				Number of Impacts[d]	
					Existing	Project[c/g]	Impact Threshold			
							Mod[g]	Severe[g]	Mod	Severe
SEGMENT 1										
1	MFR	520.50	80	55	68	63	63	68	—	—
2	MFR	522.00	95	55	68	62	63	68	—	—
3	MFR	525.00	92	55	68	62	63	68	—	—
4	MFR	528.00	92	55	68	62	63	68	—	—
5	MFR	533.50	90	55	68	62	63	68	—	—
6	MFR	536.00	80	55	68	63	63	68	—	—
7	MFR	538.50	80	55	68	63	63	68	—	—
8	MFR	542.00	80	50	68	62	63	68	—	—
9	MFR	546.50	85	35	68	58	63	68	—	—
10	MFR	550.00	90	30	68	57	63	68	—	—
11	MFR	553.50	80	45	68	67	63	68	6	—
12	MFR	570.50	140	25	68	54	63	68	—	—
13	MFR	575.00	40	25	68	59	63	68	—	—
14	MFR	577.50	140	25	68	54	63	68	—	—
15	MFR	579.00	190	25	68	53	63	68	—	—
16	MFR	580.00	260	20	68	49	63	68	—	—
17	SFR	582.50	145	20	65	45	61	66	—	—
18	SFR	587.00	110	35	65	51	61	66	—	—
19	SFR	592.00	120	35	65	50	61	66	—	—
20	SFR	595.50	125	35	65	50	61	66	—	—
21	SFR	598.50	125	35	65	54	61	66	—	—
22	SFR	601.50	~~125~~100	35	59	55	57	63	—	—
23	SFR	604.50	~~110~~100	35	59	55	57	63	—	—
24	SFR	607.00	~~110~~100	35	59	55	57	63	—	—
25	SFR	614.00	115	35	58	58	57	63	4	—
26	SFR	617.00	115	35	58	58	57	63	6	—
27	SFR	620.00	105	25	58	55	57	63	—	—
28	SFR	623.50	105	25	58	55	57	63	—	—
29	SFR	627.50	115	35	58	58	57	63	4	—
30	SFR	631.00	115	40	58	65	57	63	~~5~~—	—~~5~~
31	SFR	634.00	115	50	59	61	57	63	6	—
32	SFR	637.00	115	55	59	67	57	63	~~4~~—	—~~4~~

Table ~~10~~12 Summary of Noise Impact Assessment, Residential Land Uses

Cluster	Desc.[a]	Civil Stn.[b]	Near Track Dist (ft)	Speed[e] (mph)	L_{dn}, (dBA)				Number of Impacts[d]	
					Existing	Project[c/g]	Impact Threshold			
							Mod[g]	Severe[g]	Mod	Severe
33	SFR	639.00	115	55	59	61	57	63	6	~~6~~—
34	SFR	641.50	115	55	59	61	57	63	2	—
35	SFR	595.00	70	35	56	52	57	63	—	—
36	SFR	597.00	70	35	56	58	57	63	12	—
37	SFR	606.50	70	35	56	58	57	63	3	—
38	SFR	609.00	~~75~~70	35	56	57	57	63	3	—
39	SFR	613.00	115	35	58	58	57	63	5	—
40	SFR	617.00	115	35	58	58	57	63	7	—
41	SFR	620.00	105	25	58	55	57	63	—	—
42	SFR	622.50	105	25	58	55	57	63	—	—
43	SFR	626.50	115	35	58	64	57	63	~~3~~—	~~—~~3
44	SFR	629.00	115	35	58	58	57	63	1	—
45	SFR	630.50	115	50	58	61	57	63	1	—
46	SFR	633.00	115	55	58	61	57	63	6	—
47	SFR	636.50	115	55	59	61	57	63	6	—
48	SFR	640.00	115	55	59	67	57	63	~~0~~—	6
49	SFR	643.50	115	55	59	61	57	63	6	—
50	SFR	646.50	115	50	59	61	57	63	6	—
51	SFR	648.00	115	40	59	59	57	63	5	—
52	SFR	650.00	115	30	59	67	57	63	~~0~~—	1
53	MFR	650.00	180	30	70	54	64	69	—	—
Sepulveda Grade Separation Option										
50	SFR	646.50	115	50	59	63	57	63	—	6
51	SFR	648.00	115	40	59	59	57	63	5	—
52	SFR	650.00	115	30	59	67	57	63	—	1
53	MFR	650.00	180	30	70	54	64	69	—	—
SEGMENT 1a										
Venice										
54	MFR	521.00	211	35	59	58	57	63	6	—
55	MFR	524.00	211	35	59	58	57	63	16	—
56	MFR	535.00	88	35	73	62	65	72	—	—
57	MFR	542.00	88	35	73	62	65	71	—	—
58	MFR	562.00	126	35	69	60	64	69	—	—

Table ~~10~~12 Summary of Noise Impact Assessment, Residential Land Uses

Cluster	Desc.[a]	Civil Stn.[b]	Near Track Dist (ft)	Speed[e] (mph)	L_{dn}, (dBA)				Number of Impacts[d]	
					Existing	Project[c/g]	Impact Threshold			
							Mod[g]	Severe[g]	Mod	Severe
59	SFR	580.00	72	35	75	62	65	74	—	—
60	SFR	592.00	82	35	75	62	65	74	—	—
61	MFR	594.00	82	35	75	62	65	74	—	—
62	MFR	601.00	92	25	72	58	65	71	—	—
63	MFR	552.00	92	30	74	60	65	73	—	—
64	SFR	564.50	72	35	73	62	65	72	—	—
65	MFR	576.00	90	35	73	62	65	72	—	—
66	MFR	579.00	82	35	73	62	65	72	—	—
67	SFR	584.00	160	35	61	59	58	64	5	—
68	MFR	588.00	156	35	61	59	59	64	4	—
69	SFR	592.00	162	35	61	59	59	64	4	—
70	MFR	595.00	50	35	75	63	65	73	—	—
71	MFR	598.00	65	25	76	60	65	74	—	—
72	MFR	599.00	70	25	73	59	65	72	—	—
Sepulveda										
73	MFR	607.00	48	25	72	61	65	71	—	—
74	MFR	611.50	49	25	71	61	65	71	—	—
75	MFR	615.00	58~~.112~~	35	72	63	65	71	—	—
76	MFR	640.00	52	35	72	64	65	71	—	—
77	MFR	644.00	68	35	70	69	65	70	10	—
78	MFR	650.00	69	35	70	63	65	70	—	—
79	MFR	653.00	70	35	70	68~~9~~	65	70	10	—
80	MFR	657.00	71	35	70	62	65	70	—	—
81	MFR	671.00	60	25	72	60	65	71	—	—
82	MFR	678.00	60	35	70	63	65	70	—	—
83	SFR	688.00	180	35	55	59	55	61	22	—
84	SFR	698.00	80	35	60	62	58	64	1	—
85	MFR	692.00	60	35	69	63	64	69	—	—
86	SFR	678.00	50	35	70	64	65	70	—	—
87	MFR	674.00	105	25	58	58	57	63	12	—
88	MFR	672.00	61	25	70	60	64	69	—	—
89	MFR	657.00	46	35	71	64	65	70	—	—
90	MFR	653.00	47	35	71	70	65	70	20	—

Table ~~10~~12 Summary of Noise Impact Assessment, Residential Land Uses

Cluster	Desc.[a]	Civil Stn.[b]	Near Track Dist (ft)	Speed[e] (mph)	L_{dn}, (dBA)				Number of Impacts[d]	
					Existing	Project[c/g]	Impact Threshold			
							Mod[g]	Severe[g]	Mod	Severe
91	MFR	648.00	48	35	71	64	65	70	—	—
92	MFR	644.00	49	35	71	70	65	70	10	—
93	MFR	629.00	48	35	71	64	65	70	—	—
94	MFR	623.00	40	35	71	65	65	70	—	—
95	MFR	620.00	171	35	56	59	56	61	6	—
96	MFR	615.00	50	35	72	64	65	71	—	—
97	MFR	609.00	60	35	71	63	65	70	—	—
SEGMENT 2										
98	MFR	665.00	110	55	63	65	60	65	10	—
98a	MFR	667.00	110	55	63	65	60	65	10	—
99	MFR	669.00	115	55	63	65	60	65	12	—
99a	MFR	680.00	34	35	63	66	60	65	—	10
100	MFR	688.00	~~105~~90	55	59	63	57	63	4	—
101	SFR	692.00	~~115~~100	55	59	62	57	63	6	—
102	SFR	695.00	~~120~~105	55	59	62	57	63	8	—
103	SFR	700.00	115	50	59	64	57	63	~~0~~—	8
104	SFR	704.00	110	45	59	63	57	63	6	—
105	SFR	707.00	110	35	59	60~~1~~	57	63	6	—
106	MFR	710.50	110	25	59	58	57	63	4	—
107	MFR	713.50	110	45	59	63	57	63	4	—
108[f]	SFR	725.00	440	55	60	54	58	63	—	—
109[f]	SFR	726.50	440	55	60	55	58	63	—	—
110[f]	MFR	731.00	440	55	60	54	58	63	—	—
111	MFR	737.00	440	35	60	47	58	63	—	—
112	MFR	744.00	440	55	60	51	58	63	—	—
SEGMENT 3										
113	MFR	777.00	88	25	71	59	65	70	—	—
113a	MFR	781.00	54	25	71	61	65	70	—	—
113b	MFR	782.50	48	25	71	61	65	70	—	—
113c	SFR	783.50	324	25	71	53	65	70	—	—
SEGMENT 3a										
114	MFR	777.00	20	55	71	71	65	70	~~0~~—	28
114a	MFR	781.00	110	55	71	65	65	70	—	—

Table ~~10~~12 Summary of Noise Impact Assessment, Residential Land Uses

Cluster	Desc.[a]	Civil Stn.[b]	Near Track Dist (ft)	Speed[e] (mph)	L_{dn}, (dBA)				Number of Impacts[d]	
					Existing	Project[c/g]	Impact Threshold			
							Mod[g]	Severe[g]	Mod	Severe
114b	MFR	782.50	120	55	71	61	65	70	—	—
114c	SFR	783.50	80	55	71	63	65	70	—	—
114d*	MFR	791.00	75	35	57	59	56	62	3	—
115	MFR	844.00	38	25	71	62	65	70	—	—

Source: ATS Consulting, 2008; updated 2009.

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

b. Civil Stn refers to the locating system used on design drawings.

c. Project L_{dn} is the additional noise that would be created by the LRT operations.

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.

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

f. Based on Centinela grade separation analysis.

g. Values for the impact thresholds in the *Noise and Vibration Technical Background Report* prepared for the DEIR were switched. They have been corrected for this table in the FEIR.

* Refer to Appendix E for supplementary data analysis and results.

Mod = moderate impact, Severe = severe impact.

Table ~~11~~13 Summary of Noise Impact Assessment for Category 3 (Institutional Land Uses)

Cluster	Desc.[a]	Civil Stn.[b]	Near Track Dist (ft)	Speed[e] (mph)	L_{eq}, (dBA)[c]				Impact
					Existing	Project[d]	Impact Threshold		
							Mod[f]	Severe[f]	
SEGMENT 1									
1	Church	538.00	85	55	66	65	67	72	None
2	Boy Scouts	555.00	25	50	66	74	67	72	Severe
3	Lycée School	564.00	35	50	66	67	67	72	Moderate
4	Park	590.00	30	35	63	58	64	70	None
5*	Overland School	610.00	85	40	~~59~~64	62	65	70	~~Moderate~~ None
SEGMENT 1a									
6	Park	518.00	78	35	69	65	69	74	None
7	Church	530.00	80	35	69	64	69	74	None
8	Church	533.00	156	35	69	62	69	74	None
9	Hospital	535.00	76	35	69	65	69	74	None

Table ~~11~~13 Summary of Noise Impact Assessment for Category 3 (Institutional Land Uses)

Cluster	Desc.[a]	Civil Stn.[b]	Near Track Dist (ft)	Speed[e] (mph)	L_{eq}, (dBA)[c]				Impact
					Existing	Project[d]	Impact Threshold		
							Mod[f]	Severe[f]	
10	Church	561.00	80	25	69	62	69	74	None
11	Temple	583.00	65	35	69	65	69	74	None
Sepulveda At-Grade									
12	School	625.00	112	35	70	63	69	75	None
13	Day Care	650.00	107	35	70	63	69	75	None
Segment 2									
Lan1	Lantana West[g]	746.00	80	55	57	65	61	67	Moderate
Lan4	Lantana Center[g]	740.00	50	55	57	67	61	67	Severe
Lan5	IMAX[g]	732.00	90	55	57	71	61	67	Severe
SEGMENT 3									
14	School	783.00	90	25	66	61	67	72	None
15	School	794.00	100	35	64	62	65	71	None
16	Park	804.00	60	25	64	65	66	71	None
SEGMENT 3a									
17*	Crossroads School	794.00	75	35	57	62	61	67	Moderate

Source: ATS Consulting, 2008; updated 2009.

a. Desc. = Type of land use.

b. Civil Stn refers to the locating system used on design drawings.

c. Maximum 1-hour Leq during period of day when facility is in use.

d. Project Leq is the additional noise that would be created by the LRT operations.

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

f. Values for the impact thresholds in the *Noise and Vibration Technical Background Report* prepared for the DEIR were switched. They have been corrected for this table.

g. Refer to Appendix E (Section E.5) for discussion of the noise impact assessment for the Lantana Campus.

* Updated because of supplementary data analysis and results; refer to Appendix E.

Table ~~12~~14 Noise Impact Summary

Segment	Description	SFR	MFR[a]	Other	Moderate Impact	Severe Impact
Segment 1	Robertson to I-10	0	6	Lycee School Boy Scouts Building	7	1
	I-10 to Overland	~~17~~18	0	~~Overland School~~None	~~17~~18	0
	Overland to Sepulveda	~~91~~90	0	None	~~78~~71	~~13~~19

Table ~~12~~14 Noise Impact Summary

Segment	Description	SFR	MFR[a]	Other	Moderate Impact	Severe Impact
	Total	***108***	***6***	***~~3~~2***	***~~102~~96***	***~~14~~20***
Segment 1a	Venice Blvd.	9	26	None	35	0
	Sepulveda Blvd.	23	68	None	91	0
	Total	***32***	***94***	***None***	***126***	***0***
Segment 2	Sepulveda to Cloverfield	34	~~34~~54	Lantana[b]	~~60~~70	~~8~~19
	Total	***34***	***~~34~~54***	***1***	***~~60~~70***	***~~8~~19***
Segment 3	Olympic Blvd.	0	0	None	0	0
	Total	***0***	***0***	***None***	***0***	***0***
Segment 3a	Colorado Avenue	0	~~28~~31	Crossroads Elementary School Groove Masters Studio	~~0~~5	28
	Total	***0***	***~~28~~31***	***2***	***~~0~~5***	***28***

Source: ATS Consulting, 2008; updated 2009.

a. Estimates of units within multi-family residences

b. The Lantana Campus is summarized as a single site; refer to Appendix E for supplementary detailed data analysis and results.

Table ~~10~~12 and Table ~~11~~13 include the type of land use, the station number, the distance to the nearest track, the speed of the LRT, existing noise, the noise impact criteria, future predicted noise from the LRT only, and total predicted future noise including the LRT. The tables also include counts of the number of units that have moderate and severe impact.

Category 3 land uses adjacent to the Expo Phase 2 Corridor include:

- Seventh Day Adventist Reform Church on Exposition Boulevard between Plovon Lane and Watseka Avenue in Segment 1
- The Boy Scouts of America Westside Scout Store and Service Center on National Boulevard between Jasmine Avenue and Clarington Avenue in Segment 1
- The Lycée School under construction on National Boulevard just east of Motor Avenue in Segment 1
- Palms Park located adjacent to the Segment 1 alignment just west of I-10
- Overland Avenue Elementary School located on the east side of Overland Avenue between Northvale Road and Ashby Avenue in Segment 1
- Media Park located on the south side of Venice Boulevard between Culver Boulevard and Canfield Avenue in Segment 1a
- Church of Jesus Christ on the north side of Venice Boulevard between Watseka Avenue and Delmas Terrace in Segment 1a
- Hare Krishna Temple located at the intersection of Venice Boulevard and Delmas Terrace in Segment 1a

- HCA Brotman Medical Center on the south side of Venice Boulevard between Hughes Avenue and Delmas Terrace in Segment 1a
- West Los Angeles Christian Center located at the intersection of Venice Boulevard and Mentone Avenue in Segment 1a
- Chabad of Marina Del Rey is located on the north side of Venice Boulevard between Midvale Avenue and Kelton Avenue.
- Charnock Road Elementary School located at the intersection of Sepulveda Boulevard and Charnock Road in Segment 1a
- University Village Child Care Center is located at the UCLA Family Student Housing Complex in University Village, at 3233 Sepulveda Boulevard in Segment 1a.
- Crossroads High School on the south side of Olympic Boulevard between 20th Street and 21st Street in Segment 3
- Crossroads Elementary School located on the north side of Olympic Boulevard between 17th Street and 18th Street in Segment 3
- Memorial Park located on the north side of Olympic Boulevard between 14th Street and 16th Street in Segment 3

Severe noise impact is predicted at the Boy Scouts of America building while Moderate impact is predicted at the Lycée School ~~and the Overland Elementary School~~. Noise levels at all other Category 3 locations within the Expo Phase 2 segments are predicted to be below impact thresholds.

The following is a brief description of the predicted impact caused by Expo Phase 2 operations:

Segment 1: Expo ROW

According to the FTA standards, 108 single-family residences, 6 multi-family residences, ~~2~~21 school~~s~~, 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 ~~13~~19 single-family residences and the building used by the Boy Scouts.

- **Robertson to I-10 Freeway:** Predicted noise levels at six multi-family residences, one building that houses the Boy Scouts of America, and Lycée School ~~that is currently under construction~~ exceed the noise impact threshold. All the predicted moderate effects 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.
- **I-10 Freeway to Overland Avenue:** ~~Noise~~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 Exposition ROW is in a trench for a distance of approximately 2,000 ft. after it passes under 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 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 ~~12~~18 single-family residences adjacent to Segment 1 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 after the building is removed.

Segment 1a

Impact is predicted at 32 single-family residences and 94 multi-family residences. No severe impact is 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 Sawtelle/ Westwood 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

Noise impact is predicted for 34 single-family residences and ~~34~~54 multi-family residences and at the Lantana Campus. Of these impacts, ~~8~~19 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.

Based on supplementary analysis conducted in response to comments on the DEIR, there also may be noise impacts at 12312 Olympic Boulevard because of the filming and recording studios that are within the building. The potential for noise impacts to the sensitive uses at 12312 Olympic Boulevard and other related properties in the same area will be evaluated during final design. If impacts are identified over FTA thresholds, noise mitigation such as a sound wall will be implemented.

Segment 3

There is no predicted impact at any location within Segment 3.

Segment 3a

Moderate noise impact is predicted at Crossroads Elementary School and the 18th Street Art Studio (counted as 3 residential units). Severe noise impact is predicted for 28 multi-family residences. 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. All of the predicted severe impacts are at an eight-story multi-family residential building located on the north side of the Exposition ROW near 22nd Street and Colorado Avenue. ~~No severe impact is predicted along Segment 3a~~.

5.1.2 Audible Warnings at Grade Crossings

As discussed in 4.2.4, 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 would 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 2 and 3 land uses closest to the crossings are shown in Table ~~13~~15 (Predicted Levels of Crossing Bell Noise). Shown in the table are the predicted noise levels for the following conditions:

- 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 decibels 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 15~~3~~, ~~this~~ adjusting the bells to a maximum of 80 dBA at 10 feet is sufficient to eliminate all of the predicted noise impact from crossing bells.

- Reduced Bell Volume and Shrouds (column "Add Shrouds"): In addition to reducing the bell volume, shrouds are attached to the bells to direct noise away from the noise sensitive receptors. An additional 1 to 5 dB of attenuation is possible through the use of shrouds, which would require CPUC approval.

The bell noise can be further reduced by applying to the CPUC for a gate-down-bell-stop variance. Obtaining approval requires demonstrating to the CPUC satisfaction that the safety measures in place on the crossing more than compensate for stopping the bell noise once the gates are in the horizontal position.

Table ~~13~~15 Predicted Levels of Crossing Bell Noise

Segment	Street	Quad.	Cluster	L_{dn} [a] (dBA)					Diff,[f] (dB)
				Exist	Impact Thresh[b]	No Mitig[c]	Lower Vol[d]	Add Shrouds[e]	
Segment 1: Expo ROW	Bagley	SE	3	68	63	**64**	594	~~49~~55	~~1~~59
		SW	4	68	63	60	550	~~48~~53	~~1~~27
Segment 1: Expo ROW	Overland	NE	School	~~59~~64[g]	6~~52~~[g]	59[g]	5~~49~~[g]	~~47~~52[g]	~~1~~27
		SE	38	56	56	56	51~~46~~	47~~2~~	~~1~~49
		SW	39	58	57	**60**	550	54~~8~~	~~1~~26
		NW	25	59	57	57	52~~47~~	48~~3~~	~~1~~49
Segment 1: Expo ROW	Westwood	NE	28	59	57	**60**	550	54~~9~~	~~1~~16
		SE	42	59	57	**59**	54~~9~~	~~4~~50	~~1~~49
		SW	43	59	57	**61**	56~~1~~	550	~~1~~16
		NW	29	59	57	**58**	53~~48~~	~~4~~50	~~1~~39
Segment 1: Expo ROW	Military	NE	34	59	57	**61**	56~~1~~	54~~9~~	~~1~~27
		SE	48	59	57	**59**	54~~9~~	~~46~~51	~~1~~38
		SW	49	59	57	**61**	56~~1~~	550	~~1~~16
Segment 1: Expo ROW	Sepulveda	SE	52	60	58	**59**	54~~9~~	~~4~~50	~~1~~49
Segment 1a: Venice/Sepulveda	No gate-protected crossings								
Segment 2: Sepulveda to Cloverfield	Barrington	SE	100	59	57	**61**	56~~1~~	~~46~~51	10~~5~~
		SW	101	59	57	**59**	54~~9~~	~~47~~52	~~1~~27
	Stewart	NE	Lantana	59	62	58	53	52	7
Segment 3: Olympic	No gate-protected crossings								
Segment 3a: Colorado	20th Street	SE	114c	71	65	61	56	51	10
	17th Street	SE	15	57	56	54	49	46	8
		~~No noise sensitive receptors at crossing~~							

Table ~~13~~15 Predicted Levels of Crossing Bell Noise

Segment	Street	Quad.	Cluster	L_{dn} [a] (dBA)					Diff,[f] (dB)
				Exist	Impact Thresh[b]	No Mitig[c]	Lower Vol[d]	Add Shrouds[e]	

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. Bell noise at closest receivers with reduced bell sound level and shrouds to direct bell sound away from noise sensitive receptors.

f. Difference between bell noise with no mitigation and bell noise with reduced sound level and shrouds.

g. Predicted maximum hourly L_{eq} for Overland Avenue School, which is used for assessing impacts at institutional land uses.

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

5.1.3 Wheel Squeal

Wheel squeal noise is generated by the slip-stick interaction of the wheels and rails as 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 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 proposed alignments have relatively few curves where wheel-squeal is likely to occur. Table ~~15~~16 (Predicted Levels of Wheel Squeal Noise) shows the predicted levels of wheel squeal at sensitive receptors assuming that no measures are taken to control squeal. The clusters of sensitive receptors are the same as used in assessing normal noise from LRT operations. Aerial photographs showing buildings in each cluster are included in ~~the Noise and Vibration Technical Report~~Appendix D of this report. Table ~~15~~16 (Predicted Levels of Wheel Squeal Noise) shows that potential noise impact from wheel squeal could occur at two clusters on Segment 1, three on Segment 1a, and two on Segment 3 and two on Segment 3a. The clusters are residential land uses except for cluster 14 on Segment 3 ~~that is a school~~and Cluster 15 on Segment 3a both of which are schools. For two of the clusters on Segment 1a, noise impact is predicted without wheel squeal. For the remaining clusters, eliminating wheel squeal would eliminate the predicted noise impact.

Table 16 Predicted Levels of Wheel Squeal Noise

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

SOURCE: ATS Consulting, 2008; updated 2009.

Numbers in shaded cells exceed moderate impact threshold.

a. Closest group of sensitive receptors.

b. L_{dn} 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. Mitigation options:

A: Eliminating wheel squeal through means such as vehicle mounted or wayside applicators of friction modifier will eliminate the predicted noise impact.

B: With wheel squeal eliminated the predicted noise levels still exceed FTA moderate impact threshold. The mitigation measures discussed above for LRT noise will be required in addition to taking measures to eliminate wheel squeal noise.

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

Note: Because of extensive changes in this table, the previous version of the table was deleted entirely. Changes include: 18th Street was replaced with 17th Street because in the current design the radius of the curve at 18th Street is greater than 600 ft, while the radius of the curve at 17th Street is 400 ft; 4th Street was added due to curve at terminus.

Table 14:
Predicted Levels of Wheel Squeal Noise

Curve Locations	Cluster[a]	Dist. (ft)	L_{dn}[b] (dBA)				Impact
			Exist	Impact Threshold[c]		Worst Case[d]	
				Mod	Severe		
Segment 1: Expo ROW (LRT Alternatives 1 and 2)							
Entrance to I-10 underpass	13 14	40 140	68 68	63 68	68 68	69 64	Severe Mod
Segment 1a: Venice/Sepulveda (LRT Alternatives 3 and 4)							
Turn onto Venice from 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 (LRT Alternatives 1 through 4)							
Segment 3: Olympic (LRT Alternatives 1 and 3)							
Turn onto Olympic at 22nd St.	113 14[e]	88 90	71 66[e]	65 67	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						
4th Street	No sensitive receptors near curve						

SOURCE: ATS Consulting

a. Closest group of sensitive receptors. Refer to Noise and Vibration Technical 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. Cluster 14 is a school. The FTA impact thresholds and the predicted noise levels are hourly L_{eq} during rush hour.

5.1.4 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. Details of the measurements are given in Appendix E.

Table 17 (Predicted Maintenance Facility Noise) and Table 18 (Predicted Maintenance Facility Buffer Design Option Noise) show the predicted noise levels from each of the maintenance

facility layouts at the proposed Stewart Street site. There are no predicted impacts from original layout or the Buffer Design Option layout. Refer to Appendix E for information on the supplementary measurements that were performed to refine the Maintenance Facility noise predictions. ~~Table 16 shows the predicted noise levels from Maintenance Facility activities at the residences along Exposition Boulevard south of the proposed Stewart Street site for the Maintenance Facility. The dominant noise sources at all of the residences are the car wash and the blowdown facility. 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 Stewart Street Maintenance Facility. At 8 of the 21 residences the predicted noise levels exceed the FTA severe impact threshold.~~

Table ~~16~~17 Predicted Maintenance Facility Noise

Clust.[a]	Desc.	Civil Station	Exist L_{dn} (dBA)	Maintenance Facility L_{dn}, (dBA)			Number of Impacts[b]	
				Impact Threshold		Maintenance Facility Noise[c]		
				Mod	Severe		Mod	Severe
M1	SFR	~~553~~746.50	58	57	63	5~~2~~4	—	—
M2	SFR	~~614~~744.00	58	57	63	5~~5~~9	~~—~~4	~~—~~4
M3	SFR	~~617~~742.00	58	57	63	50~~63~~	~~—~~4	~~—~~4
M4	SFR	~~627~~740.50	58	57	63	46~~61~~	~~—~~4	—
M5	SFR	~~631~~737.00	58	57	63	52~~61~~	~~—~~4	—
M6	SFR	~~634~~735.00	58	57	63	56~~59~~	~~—~~5	—
M7	SFR	732+00	59	57	63	53	—	—
M8	Lantana	740+00	57[d]	56[d]	62[d]	54[d]	—	—

Source: ATS Consulting, 2008; updated 2009.
SFR = single-family residence
Mod = moderate impact, Severe = severe impact.
a. The locations and buildings included in each cluster are shown in Appendix D (page 171).
b. Number of dwelling units. This is a count of the number of single-family residences in the cluster.
c. Predicted noise levels from all activities expected to occur at Maintenance Facility.
d. Value is daytime Leq because it corresponds too an institutional land use, not a residence.

Table 18 Predicted Maintenance Facility Buffer Design Option Noise

Clust.[a]	Desc.	Civil Station	Exist L_{dn} (dBA)	Maintenance Facility L_{dn}, (dBA)			Number of Impacts[b]	
				Impact Threshold		Maintenance Facility Noise[c]		
				Mod	Severe		Mod	Severe
M1	SFR	746.50	58	57	63	54	—	—
M2	SFR	744.00	58	57	63	57	—	—
M3	SFR	742.00	58	57	63	55	—	—
M4	SFR	740.50	58	57	63	53	—	—
M5	SFR	737.00	58	57	63	51	—	—

Table 18 Predicted Maintenance Facility Buffer Design Option Noise

Clust.[a]	Desc.	Civil Station	Exist L_{dn} (dBA)	Maintenance Facility L_{dn} (dBA)			Number of Impacts[b]	
				Impact Threshold		Maintenance Facility Noise[c]		
				Mod	Severe		Mod	Severe
M6	SFR	735.00	58	57	63	50	—	—
M7	SFR	732.00	58	57	63	47	—	—
M8[c]	Lantana.	740.00	57[d]	56[d]	62[d]	56[d]	—	—

Source: ATS Consulting, 2008; updated 2009.
SFR = single-family residence
Mod = moderate impact, Severe = severe impact.
a. The locations and buildings included in each cluster are shown in Appendix D.
b. Number of dwelling units. This is a count of the number of single-family residences in the cluster.
c. Predicted noise levels from all activities expected to occur at Maintenance Facility.
d. Value is a daytime Leq because it corresponds to a daytime land use and not a residence.

5.1.5 Ancillary Equipment

As discussed in section 4.2.5, transit power substations (TPSS) are the only ancillary equipment associated with the proposed project with the potential for causing noise impacts. There would be approximately ~~8 to 9~~12 TPSS units distributed along the proposed project, including one in the Maintenance Facility site. The number of TPSS units varies depending upon the alignment. 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 ~~both~~potential generators, such as the transformer hum and any cooling systems would be included in the contract specifications to minimize the potential for adverse noise effects. For 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. For noise sensitive areas, baffles that reduce fan A-weighted noise levels by 6 decibels can be specified.

The Metro Design Criteria include a design goal that noise from continuous sources, such as TPSS units, not exceed the ambient. The ambient for residential land uses is defined as the nighttime L_{eq}, while the ambient for institutional land uses is identified 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 decibels below the ambient.

Table ~~17~~19 (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. ~~The~~ Where any uncertainty exists 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 if the predicted TPSS noise is 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 19 Predicted TPSS Noise

Unit	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: Due to the large amount of edits, Table 17 was completely replaced by Table 19.

~~**Table 17 Predicted TPSS Noise**~~

~~Unit~~	~~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}.~~

5.2 Operational Vibration

As discussed in Section 3.3, 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 Expo Phase 2 are a maximum vibration level of 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 1/3-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 5.6.2 (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. The number of potential impacts was reduced considerably after applying the Detailed Assessment criteria. Table ~~18~~20 (Summary of Vibration Impact Assessment, Residential Land Uses) and Table ~~19~~21 (Summary of Vibration Impact Assessment for Institutional [Category 3] Land Uses) present the LRT operation vibration impact predictions for the Expo Phase 2 project. Table ~~18~~20 (Summary of Vibration Impact Assessment, Residential Land Uses) shows residential land uses (residences, hotels, and hospitals) while Table ~~19~~21 (Summary of Vibration Impact Assessment for Institutional [Category 3] Land Uses) shows institutional land uses (schools, libraries, medical facilities, and parks). The data presented in the tables includes:

- Description of the property and land use. Single-family residences (SFR), and multi-family residences (MFR) are the most common Category 2 land uses along the Expo alignment. The most common Category 3 land uses are schools, churches, and parks.
- Whether the track plans call for a crossover near the cluster. The wheel impacts at crossover special trackwork can increase vibration levels by up to 10 decibels.
- The predicted level of LRT vibration. This prediction is for living spaces in the affected buildings.
- The applicable FTA impact threshold for a General Assessment. As discussed in Section 3, the FTA guidelines include different vibration criteria for a General Assessment and a Detailed Assessment. General Assessment criteria are single-number limits using the overall vibration velocity level, and Detailed Assessment criteria are curves that the predicted vibration spectrum is compared to.
- Whether the predicted vibration levels exceed the General Assessment threshold.
- For the locations where the predicted vibration level exceeds the General Assessment threshold, the amount that it is exceeded.
- Whether the spectrum of the predicted vibration exceeds the applicable Detailed Assessment criterion curve.

Table ~~18~~20 Summary of Vibration Impact Assessment, Residential Land Uses

Clust.	Desc.	Civil Stn.	Near Track Dist (ft)	Speed[a] (mph)	Cross-over	Aerial	Lv (VdB)	Impact Thresh. (VdB)	GA Impact?	Max Spectral Level (VdB)	Detail. Impact?[b]
SEGMENT 1											
1	MFR	520.50	80	55	No	No	76.1	72	Yes	—	—
2	MFR	522.00	95	55	No	No	74.5	72	Yes	—	—
3	MFR	525.00	92	55	No	No	74.8	72	Yes	—	—
4	MFR	528.00	92	55	No	No	74.8	72	Yes	—	—
5	MFR	533.50	90	55	No	No	75.0	72	Yes	—	—
6	MFR	536.00	80	55	No	No	76.1	72	Yes	—	—
7	MFR	538.50	80	55	No	No	76.1	72	Yes	—	—
8	MFR	542.00	80	50	No	No	75.5	72	Yes	—	—

Table ~~18~~20 Summary of Vibration Impact Assessment, Residential Land Uses

Clust.	Desc.	Civil Stn.	Near Track Dist (ft)	Speed[a] (mph)	Cross-over	Aerial	Lv (VdB)	Impact Thresh. (VdB)	GA Impact?	Max Spectral Level (VdB)	Detail. Impact?[b]
9	MFR	546.50	85	35	No	No	72.6	72	Yes	—	—
10	MFR	550.00	90	30	No	No	71.0	72	No	—	—
11	MFR	553.50	80	45	Yes	No	84.8	72	Yes	78.3	Yes
12	MFR	570.50	140	25	No	No	65.8	72	No	—	—
13	MFR	575.00	40	25	No	No	77.4	72	Yes	—	—
14	MFR	577.50	140	25	No	No	65.8	72	No	—	—
15	MFR	579.00	190	25	No	No	62.9	72	No	—	—
16	MFR	580.00	260	20	No	No	58.6	72	No	—	—
17	SFR	582.50	145	20	No	No	64.0	72	No	—	—
18	SFR	587.00	110	35	No	No	70.2	72	No	—	—
19	SFR	592.00	120	35	No	No	69.4	72	No	—	—
20	SFR	595.50	125	35	No	No	69.0	72	No	—	—
21	SFR	598.50	125	35	No	No	69.0	72	No	—	—
22	SFR	601.50	125	35	No	No	69.0	72	No	—	—
23	SFR	604.50	110	35	No	No	70.2	72	No	—	—
24	SFR	607.00	110	35	No	No	70.2	72	No	—	—
25	SFR	614.00	115	35	No	No	69.8	72	No	—	—
26	SFR	617.00	115	35	No	No	69.8	72	No	—	—
27	SFR	620.00	105	25	No	No	68.4	72	No	—	—
28	SFR	623.50	105	25	No	No	68.4	72	No	—	—
29	SFR	627.50	115	35	No	No	69.8	72	No	—	—
30	SFR	631.00	115	40	Yes~~No~~	No	~~70.7~~ 80.2	72	~~No~~ Yes	~~—~~ 73.8	~~—~~ Yes[a]
31	SFR	634.00	115	50	No	No	72.1	72	Yes	—	—
32	SFR	637.00	115	55	Yes~~No~~	No	~~72.7~~ 82.9	72	Yes	~~—~~ 75.9	~~—~~ Yes[a]
33	SFR	639.00	115	55	Yes	No	~~82.7~~ 72.9	72	Yes	~~75.9~~ =	~~Yes[(1)]~~ =
34	SFR	641.50	115	55	No	No	72.7	72	No	—	—
35	SFR	595.00	70	35	No	No	74.4	72	Yes	—	—
36	SFR	597.00	70	35	No	No	74.4	72	Yes	—	—
37	SFR	606.50	70	35	No	No	74.4	72	Yes	—	—
38	SFR	609.00	75	35	No	No	73.7	72	Yes	—	—
39	SFR	613.00	115	35	No	No	69.8	72	No	—	—

Table ~~18~~20 Summary of Vibration Impact Assessment, Residential Land Uses

Clust.	Desc.	Civil Stn.	Near Track Dist (ft)	Speed[a] (mph)	Cross-over	Aerial	Lv (VdB)	Impact Thresh. (VdB)	GA Impact?	Max Spectral Level (VdB)	Detail. Impact?[b]
40	SFR	617.00	115	35	No	No	69.8	72	No	—	—
41	SFR	620.00	105	25	No	No	68.4	72	No	—	—
42	SFR	622.50	105	25	No	No	68.4	72	No	—	—
43	SFR	626.50	115	35	~~No~~ Yes	No	~~69.8~~ 79.0	72	~~No~~ Yes	~~—~~ 72.9	~~—~~ Yes[a]
44	SFR	629.00	115	35	No	No	69.8	72	No	—	—
45	SFR	630.50	115	50	No	No	72.1	72	Yes	—	—
46	SFR	633.00	115	55	No	No	72.7	72	Yes	—	—
47	SFR	636.50	115	55	No	No	72.7	72	Yes	—	—
48	SFR	640.00	115	55	Yes	No	82.7	72	Yes	75.9	Yes[a]
49	SFR	643.50	115	55	No	No	72.7	72	Yes	—	—
	Sepulveda At Grade										
50	SFR	646.50	115	50	No	No	72.1	72	Yes	—	—
51	SFR	648.00	115	40	No	No	70.7	72	No	—	—
52	SFR	650.00	115	30	No	No	68.8	72	No	—	—
53	MFR	650.00	180	30	No	No	64.6	72	No	—	—
	Sepulveda Aerial										
50	SFR	646.50	115	50	No	No	67.1	72	No	—	—
51	SFR	648.00	115	40	No	No	65.7	72	No	—	—
52	SFR	650.00	115	30	No	No	63.8	72	No	—	—
53	MFR	650.00	180	30	No	No	59.6	72	No	—	—
SEGMENT 1a											
Venice											
54	MFR	521.00	211	35	No	Yes	59.2	72	No	—	—
55	MFR	524.00	211	35	No	No	64.2	72	No	—	—
56	MFR	535.00	88	35	No	No	72.3	72	Yes	—	—
57	MFR	542.00	88	35	No	No	72.3	72	Yes	—	—
58	MFR	562.00	126	35	No	Yes	63.9	72	No	—	—
59	SFR	580.00	72	35	No	No	74.1	72	Yes	—	—
60	SFR	592.00	82	35	No	Yes	67.9	72	No	—	—
61	MFR	594.00	82	35	No	Yes	67.9	72	No	—	—
62	MFR	601.00	92	25	No	Yes	64.7	72	No	—	—
63	MFR	552.00	92	30	No	No	70.8	72	No	—	—

Table ~~18~~20 Summary of Vibration Impact Assessment, Residential Land Uses

Clust.	Desc.	Civil Stn.	Near Track Dist (ft)	Speed[a] (mph)	Cross-over	Aerial	Lv (VdB)	Impact Thresh. (VdB)	GA Impact?	Max Spectral Level (VdB)	Detail. Impact?[b]
64	SFR	564.50	72	35	No	Yes	69.1	72	No	—	—
65	MFR	576.00	90	35	No	Yes	67.1	72	No	—	—
66	MFR	579.00	82	35	No	No	72.9	72	Yes	—	—
67	SFR	584.00	160	35	No	No	66.7	72	No	—	—
68	MFR	588.00	156	35	No	Yes	62.0	72	No	—	—
69	SFR	592.00	162	35	No	Yes	61.6	72	No	—	—
70	MFR	595.00	50	35	No	Yes	72.5	72	Yes	—	—
71	MFR	598.00	65	25	No	Yes	67.9	72	No	—	—
72	MFR	599.00	70	25	No	Yes	67.2	72	No	—	—
Sepulveda											
73	MFR	607.00	48	25	No	Yes	70.7	72	No	—	—
74	MFR	611.50	49	25	No	No	75.5	72	Yes	—	—
75	MFR	615.00	58	35	No	No	76.1	72	Yes	—	—
76	MFR	640.00	52	35	No	Yes	72.1	72	Yes	—	—
77	MFR	644.00	68	35	Yes	Yes	79.6	72	Yes	73.2	Yes(1)
78	MFR	650.00	69	35	No	Yes	69.5	72	No	—	—
79	MFR	653.00	70	35	Yes	Yes	79.4	72	Yes	72.9	Yes(1)
80	MFR	657.00	71	35	No	Yes	69.2	72	No	—	—
81	MFR	671.00	60	25	No	Yes	68.6	72	No	—	—
82	MFR	678.00	60	35	No	No	75.8	72	Yes	—	—
83	SFR	688.00	180	35	No	No	65.6	72	No	—	—
84	SFR	698.00	80	35	No	No	73.1	72	Yes	—	—
85	MFR	692.00	60	35	No	No	75.8	72	Yes	—	—
86	SFR	678.00	50	35	No	No	77.5	72	Yes	—	—
87	MFR	674.00	105	25	No	No	68.4	72	No	—	—
88	MFR	672.00	61	25	No	Yes	68.5	72	No	—	—
89	MFR	657.00	46	35	No	Yes	73.3	72	Yes	—	—
90	MFR	653.00	47	35	Yes	Yes	83.1	72	Yes	76.2	Yes
91	MFR	648.00	48	35	No	Yes	72.9	72	Yes	—	—
92	MFR	644.00	49	35	Yes	Yes	82.7	72	Yes	75.9	Yes
93	MFR	629.00	48	35	No	Yes	72.9	72	Yes	—	—
94	MFR	623.00	40	35	No	Yes	74.6	72	Yes	—	—
95	MFR	620.00	171	35	No	No	66.1	72	No	—	—

Table ~~18~~20 Summary of Vibration Impact Assessment, Residential Land Uses

Clust.	Desc.	Civil Stn.	Near Track Dist (ft)	Speed[a] (mph)	Cross-over	Aerial	Lv (VdB)	Impact Thresh. (VdB)	GA Impact?	Max Spectral Level (VdB)	Detail. Impact?[b]
96	MFR	615.00	50	35	No	No	77.5	72	Yes	—	—
97	MFR	609.00	60	35	No	No	75.8	72	Yes	—	—
SEGMENT 2											
98	MFR	665.00	110	55	No	Yes	68.1	72	No	—	—
98a	MFR	666.50	110	55	No	Yes	68.1	72	No	—	—
99	MFR	669.00	115	55	No	Yes	67.7	72	No	—	—
99a	MFR	680.00	34	35	No	Yes	75.3	72	**Yes**	—	—
100	MFR	688.00	~~105~~ 90	55	No	No	~~73.6~~ 75.2	72	**Yes**	—	—
101	SFR	692.00	~~115~~ 100	55	No	No	~~72.7~~ 74.2	72	**Yes**	—	—
102	SFR	695.00	~~120~~ 105	55	No	No	~~72.3~~ 73.8	72	**Yes**	—	—
103	SFR	700.00	115	50	No	Yes	67.1	72	No	—	—
104	SFR	704.00	110	45	No	Yes	66.8	72	No	—	—
105	SFR	707.00	110	35	No	Yes	65.2	72	No	—	—
106	MFR	710.50	110	25	No	Yes	~~63.0~~ 61.5	72	No	—	—
107	MFR	713.50	110	45	No	Yes	66.8	72	No	—	—
108	SFR	725.00	440	55	Yes No	No Yes	~~70.3~~ 55.5	72	No	—	—
109	SFR	726.50	440	55	No	No Yes	~~60.3~~ 55.5	72	No	—	—
110	MFR	731.00	440	55	Yes No	No Yes	~~70.3~~ 55.5	72	No	—	—
111	MFR	737.00	440	35	No	No	57.4	72	No	—	—
112	MFR	744.00	440	55	No	No	60.3	72	No	—	—
SEGMENT 3											
113	MFR	777.00	88	25	No	Yes	58.7	72	No	—	—
113a	MFR	781.00	54	25	No	Yes	61.9	72	No	—	—
113b	MFR	782.50	48	25	No	Yes	63.0	72	No	—	—
113c	SFR	783.50	324	25	No	Yes	44.7	72	No	—	—
SEGMENT 3a											
114	MFR	777.00	20	55	No	Yes	78.0	72	Yes	75	Yes
114a	MFR	781.00	110	55	No	Yes	61.9	72	No	—	—

Table ~~18~~20 Summary of Vibration Impact Assessment, Residential Land Uses

Clust.	Desc.	Civil Stn.	Near Track Dist (ft)	Speed[a] (mph)	Cross-over	Aerial	Lv (VdB)	Impact Thresh. (VdB)	GA Impact?	Max Spectral Level (VdB)	Detail. Impact?[b]
114b	MFR	782.50	120	55	No	No	66.1	72	No	—	—
114c	SFR	783.50	80	55	No	No	70.0	72	No	—	—
114d*	MFR	791.00	75	35	No	No	66.7	72	No	—	—
115	MFR	844.00	38	25	No	Yes	66.7	72	No	—	—

Source: ATS Consulting, 2008; updated 2009.
Notes:
a. Assumes operation of 2- and 3-car trains.
b. Detailed Assessment threshold exceeded at 20 Hz.
SFR = single-family residence, MFR = multi-family residence.
* Refer to Appendix E for supplementary data analysis and results

Table ~~19~~21 Summary of Vibration Impact Assessment for Institutional (Category 3) Land Uses

Clust.	Desc.	Stn.	Near Track Dist (ft)	Speed (mph)	Cross-over	Aerial	Lv (VdB)	Impact Thresh. (VdB)	GA Impact?	Max Spectral Level (VdB)	Detail. Impact?
SEGMENT 1											
1	Church	538.00	85	55	No	No	~~75.5~~ 73.8	75	~~Yes~~ No		—
2	Boy Scouts	555.00	25	50	Yes	No	89.0	75	Yes	89	Yes
3	School	564.00	35	50	No	No	81.2	75	Yes	—	—
4	Park	590.00	40	35	No	No	80.3	75	Yes	—	—
5*	School	610.00	85	40	No	No	73.4	75	~~Yes~~ No	—	—
Segment 1a											
6	Park	518.00	78	35	No	Yes	~~68.4~~ 65.7	75	No	—	—
7	Church	530.00	80	35	No	No	~~73.1~~ 70.5	75	No	—	—
8	Church	533.00	156	35	No	No	~~67.0~~ 64.3	75	No	—	—
9	Hospital	535.00	76	35	No	No	~~73.6~~ 70.9	75	No	—	—
10	Church	561.00	80	25	No	Yes	~~65.9~~ 62.5	75	No	—	—

11	Temple	583.00	65	35	No	No	~~75.1~~ 72.4	75	~~Yes~~ No	—	—
12	School	625.00	112	35	No	Yes	~~65.0~~ 62.5	75	No	—	—
13	Day Care	650.00	107	35	No	Yes	~~65.5~~ 62.8	75	No	—	—
	Sepulveda At-Grade, No Vibration Sensitive Category 3 Land Uses										
	Sepulveda Aerial, No Vibration Sensitive Category 3 Land Uses										
Segment 3											
14	School	783.00	90	25	No	No	~~69.9~~ 66.5	75	No	—	—
15	School	794.00	100	35	No	No	~~71.1~~ 68.4	75	No	—	—
16	Park	804.00	60	25	No	No	~~73.7~~ 71.1	75	No	—	—
Segment 3a											
17*	School	794.00	100	35	No	No	56.0	65	No	—	—

Source: ATS Consulting, 2008; updated 2009.
*Refer to Appendix E for supplementary data analysis and results.

As shown in Table ~~18~~20 (Summary of Vibration Impact Assessment, Residential Land Uses), potential for vibration impact is predicted at ~~18~~24 residences in Segment 1; 50 residences in Segment 1a; and 28 residences in Segment 3a. No vibration impact 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 ~~19~~21 (Summary of Vibration Impact Assessment for Institutional (Category 3) Land Uses), potential for vibration impact 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.

Subsequent to completion of the DEIR, two vibration sensitive land uses adjacent to the alignment were identified. Refer to Table 22 (Summary of Vibration Impact Assessment for Highly Sensitive [Category 1] Land Uses). The first is the Lantana Campus south of Olympic Boulevard between Stewart Street and Centinela Avenue in Segment 2. This facility is an approximately ¼ mile long row of low-rise commercial buildings with tenants associated with the entertainment media industry. Several of the current tenants have audio recording facilities, screening rooms, or edit suites that could be affected by groundborne vibration. The second vibration sensitive land use is the Groove Masters Studio at 14th Street and Colorado Avenue in Santa Monica on Segment 3a. Potential for vibration impact has been identified for both of these facilities. Details on the assessment are given in Appendix E.

Additional sensitive land uses include seven buildings controlled by Kilroy Realty 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, it is possible that there will be vibration impacts at 12312 Olympic Boulevard that could affect the filming and recording studios that are within the building. Thus, the potential for vibration impacts to the sensitive uses of 12312 Olympic Boulevard properties in the same area 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 22 Summary of Vibration Impact Assessment for Highly Sensitive (Category 1) Land Uses

Clust.	Desc.	Stn.	Near Track Dist (ft)	Speed (mph)	Cross-over	Aerial	Lv (VdB)	Impact Thresh. (VdB)	Impact?
SEGMENT 2									
Lan 1	Lantana West 102 Screening Room	746.00	80	55	No	No	70	72	No
Lan 1	Lantana West Office 1st Floor	746.00	80	55	No	No	67	75	No
Lan 2	Todd-AO	743.00	50	55	No	No	71	65	Yes
Lan 3	Gray Martin	743.50	50	55	No	No	75	65	Yes
Lan 4	Lantana Center	740.00	50	55	No	No	80[a]	75	No[a]
Lan 5	IMAX	732.50	90	55	Yes	No	79	72	Yes
SEGMENT 3a									
2	Groove Masters Studio	807.50	40	35	No	No	67	65	Yes

Source: ATS Consulting, 2009.

Refer to Appendix E for detailed impact analysis at the Lantana Campus and Groove Masters Studio.

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

Table ~~20~~23 Vibration Impact Summary

Segment	Description	SFR	MFR~~(1)~~[a]	Other	Impact~~(2)~~[b]
Segment 1	Robertson to I-10	~~12~~18	6	1 Boy Scouts	~~19~~25
Segment 1a	Venice Blvd.	—	~~40~~50	—	~~40~~50
Segment 2	Sepulveda to Cloverfield	—	—	Lantana Campus[c] ~~—~~	1[c] ~~—~~
Segment 3	Olympic Blvd.	—	—	—	—
Segment 3a	Colorado Avenue	—	28	Groove Masters Studio	~~28~~29
	Total	***~~12~~18***	***~~74~~88***	***~~1~~3***	***~~87~~109***

Source: ATS Consulting, 2008; updated 2009.

~~(1)~~a. Estimates of units within multi-family residences

~~(2)~~b. Impacts after detailed vibration analysis

c. The Lantana Campus is summarized as a single site; refer to Appendix E for supplementary detailed data analysis and results.

5.3 Construction Noise and Vibration

5.3.1 Construction Noise

The construction of LRT guideways requires use of heavy earth-moving equipment, pneumatic tools, generators, concrete pumps, and similar equipment. Table ~~21~~24 (Construction Noise Predictions) shows the equipment likely to be used during the noisiest periods of track construction, the typical noise generated by this equipment, the usage factors, and the estimated work-shift L_{eq}. The combined work-shift L_{eq} for the construction scenario shown in Table ~~21~~24 (Construction Noise Predictions) is 84 dBA at 50 ft.

The FTA guidance manual (Ref. 1) does provides guidance on appropriate impact thresholds for construction noise but states that the limits are for guidance and should not be considered "standardized criteria." The guidance is that an 8-hour L_{eq} of 80 dBA at residential land uses is a reasonable criterion for assessing impact to residential land uses. The Expo Design Criteria (Ref. 4) include a more restrictive standard for construction noise that is consistent with an 8-hour L_{eq} of 65 dBA. Because the Expo Design Criteria are more restrictive, they have been used to assess construction noise impact.

Based on construction activities generating a workshift L_{eq} of 84 dBA at 50 ft, the workshift L_{eq} is predicted to be 65 dBA at the following distances:

- 450 ft from the centroid of the construction site if there are no obstructions that provide acoustical shielding
- 200 ft from the centroid of the construction site if buildings, terrain, or other features block the direct path between the construction site and the sensitive receptor.

Table ~~21~~24 Construction Noise Predictions

Equipment	Sound Level at 50 ft under Load	Usage Factor (% of time under full load)	L_{eq} (8-hour workshift)
Earthmover (bulldozer, front-end loader, etc.)	82 dBA	40%	78 dBA
Mobile Crane	81 dBA	20%	74 dBA
Dump Truck	76 dBA	40%	72 dBA
Pneumatic Tools	85 dBA	30%	80 dBA
Generator	78 dBA	40%	74 dBA
Compressor	81 dBA	40%	77 dBA
Total			***84 dBA***

SOURCE: ATS Consulting, 2008.

This analysis shows that impacts are likely unless the contractor is required to implement noise control measures when working near residences. There are several methods of reducing noise levels associated with the construction phase of the project. Potential methods include:

- Avoid nighttime construction

- Use specialty equipment equipped with enclosed engines and/or high performance mufflers
- Locate equipment and staging areas as far from noise-sensitive receptors as possible
- Limit unnecessary idling of equipment
- Install temporary noise barriers
- Reroute construction related truck traffic away from residential streets
- Avoid impact pile driving where possible. Where geological conditions permit their use, drilled piles or using a vibratory pile driver is generally quieter

A specific noise control plan should be implemented by the contractor with special attention to be given to sensitive noise resources such as residences, schools, and parks. The plan should also include a noise monitoring program. In addition, Expo representatives should be available during construction to discuss resident and business owner noise complaints and to take the appropriate action where possible to minimize noise impacts.

5.3.2 Construction Vibration

Some activities, such as pile driving, pavement breaking, and the use of tracked vehicles (e.g., bulldozers), could result in perceptible levels of groundborne vibration. However, these activities would be limited in duration and vibration levels are likely to be well below thresholds for minor cosmetic building damage. Typical vibration limits are shown in Table ~~22~~25 (Construction Vibration Velocity Levels) Given that planned construction would include a limited number of activities expected to generate vibration that approaches the lowest limit in Table ~~22~~25 (Construction Vibration Velocity Levels), no special mitigation measures are required to avoid vibration impact during construction.

Table ~~22~~25 Construction Vibration Velocity Levels

Structural Damage	PPV (in/sec)[a]	Source
Typical for Construction	2.0	Building of Mines Bulletin 656, 1971
Extremely Fragile Buildings	0.2	FTA, 2006
Historic and Ancient Buildings	0.12	German Standard DIN 4150

Source: ATS Consulting, 2008.
a. Peak Particle Velocity

The noise-control plan, discussed in Section 5.3.1, would also include measures to minimize vibration impacts during construction. Expo representatives would also be available to discuss vibration-related complaints and to take appropriate action to minimize intrusion.

6. MITIGATION

6.1 Train Noise

The specific locations where noise mitigations are expected to be required are listed in Table ~~23~~26 (Train Noise Mitigation Options and Locations). Final type, location, and extent of noise mitigations will be completed in Final Design.

Solid, impervious objects that block the direct path between the sound source and the receiver shall be installed ~~where feasible~~at the proposed locations indicated in Table 26 (Train Noise Mitigation Options and Locations) to reduce the sound level at the receiver. Sound walls are a common noise mitigation measure and have been widely used on highways and on rail transit lines. Alternatively, Expo 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 wheel impacts at frogs[†], 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. Note that the design, location, and height of any fencing along the ROW are independent of noise mitigation recommendations.

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.

For crossovers 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. ~~For example, movable point frogs use a mechanism similar to a rail switch to move the frog points and close the gap in the direction of travel; this is an expensive system to install and maintain. A lower cost alternative is~~For example, a spring-rail frog that leaves the gap closed in the normal direction of travel and uses the transit vehicle wheels to force the gap open when a vehicle is crossing to the other track. ~~Another option is a flange bearing frog, which is designed so that instead of having the wheel "jump" the gap between rails, there is a ramp so that the weight of the vehicle is transferred to the wheel flange. (Note: Without careful design and maintenance the transfer of load from the wheel tread to the flange can increase vibration as much as a standard frog; therefore, this last option should be employed with caution.)~~

[†] A *frog crossover* refers to the crossing point of two rails, which can be assembled out of several appropriately cut and bent pieces of rail or can be a single casting. A frog forms part of a railroad switch, and is also used in a level junction (flat crossing).

Table ~~23~~26 Train Noise Mitigation Options and Locations

Segment	Side of Alignment	Civil Stations	Mitigation Options[a]
Segment 1: Expo ROW	South	552+00 to 556+00	A[c]~~, B~~
	South	562+50 to 565+50	A
	South	597+50 to 611+00	A
	North	612+00 to 619+00	A
	South	612+00 to 619+00	A
	North	626+00 to 642+50	A[c]~~, B~~
	South	626+00 to ~~651+00~~643+50	A[c]~~, B~~
	Sepulveda At-Grade Option		
	South	643+50 to 651+00	A
	Sepulveda Grade-Separation Option		
	South	643+50 to 651+00	A
Segment 1a: Venice/Sepulveda	North	520+00 to 527+00	A
	South	579+00 to 594+00	A
	West	619+50 to 621+50	A
	East	643+00 to 645+5	A~~,~~ or B[c]
	West	642+50 to 645+5	A, or B[c]
	East	651+00 to 654+50	A or B[c]
	West	651+00 to 654+50	A or B[c]
	West	672+00 to 675+00	A
	East	685+00 to 699+00	A
Segment 2: Sepulveda to Cloverfield	South	~~663~~664+00 to ~~665~~670+50	A
	~~S~~North~~u~~rth	~~667~~675+00 to ~~670+50~~678+00	A
	South	686+00 to 715+50	A
	North	735+00 to 747+50	A
Segment 3: Olympic	—	—	—
Segment 3a: Colorado	North	776+00 to 779+00	A or C[b]
	South	789+50~~90~~+00 to 795~~4~~+00	A

SOURCE: ATS Consulting, 2008; updated 2009.

a. Noise mitigation options will be determined in Final Design:
- A. Sound wall, berm, or equivalent.
- B. Low impact frog at crossover.
- C. 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 updates to the design.

Sound insulation of residences and other noise sensitive facilities is another alternative that shall be used when sound walls and low-impact frogs are not feasible or do not provide sufficient noise mitigation. 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.

A substantial amount of the predicted noise impact would be generated by wheel impacts at crossovers. Turnouts and crossovers where two rails cross include a special fixture referred to as a "frog." Wheel impacts at frogs would increase noise levels up to 6 dB.

The specific locations where noise mitigations are expected to be required are listed in Table ~~23~~26 (Train Noise Mitigation Options and Locations). Final type, location and extent of noise mitigations will be completed in Final Design. Noise mitigation locations are shown on drawings included in Appendix D.

6.2 Audible Warnings at Gate-Protected Grade Crossings

All of the predicted noise impact from audible warnings at gate-protected grade crossings can be eliminated by reducing the bell sound level to within 5 decibels of the bottom of the CPUC-approved range. This step is sufficient to reduce the bell noise to below the applicable FTA impact thresholds. In addition, if CPUC approval can be obtained, sheet-metal shrouds can be installed to direct noise away from residences. The combined effect of reducing the sound level of the bells and installing shrouds would be to reduce bell noise by ~~11~~6 to ~~15~~10 dBA. (The predicted noise levels with reduced bell volume and with shrouds are included in Table ~~13~~15.) With these mitigation measures, the bell noise would be ~~well~~ below the FTA noise impact thresholds.

In noise-sensitive locations, the bell noise can be further reduced by CPUC approval for a gate-down-bell-stop variance. Obtaining approval requires demonstrating to the CPUC's satisfaction that the safety measures in place on the crossing more than compensate for stopping the bell noise once the gates are in the horizontal position.

~~6.3 Maintenance Facility~~

~~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 Stewart Street Maintenance Facility. An 8 to 10 ft high sound wall installed along the southern property line of the Maintenance Facility would reduce the predicted noise levels to below the FTA moderate impact threshold.. The wall height can be reduced to 6 to 8 ft high if the car wash and blowdown facilities are designed to generate lower noise levels than standard facilities.~~

~~Other approaches to reducing the noise from the Maintenance Facility include:~~

1. ~~Eliminate the blowers in the car wash or locate the blowers on the east end of the car wash.~~
2. ~~Reduce noise from the blowdown facility by locating the vacuum equipment and compressor near the middle of the building instead of at the entrances.~~
3. ~~Include noise limits in the purchase specifications for the blowdown vacuum and compressor.~~

4. ~~Apply noise mitigation measures directly to the vacuum equipment and compressor. The mitigation measures could be as simple as partial enclosures that reduce the amount of noise radiated out of the openings of the blowdown facility.~~
5. ~~Construct the south walls of the facilities of masonry, brick, or wood studs with insulation in the cavities instead of sheet metal.~~

6.3 Transit Power Substations

Noise levels would be sufficient to warrant mitigation at ~~7~~4 of the 15 proposed TPSS sites. 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 a minimum of 20 ft from the closest residential land use.~~ See Table ~~17~~19 (Predicted TPSS Noise) for the sites under consideration for TPSS units.

6.4 Wheel Squeal

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, sound walls (or equivalent) and/or sound insulation 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.

6.5 Train Vibration

The vibration impact assessment based on General Vibration Assessment procedure identified potential for vibration impact at ~~30~~57 clusters along the alignment. The General Assessment incorporates conservative assumptions to ensure that no potential vibration impacts are overlooked. A Detailed Vibration Assessment has been performed at these locations to get a more accurate picture of the impacts. Based on this analysis, there is potential for vibration impact at ~~13~~12 clusters.

Approaches to reducing levels of groundborne vibration typically consist of building vibration isolation into the track system. The spectrum of the predicted vibration peaks between 20 and 63 Hz 1/3 octave, a frequency range that is quite effective for most track isolation systems. Potential track isolation systems that could be applied to the LRT track include:

- **Low-Impact Frogs:** A large percentage of the vibration impact occurs at the crossovers along the proposed corridor. Construct special trackwork for turnouts and crossovers including a special fixture where two rails cross. This fixture is referred to as a “frog,” apparently because the shape is thought by some to resemble the amphibian. Wheel impacts at frogs will increase vibration levels up to 10 decibels. This impact vibration can be reduced through the use of low-impact frogs.
- **Resilient track support systems:** Reducing the rail modulus by increasing the thickness and reducing the stiffness of the resilient material under the rail will tend to

reduce the vibration energy transmitted into the ground. This approach is most effective at frequencies greater than about 30 Hz.

- **Floating slab track:** In this approach, the track is constructed on a concrete slab that is supported by resilient elements. In essence, the track slab is "floating" on resilient pads, either discrete pads 8 to 12 inches in diameter or a continuous resilient mat. This type of track construction tends to be very expensive per track foot. It is typically used where substantial vibration mitigation is needed.

The specific locations where vibration mitigations are expected to be required are listed in Table ~~24~~27 (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.

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.

Table ~~24~~27 Vibration Mitigation Locations

Segment	Location of Impacts	Mitigation Locations (Civil Stations)[a]
Segment 1: Expo ROW	~~North and~~ South of Tracks	~~551~~552+00 to ~~561~~556+00
	~~North~~South of Tracks	~~636+00~~626+50 to ~~642+00~~627+50
	North of Tracks	~~635~~630+50 to ~~641~~631+50
	North of Tracks	636+50 to 637+50
	South of Tracks	640+00 to 641+00
Segment 1a: Venice/Sepulveda	~~North~~East and ~~South~~west of Tracks	~~642~~643+00 to 645+00
	~~North~~East and west of Tracks	~~651~~652+00 to ~~655~~654+50
Segment 2: Sepulveda to Cloverfield	South of Tracks~~None~~	732+00 to 733+00~~—~~
	North of Tracks	741+00 to 745+00
	North of Tracks	745+00 to 747+50
Segment 3: Olympic	None	—
Segment 3a: Colorado	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: Location and extent of vibration mitigation has changed due to updates to the design.

6.6 Construction Noise

Without noise mitigation, construction of the project is expected to generate noise levels that exceed the limits in the Metro design criteria. Measures to reduce noise levels below the limits of the Expo design criteria and the city construction noise thresholds include:

- Noise Control Plan: The contractor should be required to develop a Noise Control Plan that demonstrates how he will achieve the more restrictive of the Expo Design Criteria noise limits and the noise limits of the city noise control ordinance. The plan should include measurements of existing noise, a list of the major pieces of construction equipment that will be used, and predictions of the noise levels at the closest noise-sensitive receptors (residences, hotels, schools, churches, temples, and similar facilities). The Noise Control Plan would need to be approved by the Expo Authority prior to initiating construction.
- Alternative Construction Procedures: Where the construction cannot be preformed in accordance with the requirements of the Metro noise limits, the contractor should be required to investigate alternative construction measures that would result in lower sound levels. Also, the contractor should be required to conduct noise monitoring to demonstrate compliance with contract noise limits.
- Best Management Practices: The contractor should be required to use the following best management practices for noise abatement whenever practical:
  - Utilize specialty equipment equipped with enclosed engines and/or high performance mufflers as feasible. The contractor shall locate equipment and staging areas as far from noise-sensitive receptors as possible
  - Limit unnecessary idling of equipment
  - Install temporary noise barriers as needed where feasible
  - Reroute construction related truck traffic away from residential streets to the extent permitted by the relevant municipality
  - Avoid impact pile driving where possible. Where geological conditions permit their use, drilled piles or a vibratory pile driver is generally quieter

Specific measures to be employed to mitigate construction noise impacts would be developed by the contractor. In addition, Expo representatives should be available during construction to discuss resident and business owner noise complaints and to take appropriate action where possible to minimize noise impacts.

6.7 Construction Vibration

The noise-control plan, discussed in Section 6.6, would also include measures to minimize vibration impacts during construction. Expo representatives would also be available to discuss vibration-related complaints and to take appropriate action to minimize intrusion.

7. REFERENCES

1. Federal Transit Administration Office of Planning and Environment (FTA). 2006. Transit Noise and Vibration Impact Assessment. Document FTA-VA-90-1003-06, May 2006
2. U.S. Department of Transportation, Federal Highway Administration (USDOT). 2006. FHWA Roadway Construction Noise Model User's Guide. Report FHWA-HEP-05-054, DOT-VNTSC-FHWA-05-01, January.
3. J. T. Nelson, "Tri-Met Track Vibration Isolation Tests, Final Report," Submitted to Robert Chow, Portland Tri-Met, October 30, 1998.
4. Exposition Metro Line Construction Authority (Expo), January 2007, "Metro Design Criteria," Revision 2.

APPENDIX A: FUNDAMENTALS OF NOISE AND VIBRATION

A.1 Noise Fundamentals

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 scale (dB), is used to quantify sound intensity and compress the scale to a more convenient range.

Sound is characterized by both its amplitude and frequency (or pitch). The human ear does not hear all frequencies equally. In particular, the ear 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.” On this scale, the human range of hearing extends from approximately 3 dBA to around 140 dBA. As a point of reference,

Figure 15 (Typical Outdoor and Indoor Noise Levels) includes examples of A-weighted sound levels from common indoor and outdoor sounds.

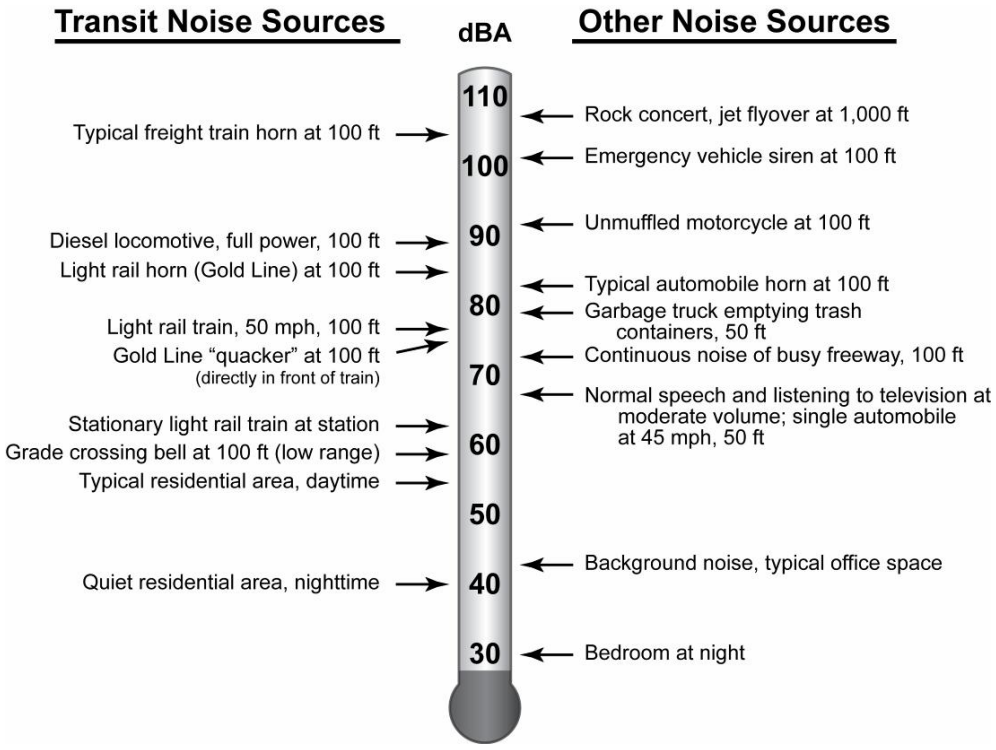


Figure 15 Typical Outdoor and Indoor Noise Levels

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 loudness.

The two primary factors that reduce levels of environmental sounds are increasing the distance between the sound source and the receiver and having intervening obstacles such as walls, buildings, or terrain features that 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.

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

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. For this analysis L_{max} is defined as the maximum sound level using the slow setting on a standard sound level meter.
- *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 effects 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. The effect of the penalty is that, when calculating L_{dn}, any event that occurs during the nighttime is equivalent to ten occurrences of the same event during the daytime. L_{dn} is the most common measure of total community noise over a 24-hour period and is used by the FTA to evaluate residential noise effects from proposed transit projects.
- *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. For a 1-hour period, L_{99} is the sound level exceeded for all except 36 seconds of the hour. 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. L_1 represents typical maximum sound levels, L_{33} is approximately equal to L_{eq} when free-flowing traffic is the dominant noise source, L_{50} is the median sound level, and L_{99} is close to the minimum sound level.
- *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}.
- *Sound Transmission Class (STC):* STC ratings are used to compare the sound insulating effectiveness of different types of noise barriers, including windows, walls, etc. Although the amount of attenuation varies with frequency, the STC rating provides a rough estimate of the transmission loss from a particular window or wall.

A.2 Vibration Fundamentals

One potential community effect from the proposed project is vibration that is transmitted from the tracks through the ground to adjacent houses. 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.).[‡] The potential adverse effects 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 build 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 effect 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.

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 µin/sec.

Figure 16 (Typical Vibration Levels) shows typical vibration levels from rail and non-rail sources as well as the human and structure response to such levels.

[‡] One µin/sec= 10^{-6} in/sec.

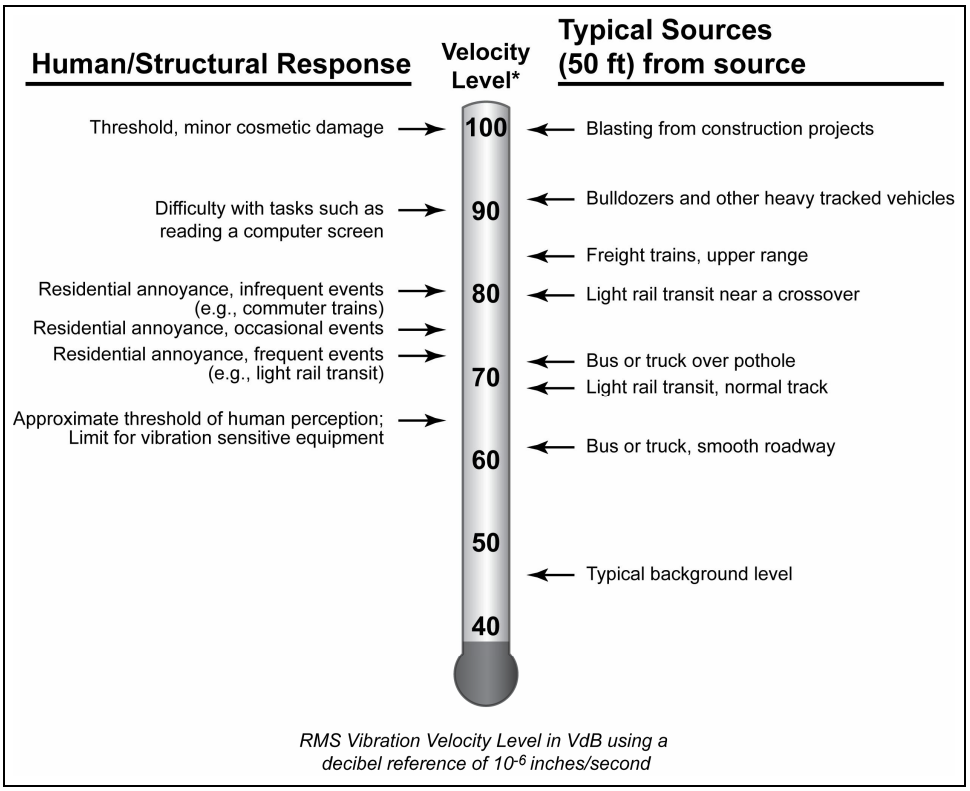


Figure 16 Typical Vibration Levels

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

- It is rare that groundborne vibration from transit systems 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.
- 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.
- For human annoyance, there is a relationship between the number of daily events and the degree of annoyance caused by groundborne vibration. The FTA Guidance Manual 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.

Often it is necessary to determine the contribution at different frequencies when evaluating vibration or noise signals. The 1/3-octave band spectrum is the most common procedure used to evaluate frequency components of acoustic signals. The term “octave” has been borrowed from music where it refers to a span of eight notes. The ratio of the highest frequency to the lowest frequency in an octave is 2:1. For a 1/3-octave band spectrum, each octave is divided into three bands where the ratio of the lowest frequency to the highest frequency in each 1/3-octave band is $2^{1/3}$:1 (1.26:1). An octave consists of three 1/3 octaves.

The 1/3-octave band spectrum of a signal is obtained by passing the signal through a bank of filters. Each filter excludes all components except those that are between the upper and lower range of one 1/3-octave band. The FTA Guidance Manual (Ref. 1) is a good reference for additional information on transit noise and vibration and the technical terms used in this section.

APPENDIX B: NOISE MEASUREMENTS RESULTS

B.1 Long Term Noise Measurements

Long Term Site 1, 3614 Faris Drive

Measurement Site LT-1 was located in the side yard of a multi family residence located adjacent to Exposition Boulevard between Faris Drive and Watseka Avenue. The major noise source in this area was vehicular traffic on I-10. The measurement position was 25 feet from the Exposition Boulevard, approximately 100 feet from the original Exposition Corridor tracks, and approximately 180 feet from the nearest eastbound lane of I-10. The noise measurement started at 9:00 am on Monday May 14, 2007 and continued until 4 am on Wednesday May 16, 2007.

Including all of the weekday hours during the measurement, the measured L_{dn} was 68~~9~~ dBA with the L_{eq} (day) and L_{eq} (night) being measured at 65 dBA and 61 dBA respectively. The maximum 1 hour L_{eq} of 71 dBA was recorded at 2 pm on the second day of the measurement; there were several powerful motorcycles parked in the garage adjacent to the measurement equipment that could account for this. Without the two unusually loud hours at 2 pm and 6 pm on Tuesday May 15, the maximum 1-hour L_{eq} was 66 to 67 dBA between 6 a.m. and 12 a.m. on Tuesday May 15.

Ldn = 68.4 dBA
Leq(day) = 65.4 dBA
Leq(night) = 60.9 dBA
Max 1-hr Leq = 70.6 at 2 pm, 15-May-07

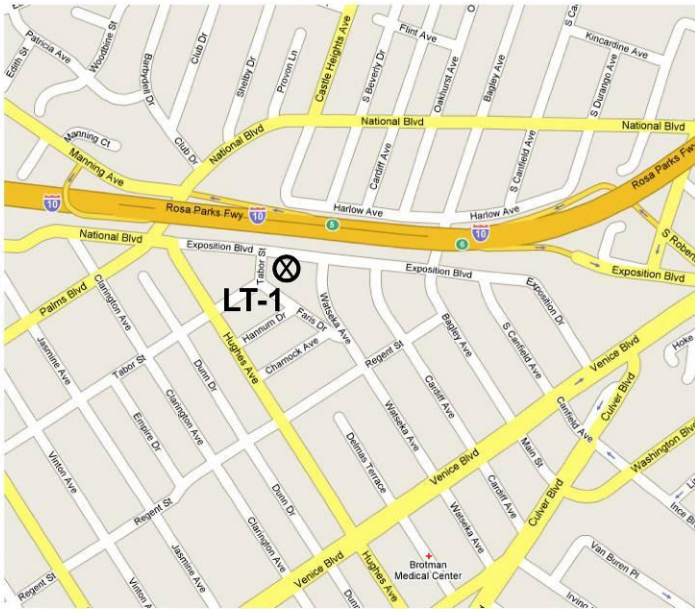


Figure 17 Site LT-1, 3614 Faris Drive

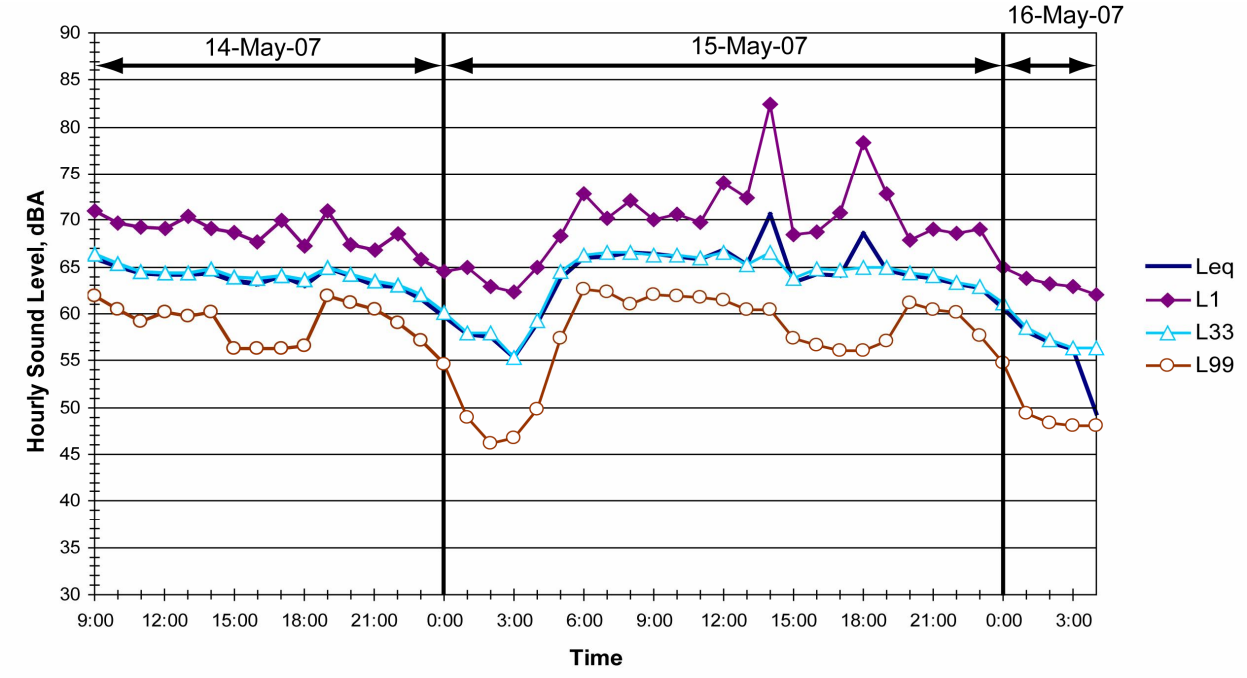


Figure 18 Hourly Sound Levels, Site LT-1, 3614 Faris Drive

Table ~~25~~28 Hourly Noise Monitoring Results, Site LT-1

Start Time	Hourly Sound Levels, dBA						
	L_1	L_{33}	L_{50}	L_{99}	L_{min}	L_{max}	L_{eq}
9:00:00	70.9	66.4	65.4	61.9	60.1	72.2	66.0
10:00:00	69.7	65.3	64.3	60.5	59.8	70.2	65.0
11:00:00	69.3	64.4	63.5	59.2	58.2	78.8	64.4
12:00:00	69.1	64.3	63.6	60.1	59.2	73.0	64.2
13:00:00	70.4	64.3	63.6	59.7	58.8	72.9	64.2
14:00:00	69.1	64.8	63.9	60.2	59.1	71.5	64.3
15:00:00	68.6	63.9	62.9	56.3	55.1	75.7	63.4
16:00:00	67.7	63.8	62.7	56.3	55.3	68.5	63.2
17:00:00	69.9	64.1	62.8	56.2	55.4	77.6	64.0
18:00:00	67.2	63.6	62.6	56.6	55.5	71.0	63.0
19:00:00	71.0	64.9	64.5	61.9	61.0	74.5	64.9
20:00:00	67.3	64.2	63.8	61.2	60.3	71.3	64.0
21:00:00	66.8	63.4	62.8	60.4	59.7	68.1	63.1
22:00:00	68.5	63.1	62.4	59.0	57.2	72.1	62.9
23:00:00	65.7	62.0	61.1	57.1	55.8	71.9	61.6
0:00:00	64.5	60.1	59.1	54.6	53.3	67.0	59.6

Table ~~25~~28 Hourly Noise Monitoring Results, Site LT-1

Start Time	Hourly Sound Levels, dBA						
	L_1	L_{33}	L_{50}	L_{99}	L_{min}	L_{max}	L_{eq}
1:00:00	64.9	58.0	56.9	49.0	43.8	67.7	57.8
2:00:00	62.9	58.0	56.8	46.2	45.4	67.5	57.5
3:00:00	62.3	55.4	54.1	46.7	42.5	63.7	55.3
4:00:00	64.9	59.2	57.7	49.8	47.3	66.8	58.9
5:00:00	68.3	64.5	63.2	57.4	54.5	68.9	63.8
6:00:00	72.8	66.2	65.5	62.6	61.1	74.9	66.0
7:00:00	70.2	66.5	65.8	62.3	61.1	73.9	66.1
8:00:00	72.1	66.6	65.8	61.0	59.8	75.2	66.5
9:00:00	70.0	66.3	65.5	62.1	60.3	82.1	66.3
10:00:00	70.7	66.3	65.6	61.9	59.7	73.7	66.1
11:00:00	69.8	66.0	65.4	61.7	61.0	70.6	65.8
12:00:00	74.0	66.5	65.6	61.4	60.5	79.2	66.8
13:00:00	72.4	65.2	64.3	60.4	60.0	78.7	65.2
14:00:00	82.4	66.6	64.8	60.5	59.3	85.7	70.6
15:00:00	68.4	63.8	62.7	57.4	55.6	71.1	63.3
16:00:00	68.7	64.8	63.8	56.6	55.1	72.3	64.2
17:00:00	70.8	64.6	63.2	56.0	55.2	72.5	64.1
18:00:00	78.3	64.9	63.8	56.1	53.6	91.0	68.6
19:00:00	72.8	64.9	64.1	57.1	56.1	78.1	64.7
20:00:00	67.8	64.3	63.8	61.1	60.4	72.2	64.1
21:00:00	69.1	64.1	63.5	60.5	59.6	70.1	63.8
22:00:00	68.6	63.3	62.8	60.1	58.8	70.3	63.1
23:00:00	69.1	62.9	62.2	57.6	54.3	71.6	62.7
0:00:00	65.0	61.1	60.2	54.7	52.9	66.1	60.6
1:00:00	63.8	58.5	57.1	49.4	46.2	64.9	58.1
2:00:00	63.2	57.3	56.0	48.3	46.9	64.4	57.0
3:00:00	62.9	56.3	55.1	48.0	46.3	64.2	56.2
4:00:00	62.1	56.3	55.1	48.0	48.9	65.8	49.3

SOURCE: ATS Consulting, 2008.

Long Term Site 2, 10590 Northvale Road

The measurement site was in the front yard of a single-family residence located on the southeast corner of Northvale Road and Dunleer Drive. The major noise sources in this area are vehicular traffic on I-10 and on the westbound on- and off-ramps of the I-10. The measurement position was 35 feet from edge of Northvale Road and approximately 210 feet from the I-10 off-ramp. The noise measurement was started at 2 p.m. May 15, 2007 and ended at 9 a.m. on May 17, 2007.

The measured L_{dn} was 65 dBA with the L_{eq} (day) and L_{eq} (night) being measured at 61 dBA and 57 dBA respectively. A maximum 1 hour L_{eq} of 63 dBA was recorded at 6 pm on the first day of the measurement. Typical hourly L_{eq} values during daytime hours were in the 60 to 65 dBA range. The lowest sound levels were between midnight and 4 a.m.

Figure 19 Site LT-2, 10590 Northvale Road

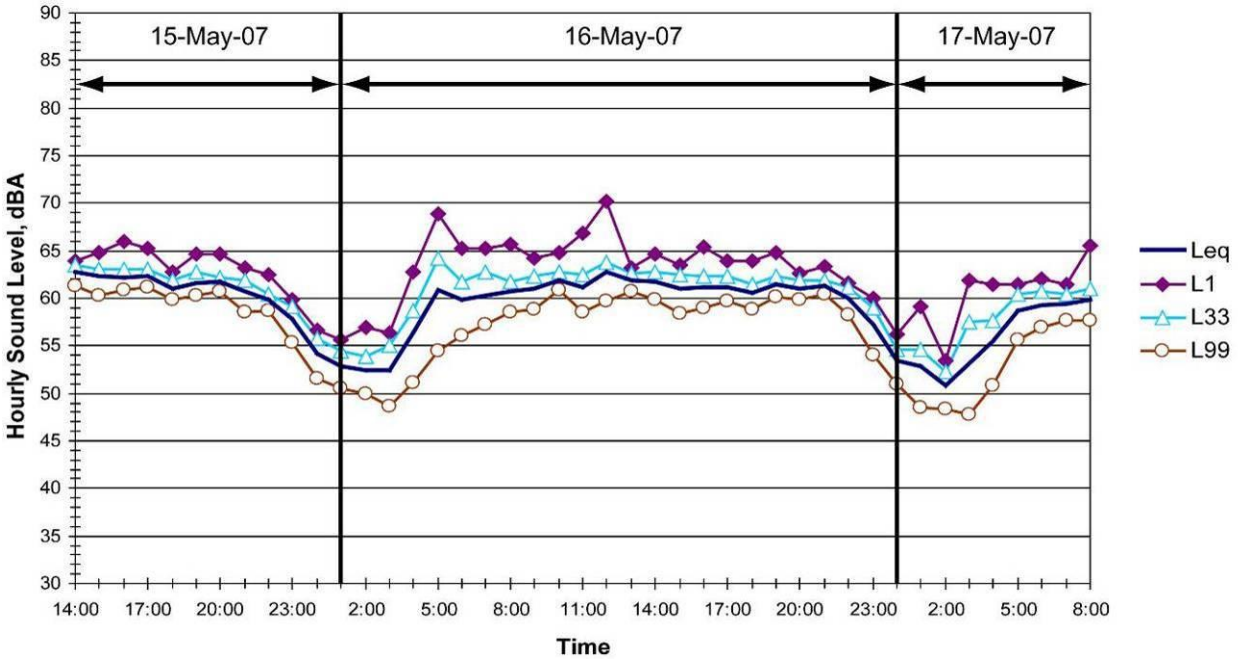


Figure 20 Noise Monitoring Results, Site LT-2, 10590 Northvale Road (May 15–17, 2007)

Table ~~26~~29 Hourly Noise Monitoring Results, Site LT-2, 10590 Northvale Road (May 15–17, 2007)

Start Time	Hourly Sound Levels, dBA						
	L_1	L_{33}	L_{50}	L_{99}	L_{min}	L_{max}	L_{eq}
14:00:00	64.0	63.0	62.7	61.3	61.1	64.0	62.7
15:00:00	64.8	62.6	62.3	60.3	60.0	64.8	62.4
16:00:00	65.9	62.2	61.9	60.9	60.9	65.9	62.2
17:00:00	65.3	62.5	62.1	61.1	60.9	65.3	62.3
18:00:00	62.8	61.3	61.0	59.9	59.6	62.8	61.1
19:00:00	64.7	61.7	61.4	60.3	60.1	64.7	61.6
20:00:00	64.6	61.8	61.7	60.8	60.6	64.6	61.7
21:00:00	63.2	61.2	60.6	58.5	58.2	63.2	60.8
22:00:00	62.5	60.0	59.8	58.7	58.4	62.5	59.8
23:00:00	59.8	58.4	57.5	55.4	55.1	59.8	57.8
0:00:00	56.6	54.6	54.2	51.5	51.1	56.6	54.2
1:00:00	55.6	53.2	52.7	50.5	48.2	55.6	52.8
2:00:00	56.9	52.8	52.1	49.9	49.4	56.9	52.4
3:00:00	56.4	52.9	51.9	48.6	47.9	56.4	52.5

Table ~~26~~29 Hourly Noise Monitoring Results, Site LT-2, 10590 Northvale Road (May 15–17, 2007)

Start Time	Hourly Sound Levels, dBA						
	L_1	L_{33}	L_{50}	L_{99}	L_{min}	L_{max}	L_{eq}
4:00:00	62.7	55.8	54.6	51.1	50.6	62.7	56.3
5:00:00	68.9	59.6	58.8	54.4	53.4	68.9	60.8
6:00:00	65.2	59.6	59.0	56.1	56.0	65.2	59.8
7:00:00	65.2	60.4	59.4	57.3	57.0	65.2	60.3
8:00:00	65.7	60.7	60.3	58.6	58.3	65.7	60.7
9:00:00	64.2	61.6	60.6	58.9	58.7	64.2	61.0
10:00:00	64.8	62.1	61.8	60.9	60.2	64.8	62.0
11:00:00	66.8	61.3	61.0	58.5	58.3	66.8	61.2
12:00:00	70.2	62.2	61.8	59.7	59.2	70.2	62.7
13:00:00	63.2	62.2	61.9	60.8	60.7	63.2	61.9
14:00:00	64.7	62.1	61.8	59.8	59.7	64.7	61.8
15:00:00	63.5	61.3	60.8	58.4	57.7	63.5	61.0
16:00:00	65.4	61.5	61.0	59.0	57.3	65.4	61.2
17:00:00	64.0	61.5	61.0	59.7	59.4	64.0	61.2
18:00:00	63.9	60.7	60.4	58.9	57.8	63.9	60.6
19:00:00	64.8	61.5	61.3	60.1	60.1	64.8	61.4
20:00:00	62.6	61.2	61.0	59.9	59.6	62.6	61.0
21:00:00	63.3	61.4	61.1	60.4	60.3	63.3	61.3
22:00:00	61.6	60.3	60.0	58.2	57.9	61.6	60.0
23:00:00	60.0	58.3	56.8	54.1	53.9	60.0	57.2
0:00:00	56.2	53.7	53.3	50.9	50.9	56.2	53.5
1:00:00	59.1	53.0	52.5	48.5	48.1	59.1	52.8
2:00:00	53.4	51.4	50.4	48.4	48.4	53.4	50.8
3:00:00	61.9	52.1	51.2	47.8	47.3	61.9	53.1
4:00:00	61.4	56.7	54.8	50.8	48.7	61.4	55.5
5:00:00	61.4	59.5	58.8	55.7	55.6	61.4	58.7
6:00:00	62.1	59.5	59.1	57.0	56.6	62.1	59.3
7:00:00	61.5	59.7	59.4	57.7	57.6	61.5	59.4
8:00:00	65.6	60.2	59.8	57.6	57.4	65.6	59.9

SOURCE: ATS Consulting, 2008.

Long Term Site 3, 2814 Dunleer Place

The measurement site was in the backyard of a single family residence located on Dunleer Place. The microphone was located adjacent to the Exposition Corridor at approximately 100 feet from where the old tracks are still in place. The noise measurement started at 8 p.m. on May 8, 2007 and completed at 8 p.m. on May 9, 2007.

The measured L_{dn} was 59 dBA and the measured L_{eq} (day) and L_{eq} (night) were 59 dBA and 49 dBA respectively. A maximum 1 hour L_{eq} of 70 dBA was recorded at 10 a.m. on the second day of the measurement. As can be seen in Figure 22 (Noise Monitoring Results, Site LT-3, 2814 Dunleer Place [May 15–17, 2007]), the L_{eq} for this hour was approximately 15 decibels higher than the L_{eq} for any other hour. The L_{dn} and L_{eq} (day) were 56 dBA and 51 dBA respectively because the data from 10 am was excluded from the calculation.

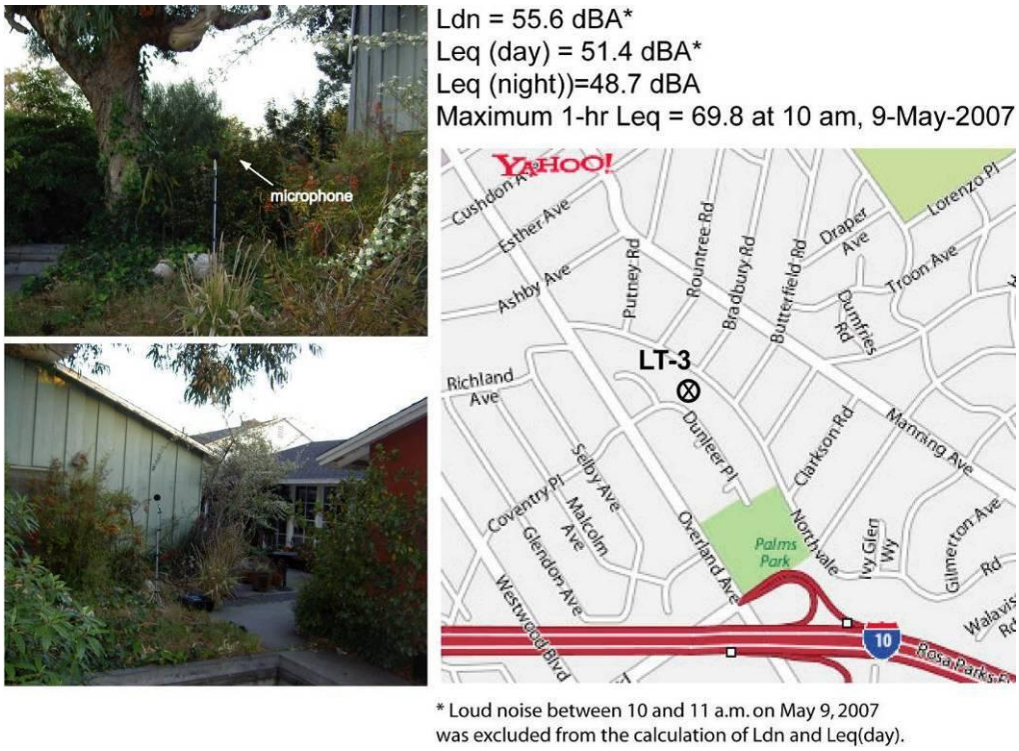


Figure 21 Site LT-3, 2814 Dunleer Place

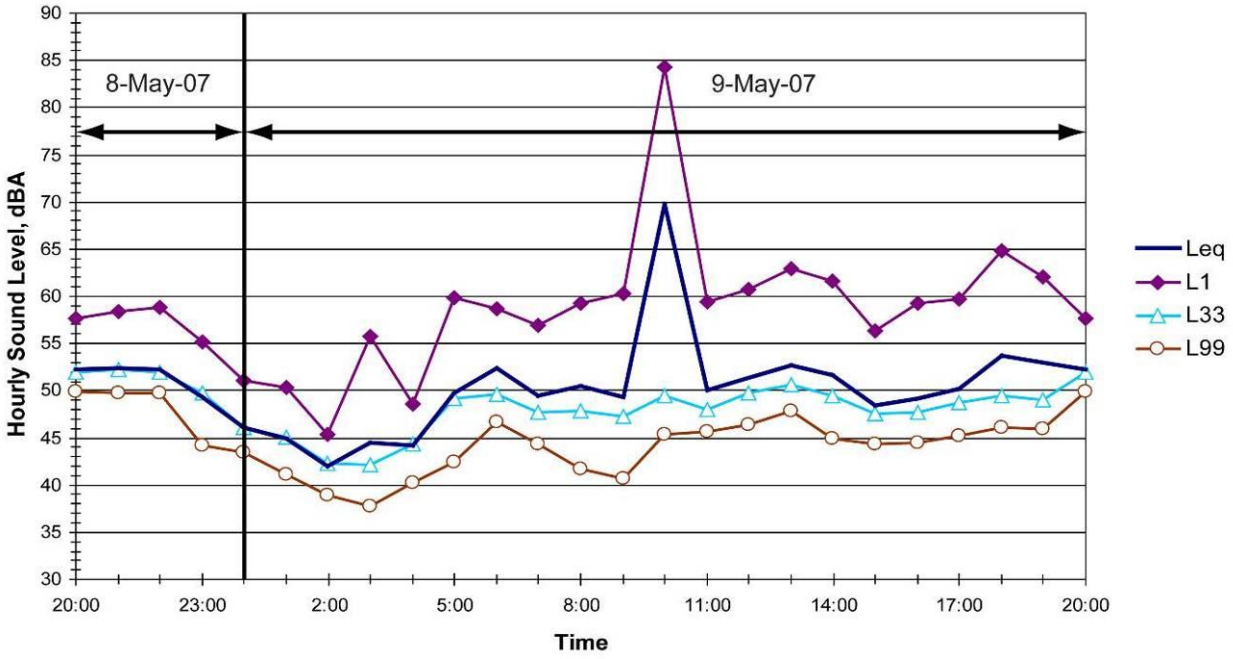


Figure 22 Noise Monitoring Results, Site LT-3, 2814 Dunleer Place (May 15–17, 2007)

Table ~~27~~30 Hourly Noise Monitoring Results, Site LT-3, 2814 Dunleer Place (May 8–10, 2007)

Start Time	Hourly Sound Levels, dBA						
	L_1	L_{33}	L_{50}	L_{99}	L_{min}	L_{max}	L_{eq}
20:00:00	57.6	52.0	51.6	49.9	49.0	67.8	52.3
21:00:00	58.4	52.3	51.9	49.8	48.7	66.7	52.5
22:00:00	58.8	52.0	51.5	49.7	48.8	66.1	52.2
23:00:00	55.2	49.7	48.8	44.2	42.9	62.1	49.4
0:00:00	51.1	46.1	45.7	43.4	41.8	55.9	46.1
1:00:00	50.3	45.1	44.3	41.1	39.6	56.6	45.0
2:00:00	45.3	42.3	41.7	39.0	37.7	49.0	42.0
3:00:00	55.7	42.1	41.2	37.8	36.7	64.9	44.5
4:00:00	48.6	44.4	43.7	40.2	38.9	59.3	44.2
5:00:00	59.8	49.1	47.9	42.4	41.4	73.5	49.8
6:00:00	58.7	49.6	49.1	46.7	45.7	78.2	52.4
7:00:00	56.9	47.7	47.1	44.3	43.0	73.4	49.5
8:00:00	59.3	47.8	46.2	41.7	40.4	74.1	50.5
9:00:00	60.3	47.2	45.8	40.7	38.8	66.4	49.3
10:00:00[a]	***84.3***	***49.4***	***48.5***	***45.3***	***44.5***	***93.5***	***69.8***
11:00:00	59.4	48.0	47.3	45.7	45.1	74.8	50.0

Table ~~27~~30 Hourly Noise Monitoring Results, Site LT-3, 2814 Dunleer Place (May 8–10, 2007)

Start Time	Hourly Sound Levels, dBA						
	L_1	L_{33}	L_{50}	L_{99}	L_{min}	L_{max}	L_{eq}
12:00:00	60.7	49.8	49.0	46.4	45.8	69.3	51.4
13:00:00	63.0	50.6	49.8	47.8	46.9	69.7	52.7
14:00:00	61.6	49.4	48.5	45.0	43.6	71.1	51.6
15:00:00	56.4	47.6	46.8	44.3	43.4	65.7	48.4
16:00:00	59.3	47.7	46.9	44.5	43.4	68.1	49.1
17:00:00	59.7	48.8	47.8	45.2	44.0	68.8	50.1
18:00:00	64.9	49.4	48.5	46.1	45.1	79.1	53.7
19:00:00	62.1	49.0	47.9	46.0	47.0	70.7	53.0

SOURCE: ATS Consulting, 2008.

Note:

a. The high sound levels between 10 and 11 am appear to be non-representative of the noise levels in this area and have not been included in the calculation of the L_{dn} or L_{eq} (day).

Long Term Site 4, 10636 Rountree Road

The measurement site was in the side yard of a single-family residence located on the northeast corner of Northvale Drive and Rountree Road. The major noise sources in this area are intermittent vehicular traffic on Northvale Drive and the constant background noise from traffic on I-10. The measurement position was 100 feet from Northvale Drive. The noise measurement was started at 8 p.m. on May 8, 2007 and completed at 8 p.m. on May 9, 2007.

The measured L_{dn} was 59 dBA and the measured L_{eq} (day) and L_{eq} (night) were 56 dBA and 52 dBA respectively. The maximum 1 hour L_{eq} of 58 dBA was between 2 and 3 p.m. on May 9, 2007. Daytime sound levels at this site were typically in the 50 to 55 dBA range and the lowest nighttime sound levels were between 40 and 45 dBA.

Ldn = 59.3 dBA
Leq (day) = 56.1 dBA
Leq (night)) = 52.2 dBA
Maximum 1-hr Leq = 58.4 at 2 pm, 9-May-2007

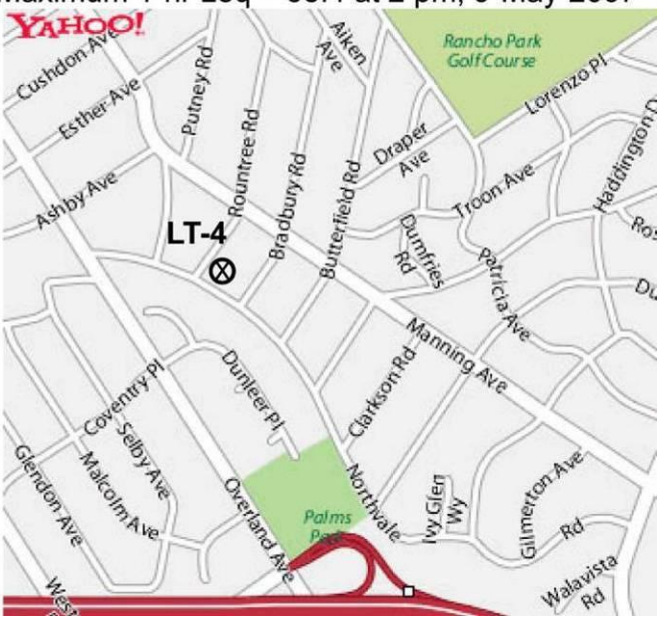


Figure 23 Site LT-4, 10636 Rountree Road

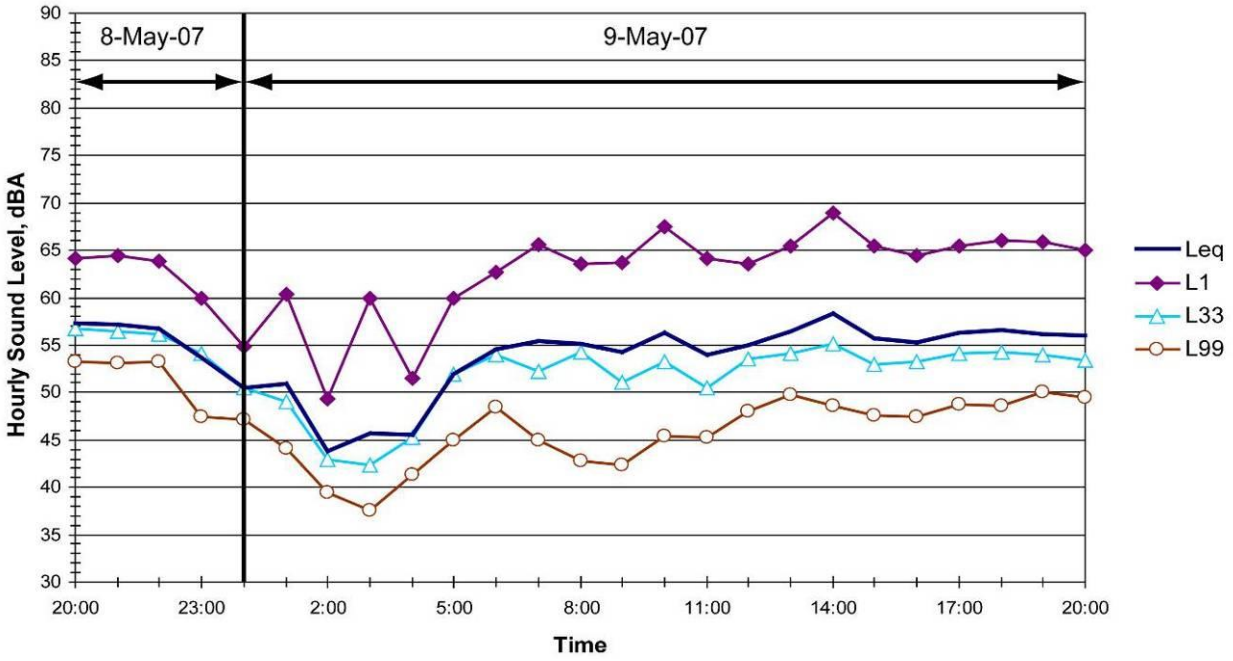


Figure 24 Noise Monitoring Results, Site LT-4, 10636 Rountree Road (May 8–9, 2007)

Table ~~28~~31 Hourly Noise Monitoring Results, Site LT-4, 10636 Rountree Road (May 8–9, 2007)

Start Time	Hourly Sound Levels, dBA						
	L_1	L_{33}	L_{50}	L_{99}	L_{min}	L_{max}	L_{eq}
20:00:00	64.1	56.8	56	53.2	52.8	70.1	57.3
21:00:00	64.5	56.5	55.8	53.1	52.5	73.4	57.2
22:00:00	63.9	56.2	55.6	53.3	52.9	71.5	56.8
23:00:00	59.9	54.1	53.3	47.5	46.5	65	53.7
0:00:00	54.9	50.5	49.9	47.2	46.3	65.9	50.5
1:00:00	60.3	49.1	47.8	44.1	43.6	70.5	50.9
2:00:00	49.3	42.9	42.2	39.4	38.9	64.5	43.8
3:00:00	60	42.4	41.2	37.5	37	64.1	45.7
4:00:00	51.5	45.3	44.6	41.3	40.1	64.7	45.6
5:00:00	59.9	51.9	50.8	45	44.3	67.8	51.9
6:00:00	62.7	53.9	53	48.4	47	70	54.5
7:00:00	65.6	52.2	50.1	45	43.6	74	55.4
8:00:00	63.5	54.2	51.2	42.8	41.7	72	55.1
9:00:00	63.7	51.1	48.5	42.4	41.4	77.4	54.3
10:00:00	67.5	53.3	51.3	45.4	43.8	77.6	56.3
11:00:00	64.1	50.5	49.1	45.3	44.3	71	54.0

Table ~~28~~31 Hourly Noise Monitoring Results, Site LT-4, 10636 Rountree Road (May 8–9, 2007)

Start Time	Hourly Sound Levels, dBA						
	L_1	L_{33}	L_{50}	L_{99}	L_{min}	L_{max}	L_{eq}
12:00:00	63.5	53.5	52.2	48	46.9	68	55.0
13:00:00	65.5	54.1	52.9	49.8	49.3	77	56.4
14:00:00	68.9	55.1	52.9	48.6	48.1	78.1	58.4
15:00:00	65.4	53	51.3	47.6	47	71.7	55.7
16:00:00	64.5	53.2	51.5	47.5	46.9	68.5	55.3
17:00:00	65.4	54.1	52.5	48.8	47.6	67.9	56.3
18:00:00	66.1	54.3	52.6	48.6	47.8	73.7	56.6
19:00:00	65.9	54	52.9	50	49.3	71.7	56.1

SOURCE: ATS Consulting, 2008.

Long Term Site 5, 10804 Ashby Avenue

The measurement site was in the backyard of a single family residence located on Ashby Avenue between Overland Boulevard and Westwood Boulevard. The major noise source in this area is vehicular traffic on Overland Boulevard and other arterials although the measurement site was not directly exposed to any traffic noise sources. The noise measurement was started at 8 p.m. on May 8, 2007 and completed at 8 p.m. on May 9, 2007.

The measured L_{dn} was 58~~9~~ dBA and the measured L_{eq} (day) and L_{eq} (night) were measured at 56 dBA and 51 dBA respectively. The maximum 1-hour L_{eq} of 61 dBA was between 5 and 6 p.m. on the second day of the measurement. There was a considerable amount of shielding at this site from outbuildings and landscaping walls.

Ldn = 58.4 dBA
Leq (day) = 56.3 dBA
Leq (night)) = 50.7 dBA
Maximum 1-hr Leq = 60.5 at 5 pm, 9-May-2007

Figure 25 Site LT-5, 10804 Ashby Avenue

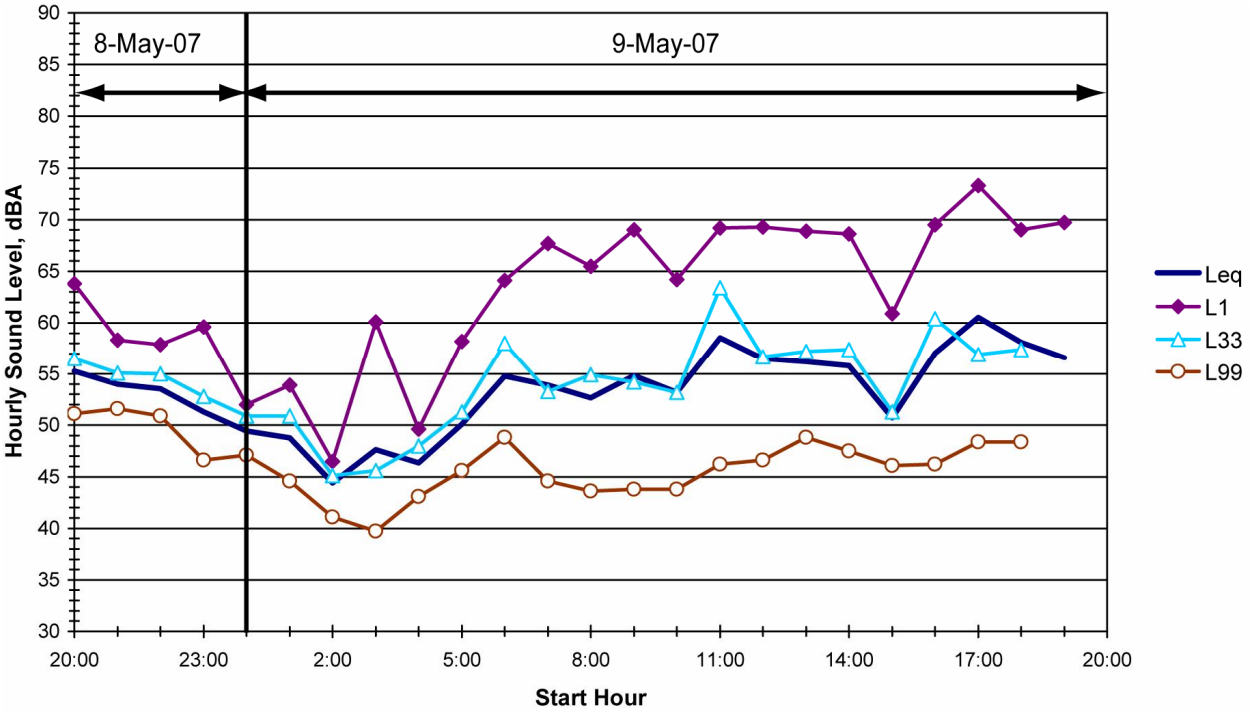


Figure 26 Noise Monitoring Results, Site LT-5, 10804 Ashby Avenue (May 8–9, 2007)

Table ~~29~~32 Hourly Noise Monitoring Results, Site LT-5, 10804 Ashby Avenue (May 8–9, 2007)

Start Time	Hourly Sound Levels, dBA						
	L_1	L_{33}	L_{50}	L_{99}	L_{min}	L_{max}	L_{eq}
20:00:00	63.8	56.5	53.9	51.1	50.2	67.9	55.3
21:00:00	58.3	55.1	53.6	51.6	51.5	63.8	54.0
22:00:00	57.9	55.0	53.1	50.9	50.5	61.8	53.6
23:00:00	59.6	52.8	50.3	46.6	46.0	66.6	51.3
0:00:00	52.0	50.9	49.2	47.1	46.8	53.4	49.5
1:00:00	53.9	50.9	48.0	44.6	44.2	54.7	48.8
2:00:00	46.5	45.1	43.3	41.1	40.8	61.5	44.4
3:00:00	60.1	45.6	42.9	39.7	38.1	67.9	47.6
4:00:00	49.6	48.0	46.0	43.1	42.1	54.1	46.4
5:00:00	58.2	51.3	48.6	45.6	45.0	62.9	50.1
6:00:00	64.1	58.0	51.1	48.8	48.5	69.8	54.8
7:00:00	67.7	53.3	48.4	44.6	44.2	73.0	53.9
8:00:00	65.5	54.9	47.8	43.6	43.5	67.9	52.7
9:00:00	69.0	54.2	48.1	43.8	43.4	72.2	54.8

Table ~~29~~32 Hourly Noise Monitoring Results, Site LT-5, 10804 Ashby Avenue (May 8–9, 2007)

Start Time	Hourly Sound Levels, dBA						
	L_1	L_{33}	L_{50}	L_{99}	L_{min}	L_{max}	L_{eq}
10:00:00	64.2	53.2	49.2	43.8	42.9	72.1	53.2
11:00:00	69.2	63.4	49.0	46.2	45.8	75.7	58.5
12:00:00	69.3	56.7	50.3	46.6	45.7	73.8	56.5
13:00:00	68.9	57.2	50.4	48.8	48.5	72.2	56.2
14:00:00	68.6	57.4	50.1	47.5	46.8	72.1	55.8
15:00:00	60.9	51.3	48.4	46.1	45.6	66.2	50.7
16:00:00	69.5	60.4	50.3	46.2	45.3	72.2	57.0
17:00:00	73.3	56.9	51.2	48.4	48.0	81.2	60.5
18:00:00	69.0	57.4	50.9	48.4	48.0	78.5	58.1
19:00:00	69.7	57.7	50.8	--	48.5	72.5	56.6

SOURCE: ATS Consulting, 2008.

Long Term Site 6, 11007 Exposition Boulevard

Site LT-6 was located in the side yard of a single family residence located on the north side Exposition Boulevard east of Military Avenue. The major noise source in this area is vehicular traffic on Military Avenue and noise from aircraft approaching Santa Monica Airport. The measurement position was 30 feet from Exposition Boulevard and approximately 115 feet from the center of the old exposition alignment. The noise measurement was performed for 8 hours on May 16, 2007 and twelve hours on May 17, 2007.

Including all of the weekday hours during the measurement, the measured L_{dn} was ~~67~~59 dBA with the L_{eq} (day) and L_{eq} (night) being measured at ~~65~~56 dBA and ~~59~~50 dBA respectively. A maximum 1 hour L_{eq} of ~~67~~58 dBA was recorded at 11 a.m. on the second day of the measurement. The resident complained of a considerable amount of aircraft noise from Santa Monica Airport.

Ldn = 58.7 dBA
Leq (day) = 56.2 dBA
Leq (night)) = 49.8 dBA
Maximum 1-hr Leq = 58.2 at 11 am, 17-May-2007

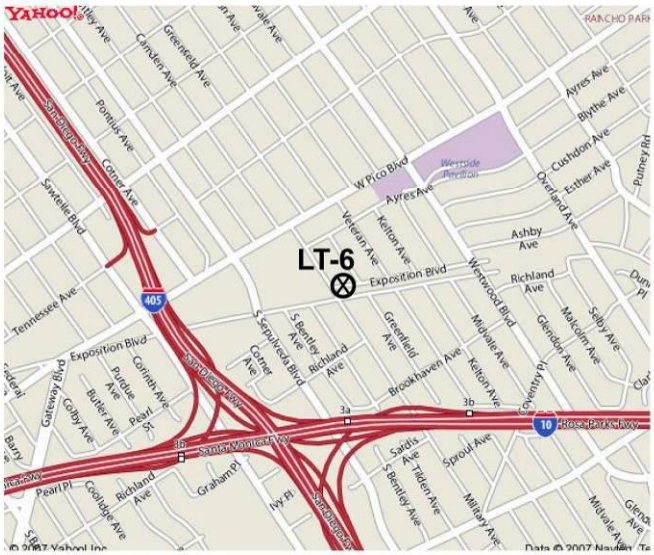


Figure 27 Site LT-6, 11007 Exposition Boulevard

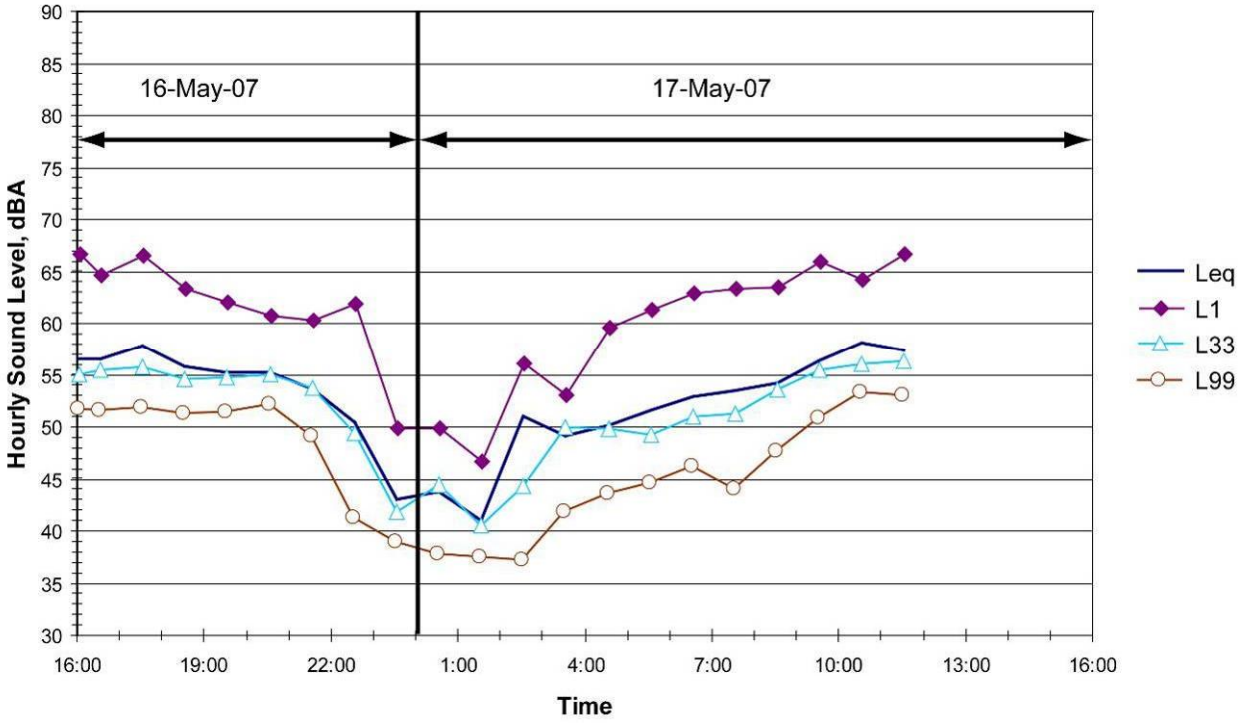


Figure 28 Noise Monitoring Results, Site LT-6, 11007 Exposition Boulevard (May 16)

Table 33 Hourly Noise Monitoring Results, Site LT-6, 11007 Exposition Boulevard (May 16–17, 2007)

Start Time	Hourly Sound Levels, dBA						
	L_1	L_{33}	L_{50}	L_{99}	L_{min}	L_{max}	L_{eq}
16:00:00	67.5	55.4	54.4	51.7	50.8	75.9	57.2
17:00:00	64.7	55.3	54.2	51.6	50.9	76.1	56.6
18:00:00	66.5	55.7	54.7	51.9	51.2	75.2	57.8
19:00:00	63.3	54.5	53.9	51.3	50.4	74.2	55.9
20:00:00	62.1	54.6	53.8	51.5	50.9	71.1	55.2
21:00:00	60.7	55.0	54.6	52.2	51.2	72.7	55.3
22:00:00	60.3	53.6	52.9	49.2	48.5	70.9	53.7
23:00:00	61.9	49.3	48.7	41.3	40.7	67.6	50.4
0:00:00	49.9	41.7	41.1	39.0	38.4	65.7	43.1
1:00:00	49.8	44.3	42.9	37.8	37.1	58.9	43.8
2:00:00	46.7	40.5	39.7	37.6	36.7	61.3	41.0
3:00:00	56.1	44.2	42.8	37.3	36.2	77.7	51.0
4:00:00	53.0	49.9	49.0	41.9	39.9	56.2	49.1
5:00:00	59.6	49.7	48.4	43.6	42.2	67.2	50.1

Table 33 Hourly Noise Monitoring Results, Site LT-6, 11007 Exposition Boulevard (May 16–17, 2007)

Start Time	Hourly Sound Levels, dBA						
	L_1	L_{33}	L_{50}	L_{99}	L_{min}	L_{max}	L_{eq}
6:00:00	61.3	49.2	48.2	44.7	44.1	71.4	51.6
7:00:00	62.9	50.9	50.0	46.3	45.4	71.2	52.9
8:00:00	63.3	51.2	49.5	44.1	42.4	73.0	53.4
9:00:00	63.5	53.5	52.5	47.7	46.2	68.7	54.3
10:00:00	66.0	55.4	54.9	50.8	50.0	76.4	56.4
11:00:00	64.2	55.9	55.4	53.4	52.4	83.5	58.2

SOURCE: ATS Consulting, 2008.
Results for Table 33 were incorrect in the DEIR version of the *Noise and Vibration Technical Background Report*. The entire table has been replaced with the correct results.

~~Table 30 Hourly Noise Monitoring Results, Site LT-6, 11007 Exposition Boulevard (May 16–17, 2007)~~

~~Start Time~~	~~Hourly Sound Levels, dBA~~						
	~~L_1~~	~~L_{33}~~	~~L_{50}~~	~~L_{99}~~	~~L_{min}~~	~~L_{max}~~	~~L_{eq}~~
~~16:00:00~~	~~66.7~~	~~55.1~~	~~54.2~~	~~48.9~~	~~45.4~~	~~95.6~~	~~61.8~~
~~17:00:00~~	~~64.7~~	~~54.5~~	~~53.5~~	~~48.2~~	~~44.9~~	~~72.7~~	~~55.2~~
~~18:00:00~~	~~60.6~~	~~54.8~~	~~53.8~~	~~48.5~~	~~45.9~~	~~65.8~~	~~54.5~~
~~19:00:00~~	~~59.3~~	~~54.3~~	~~53.3~~	~~47.5~~	~~44.8~~	~~65.5~~	~~54.0~~
~~20:00:00~~	~~59.7~~	~~53.1~~	~~52.1~~	~~46.6~~	~~43.4~~	~~64.6~~	~~53.1~~
~~21:00:00~~	~~59.5~~	~~52.8~~	~~51.7~~	~~46.1~~	~~43.8~~	~~67.0~~	~~52.9~~
~~22:00:00~~	~~58.4~~	~~51.7~~	~~50.6~~	~~44.9~~	~~41.4~~	~~63.2~~	~~51.8~~
~~23:00:00~~	~~60.8~~	~~51.2~~	~~49.8~~	~~43.3~~	~~39.8~~	~~73.7~~	~~53.0~~
~~0:00:00~~	~~68.4~~	~~60.1~~	~~59.0~~	~~55.5~~	~~54.3~~	~~80.7~~	~~60.9~~
~~1:00:00~~	~~65.7~~	~~58.8~~	~~57.8~~	~~54.4~~	~~53.3~~	~~72.9~~	~~59.1~~
~~2:00:00~~	~~63.7~~	~~56.4~~	~~55.4~~	~~52.2~~	~~50.7~~	~~78.3~~	~~57.1~~
~~3:00:00~~	~~72.4~~	~~56.6~~	~~55.8~~	~~52.3~~	~~50.9~~	~~91.6~~	~~64.8~~
~~4:00:00~~	~~64.8~~	~~59.4~~	~~58.6~~	~~55.4~~	~~54.3~~	~~76.1~~	~~59.6~~
~~5:00:00~~	~~73.8~~	~~60.7~~	~~59.8~~	~~55.9~~	~~54.4~~	~~84.5~~	~~63.0~~
~~6:00:00~~	~~71.6~~	~~62.3~~	~~61.3~~	~~58.3~~	~~57.5~~	~~82.1~~	~~63.2~~
~~7:00:00~~	~~74.5~~	~~64.1~~	~~63.0~~	~~59.6~~	~~58.8~~	~~84.0~~	~~65.5~~
~~8:00:00~~	~~76.7~~	~~65.7~~	~~64.4~~	~~60.4~~	~~58.8~~	~~86.2~~	~~67.1~~
~~9:00:00~~	~~73.9~~	~~65.3~~	~~64.4~~	~~61.2~~	~~59.8~~	~~82.1~~	~~66.1~~

~~**Table 30 Hourly Noise Monitoring Results, Site LT-6, 11007 Exposition Boulevard (May 16–17, 2007)**~~

~~Start Time~~	~~Hourly Sound Levels, dBA~~						
	~~L_1~~	~~L_{33}~~	~~L_{50}~~	~~L_{99}~~	~~L_{min}~~	~~L_{max}~~	~~L_{eq}~~
~~10:00:00~~	~~76.4~~	~~66.0~~	~~65.2~~	~~61.8~~	~~60.6~~	~~84.2~~	~~67.2~~
~~11:00:00~~	~~76.9~~	~~67.0~~	~~66.3~~	~~63.9~~	~~63.1~~	~~93.5~~	~~69.7~~

Long Term Site 7, 11364 Exposition Boulevard

The measurement site was in the side yard of a multi family residence located adjacent to Exposition Boulevard two blocks west of the I-405. The major noise sources in this area is vehicular traffic on Exposition Boulevard and Sawtelle Boulevard. The measurement site is shielded from vehicular traffic noise from the I-405 because the I-405 is on an elevated structure. The measurement position was 37 feet from Exposition Boulevard and approximately 475 feet from Sawtelle Boulevard. The noise measurement was performed for ten hours on May 10, 2007 and fifteen hours on May 11, 2007

Including all of the weekday hours during the measurement, the measured L_{dn} was 63 dBA with the L_{eq} (day) and L_{eq} (night) being measured at 59 dBA and 56 dBA respectively. A maximum 1 hour L_{eq} of 60 dBA was recorded at 3 p.m. on the first day of the measurement. Several storage units are located opposite the measurement site and this could account for heavier vehicular traffic in the vicinity of the measurement equipment than would be typical.

Ldn = 63.0 dBA
Leq (day) = 59.1 dBA
Leq (night)) = 56.1 dBA
Maximum 1-hr Leq = 60.7 at 3 pm, 10-May-2007

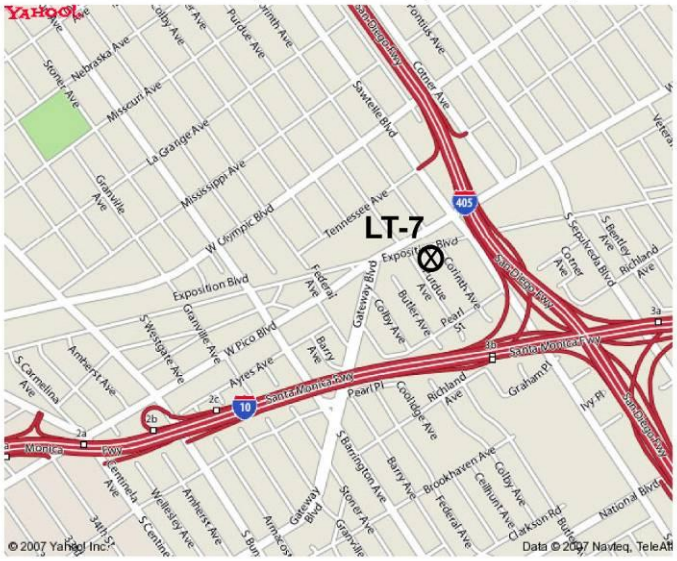


Figure ~~13~~29 Site LT-7, 11364 Exposition Boulevard

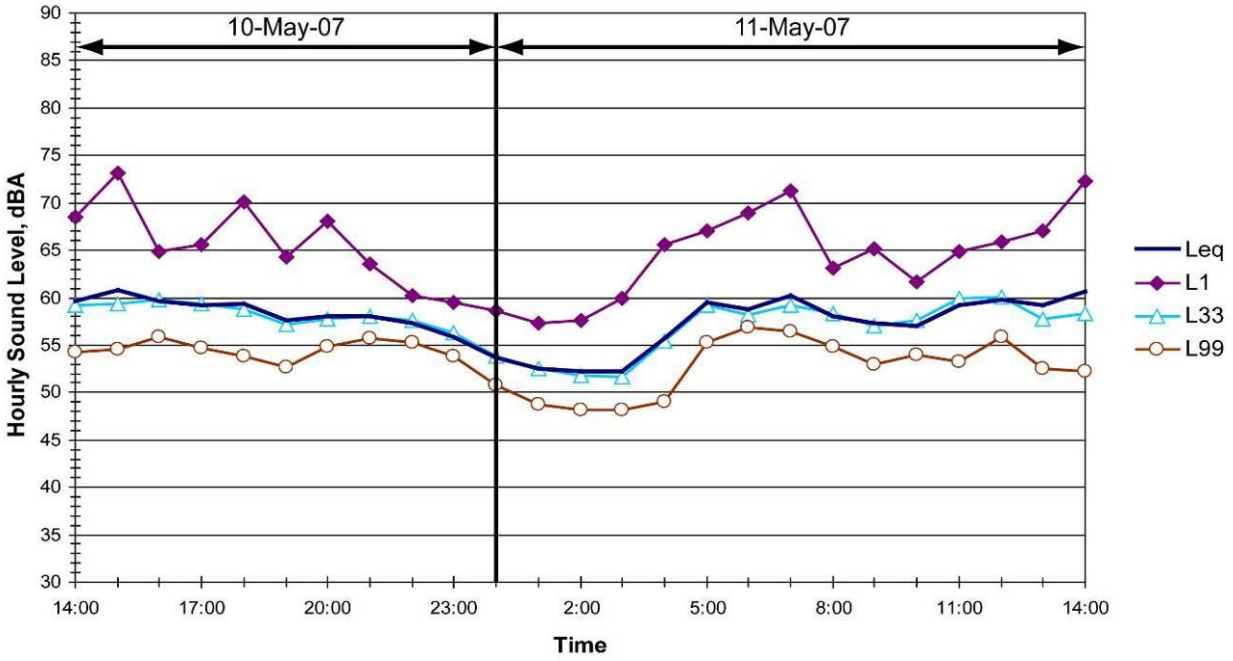


Figure ~~14~~30 Noise Monitoring Results, Site LT-7, 11364 Exposition Boulevard (May 10–11, 2007)

Table ~~31~~34 Hourly Noise Monitoring Results, Site LT-7, 11364 Exposition Boulevard (May 10–11, 2007)

Start Time	Hourly Sound Levels, dBA						
	L_1	L_{33}	L_{50}	L_{99}	L_{min}	L_{max}	L_{eq}
14:00:00	68.5	59.2	57.8	54.3	54.2	68.5	59.6
15:00:00	73.1	59.4	58.4	54.6	52.1	73.1	60.7
16:00:00	64.8	59.8	58.8	55.8	55.4	64.8	59.6
17:00:00	65.6	59.4	58.3	54.7	52.1	65.6	59.2
18:00:00	70.1	58.8	57.8	53.8	53.6	70.1	59.3
19:00:00	64.3	57.2	56.4	52.6	52.0	64.3	57.6
20:00:00	68.1	57.8	56.9	54.9	53.7	68.1	58.1
21:00:00	63.5	58.1	57.6	55.7	55.4	63.5	58.0
22:00:00	60.2	57.6	57.1	55.3	55.1	60.2	57.3
23:00:00	59.5	56.3	55.5	53.8	53.0	59.5	55.9
0:00:00	58.6	53.8	53.3	50.8	50.8	58.6	53.6
1:00:00	57.3	52.5	52.0	48.7	48.4	57.3	52.6
2:00:00	57.6	51.8	51.1	48.2	47.5	57.6	52.2
3:00:00	60.0	51.7	50.9	48.2	48.1	60.0	52.3
4:00:00	65.6	55.4	54.5	49.0	48.8	65.6	55.7

Table ~~31~~34 Hourly Noise Monitoring Results, Site LT-7, 11364 Exposition Boulevard (May 10–11, 2007)

Start Time	Hourly Sound Levels, dBA						
	L_1	L_{33}	L_{50}	L_{99}	L_{min}	L_{max}	L_{eq}
5:00:00	67.0	59.2	58.8	55.3	55.0	67.0	59.5
6:00:00	68.9	58.2	57.8	56.9	56.7	68.9	58.7
7:00:00	71.2	59.2	58.6	56.5	56.3	71.2	60.2
8:00:00	63.1	58.3	57.1	54.8	54.5	63.1	58.1
9:00:00	65.2	57.0	56.3	52.9	52.6	65.2	57.3
10:00:00	61.6	57.6	56.5	54.0	53.9	61.6	57.0
11:00:00	64.9	59.9	58.8	53.3	52.4	64.9	59.3
12:00:00	65.9	60.1	59.3	55.9	55.1	65.9	59.8
13:00:00	67.0	57.8	57.0	52.5	51.9	67.0	59.3
14:00:00	72.3	58.3	57.5	52.2	52.2	72.3	60.6

SOURCE: ATS Consulting, 2008.

Long Term Site 8, 11918 Exposition Boulevard

Site LT-8 was located in the front yard of a multi family residence adjacent to Exposition Boulevard between Bundy Drive and Westgate Avenue. The major noise source in this area is vehicular traffic on Exposition Boulevard. The measurement position was 20 feet from Exposition Boulevard. The noise measurement was performed for nine hours on May 10, 2007 and 15 hours on May 11, 2007.

Including all of the weekday hours during the measurement, the measured L_{dn} was 59 dBA with the L_{eq} (day) and L_{eq} (night) being measured at 57 dBA and 51 dBA respectively. A maximum 1 hour L_{eq} of 60 dBA was recorded at 2 pm on the second day of the measurement.

Ldn = 58.8 dBA
Leq (day) = 57.0 dBA
Leq (night)) = 50.8 dBA
Maximum 1-hr Leq = 59.6 at 2 pm, 11-May-2007

Figure ~~15~~31 Site LT-8, 11918 Exposition Boulevard

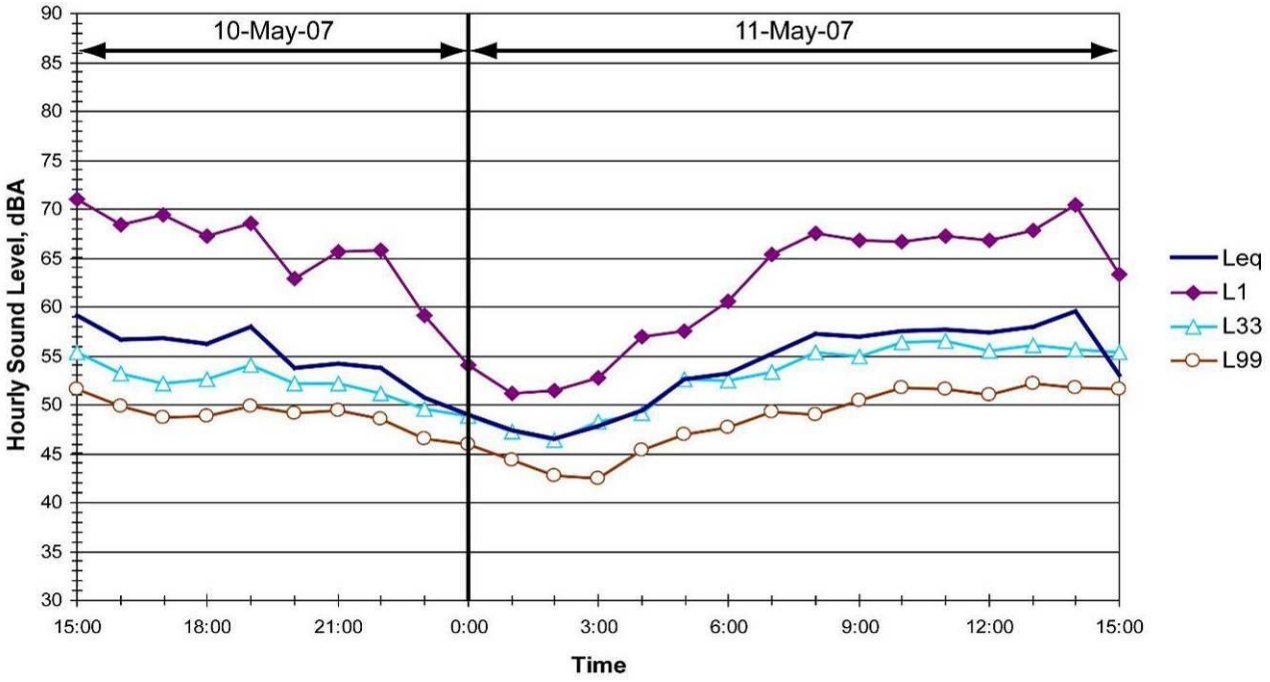


Figure ~~16~~32 Noise Monitoring Results, Site LT-8, 11918 Exposition Boulevard (May 10–11, 2007)

Table ~~32~~35 Hourly Noise Monitoring Results, Site LT-8, 11918 Exposition Boulevard (May 10–11, 2007)

Start Time	Hourly Sound Levels, dBA						
	L_1	L_{33}	L_{50}	L_{99}	L_{min}	L_{max}	L_{eq}
15:00:00	71.0	55.3	54.4	51.6	50.5	81.3	59.1
16:00:00	68.4	53.2	52.3	49.8	48.8	74.4	56.7
17:00:00	69.4	52.2	51.1	48.7	47.8	75.4	56.8
18:00:00	67.3	52.6	51.6	48.8	47.5	79.0	56.2
19:00:00	68.5	54.1	53.0	49.8	47.9	82.2	57.9
20:00:00	62.9	52.2	51.6	49.2	48.2	77.2	53.8
21:00:00	65.7	52.2	51.7	49.4	47.8	72.6	54.3
22:00:00	65.8	51.2	50.7	48.5	47.6	74.9	53.8
23:00:00	59.2	49.6	49.1	46.5	45.7	76.3	50.7
0:00:00	54.0	48.9	48.3	45.9	44.5	65.6	48.9
1:00:00	51.2	47.2	46.7	44.4	42.7	69.7	47.4
2:00:00	51.4	46.4	45.7	42.7	41.6	64.0	46.5
3:00:00	52.7	48.2	47.6	42.5	41.5	63.9	47.8
4:00:00	57.0	49.2	48.6	45.3	44.2	62.9	49.4

Table ~~32~~35 Hourly Noise Monitoring Results, Site LT-8, 11918 Exposition Boulevard (May 10–11, 2007)

Start Time	Hourly Sound Levels, dBA						
	L_1	L_{33}	L_{50}	L_{99}	L_{min}	L_{max}	L_{eq}
5:00:00	57.6	52.6	51.8	47.0	45.8	76.2	52.6
6:00:00	60.6	52.5	51.6	47.7	46.9	80.8	53.2
7:00:00	65.3	53.3	52.2	49.3	48.4	73.1	55.2
8:00:00	67.5	55.3	53.6	49.0	48.0	80.1	57.3
9:00:00	66.8	55.0	53.6	50.5	49.5	79.0	56.9
10:00:00	66.6	56.4	54.9	51.7	50.5	77.6	57.5
11:00:00	67.3	56.5	54.6	51.6	50.8	73.7	57.7
12:00:00	66.8	55.5	54.2	51.0	49.8	76.0	57.4
13:00:00	67.8	56.1	55.0	52.2	51.2	74.4	58.0
14:00:00	70.5	55.6	54.7	51.7	50.7	83.1	59.6
15:00:00	63.4	55.3	54.4	51.6	52.4	83.9	53.0

SOURCE: ATS Consulting, 2008.

Long Term Site 9, 3014 Exposition Boulevard

The measurement site was in the front yard of a multi family residence located adjacent to Exposition Boulevard between Dorchester Avenue and Centinela Avenue. The major noise sources in this area is vehicular traffic on Exposition Boulevard. The measurement position was 25 feet from Exposition Boulevard. The noise measurement was performed for nine hours on May 16, 2007 and sixteen hours on May 17, 2007.

Including all of the weekday hours during the measurement, the measured L_{dn} was 60 dBA with the L_{eq} (day) and L_{eq} (night) being measured at 59 dBA and 51 dBA respectively. A maximum 1 hour L_{eq} of 63 dBA was recorded at 11 a.m. on the second day of the measurement. It was observed while setting up the measurement equipment that there was a construction site on the north side of the exposition corridor and although no construction activities were taking place at that time, it should be noted that noise levels in the area could be affected by construction activities near this location.

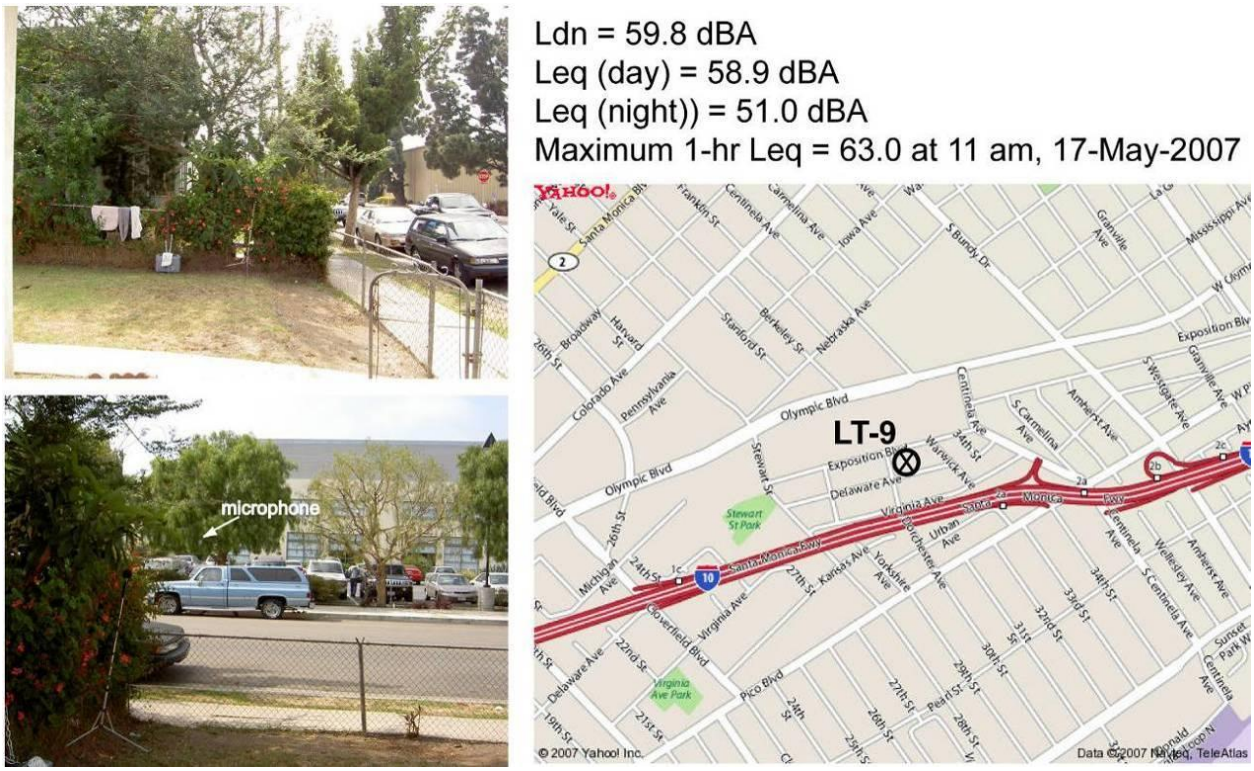


Figure ~~17~~33 Site LT-9, 3014 Exposition Boulevard

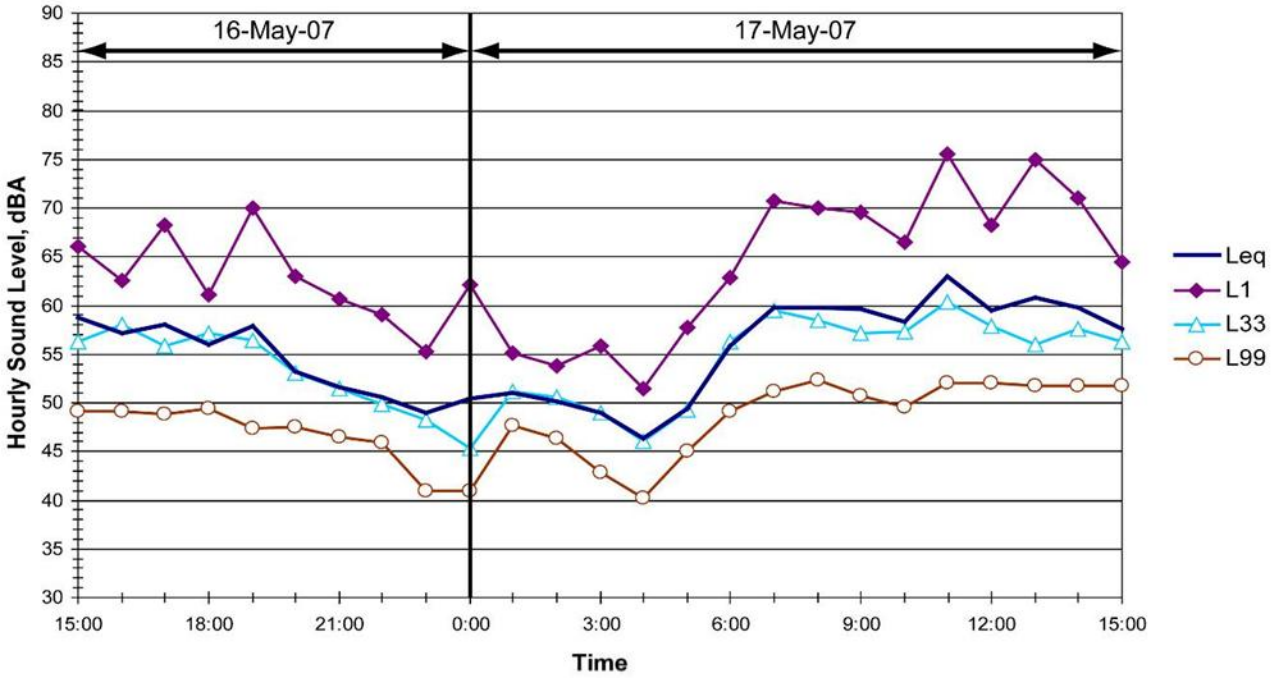


Figure ~~18~~34 Noise Monitoring Results, Site LT-9, 3014 Exposition Boulevard (May 16–17, 2007)

Table ~~33~~36 Hourly Noise Monitoring Results, Site LT-9, 3014 Exposition Boulevard (May 16–17, 2007)

Start Time	Hourly Sound Levels, dBA						
	L_1	L_{33}	L_{50}	L_{99}	L_{min}	L_{max}	L_{eq}
15:00:00	66.0	56.3	53.0	49.1	51.4	66.0	58.8
16:00:00	62.6	58.0	56.0	49.1	49.1	62.6	57.2
17:00:00	68.3	55.8	54.8	48.8	48.6	68.3	58.1
18:00:00	61.1	57.1	55.4	49.4	48.5	61.1	56.0
19:00:00	70.0	56.4	55.2	47.3	47.2	70.0	57.9
20:00:00	63.0	53.1	51.7	47.5	46.2	63.0	53.3
21:00:00	60.6	51.4	50.7	46.5	46.5	60.6	51.5
22:00:00	59.1	49.8	48.9	45.9	45.0	59.1	50.6
23:00:00	55.2	48.3	47.3	40.9	40.9	55.2	48.9
0:00:00	62.1	45.3	44.2	40.9	40.8	62.1	50.4
1:00:00	55.1	51.2	50.5	47.7	47.1	55.1	51.0
2:00:00	53.8	50.6	50.1	46.3	46.1	53.8	50.2
3:00:00	55.9	49.0	47.6	42.8	42.4	55.9	49.0
4:00:00	51.5	46.0	45.5	40.2	39.9	51.5	46.3

Table ~~33~~36 Hourly Noise Monitoring Results, Site LT-9, 3014 Exposition Boulevard (May 16–17, 2007)

Start Time	Hourly Sound Levels, dBA						
	L_1	L_{33}	L_{50}	L_{99}	L_{min}	L_{max}	L_{eq}
5:00:00	57.8	49.2	48.1	45.1	44.8	57.8	49.4
6:00:00	62.8	56.3	54.2	49.1	48.7	62.8	55.8
7:00:00	70.7	59.5	57.2	51.2	51.0	70.7	59.8
8:00:00	70.0	58.5	57.5	52.3	50.5	70.0	59.8
9:00:00	69.5	57.2	55.6	50.7	50.4	69.5	59.6
10:00:00	66.5	57.3	55.8	49.5	48.6	66.5	58.3
11:00:00	75.5	60.4	56.7	52.0	52.0	75.5	63.0
12:00:00	68.2	57.9	57.2	52.1	51.8	68.2	59.5
13:00:00	74.9	56.0	55.2	51.8	51.0	74.9	60.8
14:00:00	71.0	57.6	56.3	51.8	50.9	71.0	59.8
15:00:00	64.4	56.3	53.1	51.8	50.2	64.4	57.6

SOURCE: ATS Consulting, 2008.

Long Term Site 10, Crossroads High School

The measurement site was in the parking lot of Crossroads High School. The school is located on the south side of Olympic Boulevard between 20th Street and 21st Street in Santa Monica. The major noise sources in this area are vehicular traffic on Olympic Boulevard, vehicular traffic within the parking lot, and noise from general school activities. The measurement position was 20 feet from the near lane of Olympic Boulevard. The noise measurement was performed for fifteen hours on May 23 and 9 hours on May 24, 2007.

The measured L_{dn} for Site LT-10 was 71 dBA with the L_{eq} (day) and L_{eq} (night) being measured at 68 dBA and 63 dBA respectively. A maximum 1 hour L_{eq} of 73 dBA was recorded at 7 pm on the first day of the measurement.

Ldn = 70.8 dBA
Leq (day) = 68.4 dBA
Leq (night)) = 63.2 dBA
Maximum 1-hr Leq = 73.1 at 7 pm, 23-May-2007

Figure ~~19~~35 Site LT-10, Crossroads High School

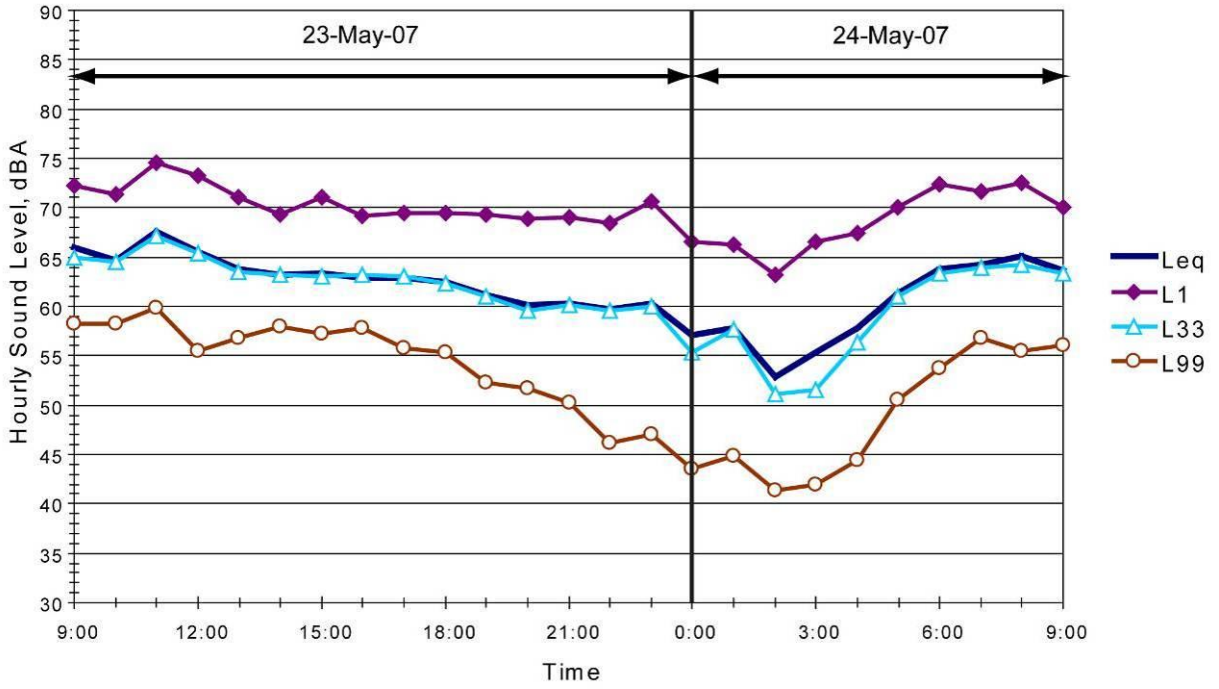


Figure ~~20~~36 Noise Monitoring Results, Site LT-10, Crossroads High School (May 23–24, 2007)

Table ~~34~~37 Hourly Noise Monitoring Results, Site LT-10, Crossroads Elementary School (May 23–24, 2007)

Start Time	Hourly Sound Levels, dBA						
	L_1	L_{33}	L_{50}	L_{99}	L_{min}	L_{max}	L_{eq}
9:00:00	75.5	65.3	61.8	57.0	57.9	84.7	68.4
10:00:00	76.7	66.6	64.6	57.0	55.5	85.8	67.6
11:00:00	77.0	66.9	65.1	58.1	55.2	87.0	67.8
12:00:00	79.1	69.0	67.6	60.4	57.2	96.1	70.4
13:00:00	77.6	67.3	65.7	58.7	56.5	92.3	68.7
14:00:00	76.8	67.4	65.9	58.8	56.4	97.1	69.5
15:00:00	76.5	67.8	66.4	59.5	57.5	82.7	68.1
16:00:00	76.1	67.4	66.0	58.3	55.8	84.2	67.6
17:00:00	74.3	67.4	65.8	59.1	57.1	82.4	67.4
18:00:00	74.1	66.5	64.7	57.4	55.7	81.6	66.6
19:00:00	76.3	65.6	63.3	55.7	53.8	103.5	73.1
20:00:00	72.3	63.2	60.7	52.9	51.2	81.7	64.0
21:00:00	71.5	62.1	59.4	51.6	49.2	79.5	63.0

Table ~~34~~37 Hourly Noise Monitoring Results, Site LT-10, Crossroads Elementary School (May 23–24, 2007)

Start Time	Hourly Sound Levels, dBA						
	L_1	L_{33}	L_{50}	L_{99}	L_{min}	L_{max}	L_{eq}
22:00:00	75.3	63.4	59.8	50.3	48.8	83.1	65.4
23:00:00	73.9	62.9	58.4	46.1	44.2	82.0	64.7
0:00:00	74.7	59.7	56.2	47.1	44.0	91.7	64.9
1:00:00	71.7	56.3	53.5	43.4	42.0	86.9	61.7
2:00:00	71.6	55.4	53.5	44.7	43.0	79.7	60.3
3:00:00	68.9	51.5	47.7	40.6	39.6	77.7	57.1
4:00:00	74.1	54.2	51.1	42.0	41.3	83.9	61.3
5:00:00	74.9	58.7	55.1	44.7	43.6	82.8	63.5
6:00:00	73.7	63.1	60.6	48.8	46.8	80.6	64.3
7:00:00	75.8	66.7	64.9	55.7	52.6	88.2	67.3
8:00:00	75.5	68.1	66.2	57.9	56.3	81.9	68.0
9:00:00	76.1	67.7	64.3	57.9	55.6	82.0	67.7

Long Term Site 11, Crossroads Elementary School

The measurement site was in the parking lot of Crossroads Elementary School. The school is located on the north side of Olympic Boulevard between 17th Street and 18th Street in Santa Monica. The major noise sources in this area are vehicular traffic on Olympic Boulevard, vehicular traffic entering and exiting the parking lot, and noise from general school activities in the playing fields adjacent to the measurement site. The measurement position was 25 feet from the near lane of Olympic Boulevard. The noise measurement was performed for fifteen hours on May 23, 2007 and 9 hours on May 24, 2007.

Including all of the weekday hours during the measurement, the measured L_{dn} was 67 dBA with the L_{eq} (day) and L_{eq} (night) being measured at 64 dBA and 59 dBA respectively. A maximum 1 hour L_{eq} of 68 dBA was recorded at 12 pm on the first day of the measurement.

Figure ~~21~~37 Site LT-11, Crossroads Elementary School

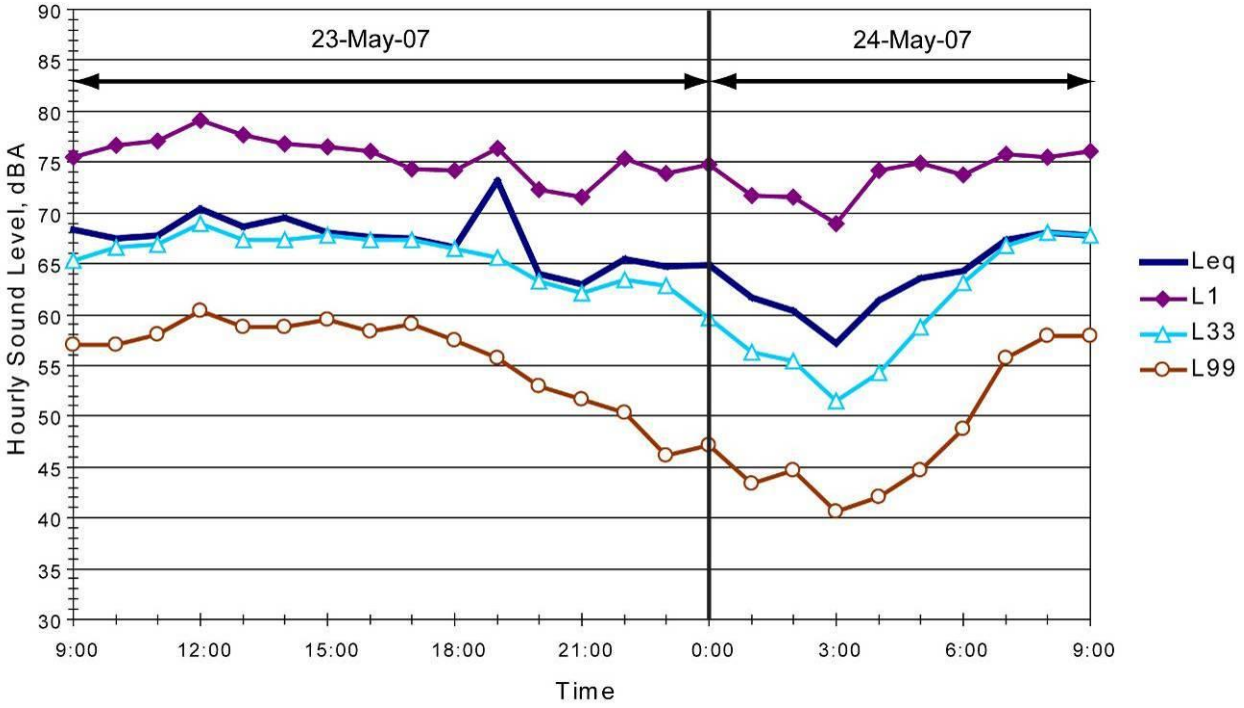


Figure ~~22~~38 Noise Monitoring Results, Site LT-11, Crossroads Elementary School (May 23–24, 2007)

Table ~~35~~38 Hourly Noise Monitoring Results, Site LT-11, Crossroads Elementary School (May 23–24, 2007)

Start Time	Hourly Sound Levels, dBA						
	L_1	L_{33}	L_{50}	L_{99}	L_{min}	L_{max}	L_{eq}
10:00:00	72.3	65.0	63.2	58.3	57.8	76.7	66.0
11:00:00	71.4	64.5	63.3	58.3	56.6	72.5	64.7
12:00:00	74.6	67.2	66.0	59.9	59.1	81.2	67.5
13:00:00	73.2	65.4	63.4	55.5	54.6	74.2	65.5
14:00:00	71.0	63.5	62.1	56.8	55.5	77.2	63.8
15:00:00	69.3	63.2	62.1	57.9	56.0	72.8	63.1
16:00:00	71.1	63.1	61.9	57.2	56.5	76.0	63.4
17:00:00	69.2	63.2	61.7	57.8	56.9	69.4	62.9
18:00:00	69.5	63.0	61.8	55.8	55.7	70.3	62.9
19:00:00	69.5	62.4	60.7	55.3	54.7	71.5	62.5
20:00:00	69.3	61.0	59.3	52.3	50.9	71.2	61.2
21:00:00	68.9	59.5	57.1	51.7	50.2	70.8	60.2
22:00:00	69.1	60.2	57.9	50.2	49.4	72.5	60.3
23:00:00	68.5	59.6	56.2	46.2	44.8	72.0	59.7

Table ~~35~~38 Hourly Noise Monitoring Results, Site LT-11, Crossroads Elementary School (May 23–24, 2007)

Start Time	Hourly Sound Levels, dBA						
	L_1	L_{33}	L_{50}	L_{99}	L_{min}	L_{max}	L_{eq}
0:00:00	70.6	60.0	58.1	47.1	44.9	72.5	60.3
1:00:00	66.5	55.4	53.5	43.6	42.9	74.7	57.2
2:00:00	66.3	57.6	55.2	44.9	44.4	71.7	57.8
3:00:00	63.2	51.1	49.1	41.3	40.6	66.8	52.9
4:00:00	66.6	51.5	47.9	42.0	41.5	70.9	55.4
5:00:00	67.4	56.3	53.6	44.4	43.9	68.9	57.8
6:00:00	70.0	61.0	58.6	50.5	49.8	70.8	61.3
7:00:00	72.4	63.4	61.4	53.8	53.2	75.1	63.8
8:00:00	71.7	64.0	62.4	56.8	55.4	76.6	64.3
9:00:00	72.5	64.2	62.3	55.5	55.0	74.6	65.1

SOURCE: ATS Consulting, 2008.

Long Term Site 12, 10910 Venice Boulevard

Site LT-12 was located in the front yard of a single family residence and catering business on Venice Boulevard between Prospect Court and College Avenue. The major noise source in this area is vehicular traffic on Venice Boulevard. The microphone was located at 30 feet from Venice Boulevard, which is the approximate set-back distance of the residence from Venice. The noise measurement was performed for ten hours on May 10, 2007, and fourteen hours on May 11, 2007.

Including all of the weekday hours during the measurement, the measured L_{dn} was 74 dBA with the L_{eq} (day) and L_{eq} (night) being measured at 71 dBA and 67 dBA respectively. A maximum 1 hour L_{eq} of 72 dBA was recorded at 7 a.m. on the second day of the measurement.

Ldn = 74.0 dBA
Leq (day) = 70.7 dBA
Leq (night)) = 67.0 dBA
Maximum 1-hr Leq = 71.9 at 7 am, 11-May-2007

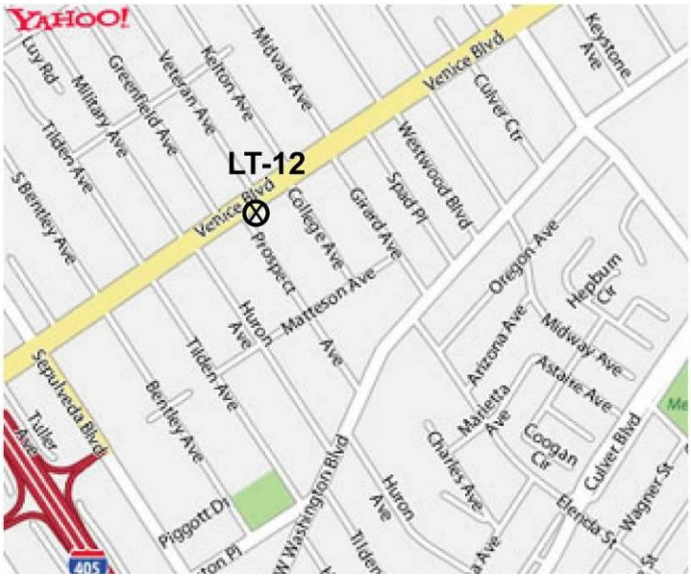


Figure 2339 Site LT-12, 10910 Venice Boulevard

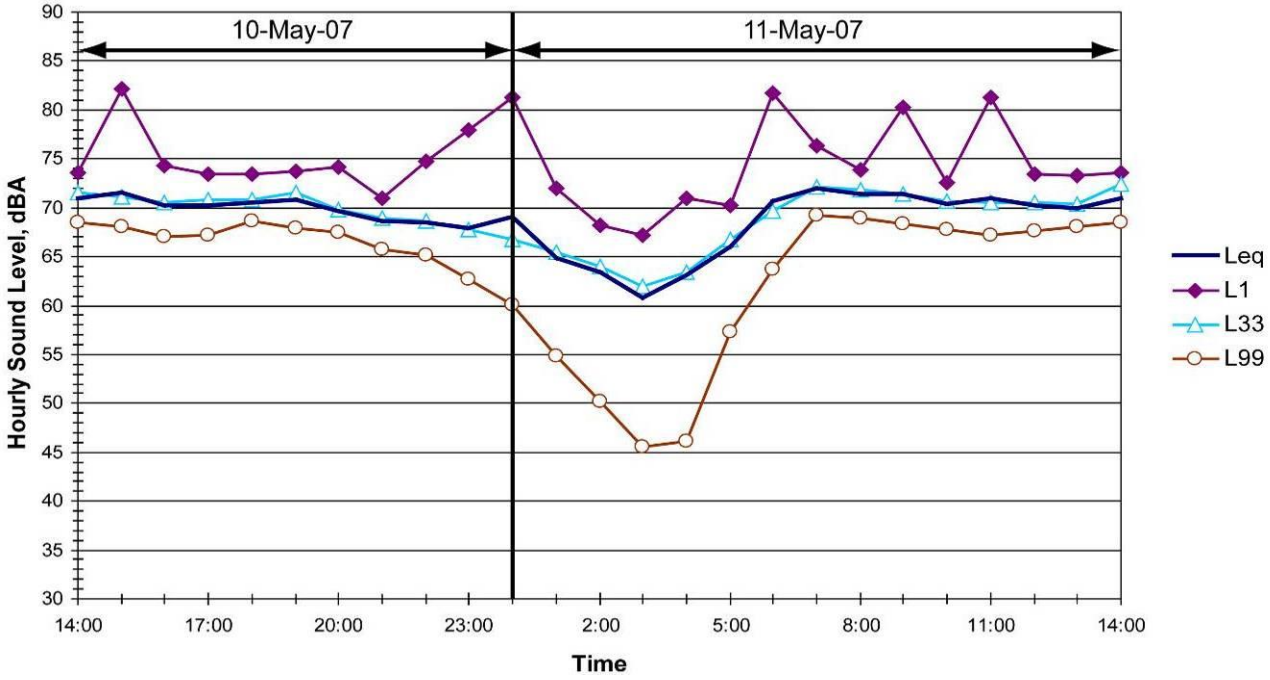


Figure ~~24~~40 Noise Monitoring Results, Site LT-12, 10910 Venice Boulevard (May 10–11, 2007)

Table ~~36~~39 Hourly Noise Monitoring Results, Site LT-12, 10910 Venice Boulevard (May 10–11, 2007)

Start Time	Hourly Sound Levels, dBA						
	L_1	L_{33}	L_{50}	L_{99}	L_{min}	L_{max}	L_{eq}
14:00:00	73.6	71.5	70.7	68.5	68.2	73.6	71.0
15:00:00	82.2	71.1	70.8	68.1	68.0	82.2	71.5
16:00:00	74.3	70.5	70.0	67.0	66.7	74.3	70.2
17:00:00	73.4	70.8	70.2	67.2	66.4	73.4	70.3
18:00:00	73.5	70.8	70.3	68.7	67.2	73.5	70.6
19:00:00	73.7	71.5	70.8	67.9	67.6	73.7	70.9
20:00:00	74.2	69.8	69.5	67.5	67.1	74.2	69.7
21:00:00	71.0	69.0	68.6	65.7	65.4	71.0	68.7
22:00:00	74.8	68.7	68.0	65.2	64.4	74.8	68.5
23:00:00	77.9	67.7	66.9	62.7	62.5	77.9	67.9
0:00:00	81.3	66.8	66.4	60.1	58.6	81.3	69.1
1:00:00	72.0	65.4	64.6	54.8	54.4	72.0	64.9
2:00:00	68.2	64.0	62.7	50.2	46.8	68.2	63.4
3:00:00	67.2	62.0	59.4	45.6	44.9	67.2	60.8

Table ~~36~~39 Hourly Noise Monitoring Results, Site LT-12, 10910 Venice Boulevard (May 10–11, 2007)

Start Time	Hourly Sound Levels, dBA						
	L_1	L_{33}	L_{50}	L_{99}	L_{min}	L_{max}	L_{eq}
4:00:00	70.9	63.4	62.0	46.1	45.8	70.9	63.1
5:00:00	70.3	66.7	65.6	57.3	55.6	70.3	66.1
6:00:00	81.7	69.6	69.0	63.7	63.6	81.7	70.7
7:00:00	76.4	72.1	71.5	69.2	68.8	76.4	71.9
8:00:00	73.9	71.9	71.4	69.0	67.7	73.9	71.5
9:00:00	80.2	71.4	70.8	68.4	67.8	80.2	71.5
10:00:00	72.5	70.7	70.4	67.7	67.5	72.5	70.3
11:00:00	81.3	70.6	70.1	67.2	67.0	81.3	71.0
12:00:00	73.4	70.6	70.2	67.6	67.1	73.4	70.3
13:00:00	73.3	70.4	69.9	68.0	67.6	73.3	70.0
14:00:00	73.6	72.4	70.7	68.5	68.2	73.6	71.0

SOURCE: ATS Consulting, 2008.

Long Term Site 13, UCLA University Apartments

Site LT-13 was in the front yard of the UCLA residences located on the west side of Sepulveda Boulevard between Queensland Street and National Boulevard. The major noise source in this area is vehicular traffic on Sepulveda Boulevard. The measurement position was 25 feet from the Sepulveda Boulevard. The noise measurement was performed for fourteen hours on May 14, 2007, twenty-four hours on May 15, 2007, and ten hours on May 16, 2007.

Including all of the weekday hours during the measurement, the measured L_{dn} was 71~~0~~ dBA with the L_{eq} (day) and L_{eq} (night) being measured at 68 dBA and 62 dBA respectively. A maximum 1 hour L_{eq} of 71 dBA was recorded at 6 p.m. on the second day of the measurement.

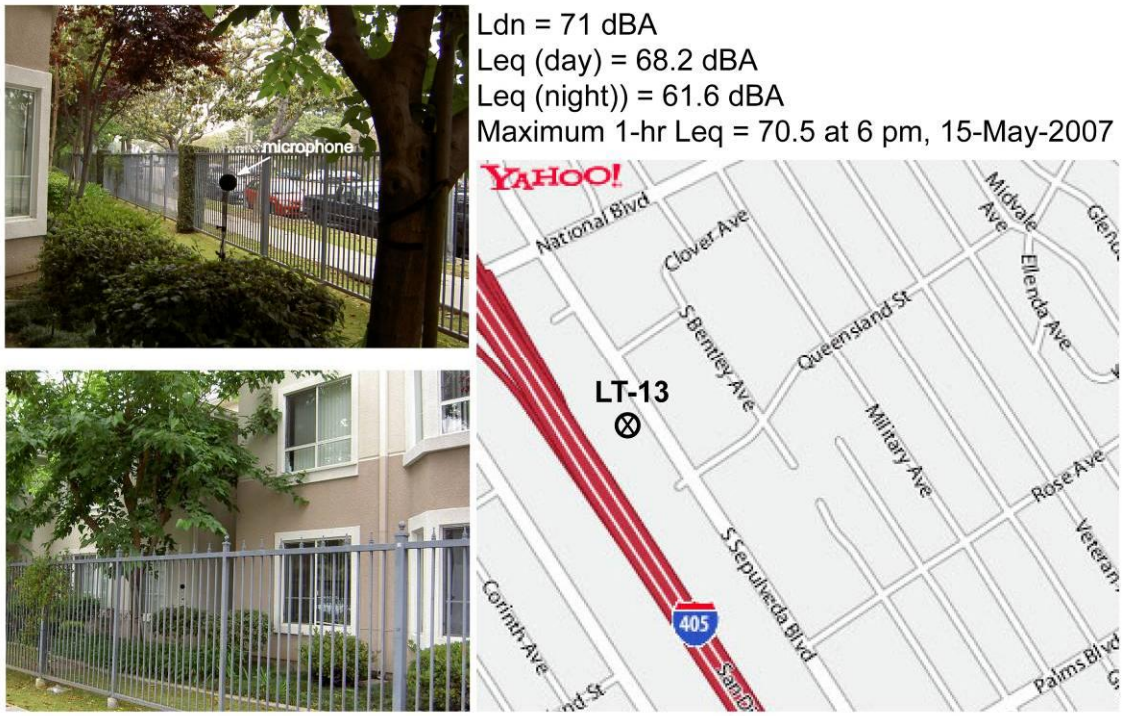


Figure ~~25~~41 Site LT-13, UCLA University Apartments

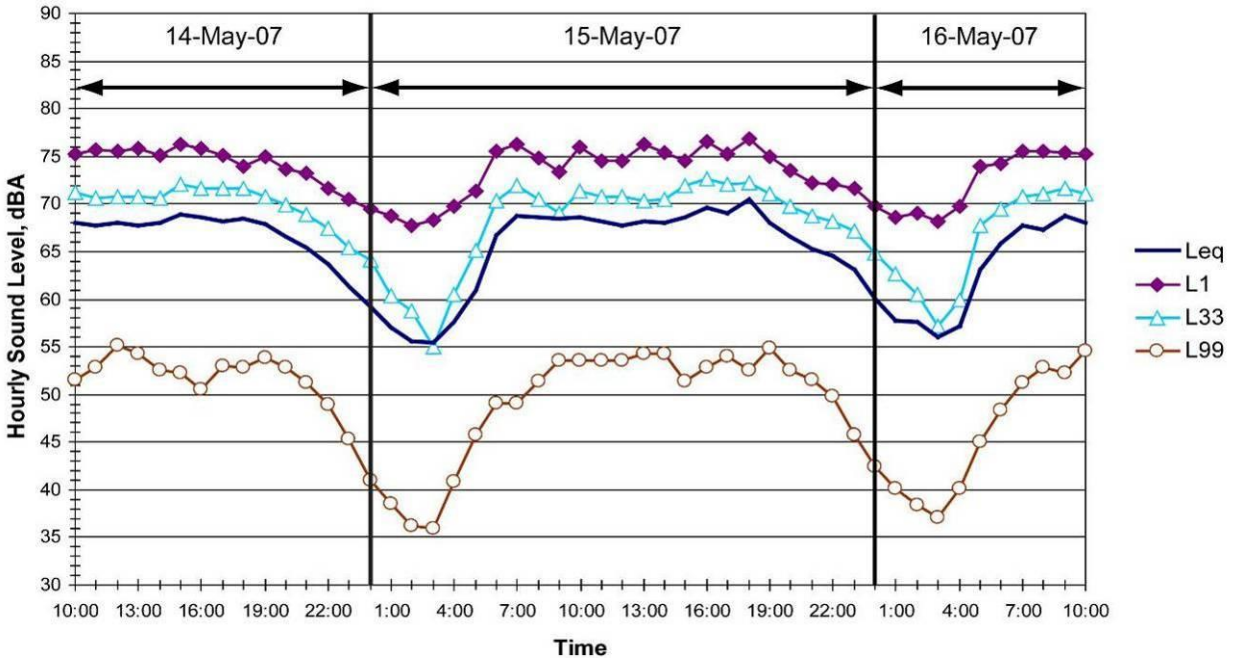


Figure ~~26~~42 Noise Monitoring Results, Site LT-13, UCLA University Apartments (May 14–16, 2007)

Table ~~37~~40 Hourly Noise Monitoring Results, Site LT-13, UCLA University Apartments (May 14–16, 2007)

Start Time	Hourly Sound Levels, dBA						
	L_1	L_{33}	L_{50}	L_{99}	L_{min}	L_{max}	L_{eq}
10:00:00	75.3	71.2	66.5	51.5	47.9	82.5	68.1
11:00:00	75.7	70.6	66.4	52.9	50.4	83.2	67.8
12:00:00	75.6	70.7	66.5	55.1	52.5	83.2	68.0
13:00:00	75.8	70.7	66.0	54.3	51.8	88.6	67.8
14:00:00	75.1	70.6	66.1	52.6	50.6	92.8	68.0
15:00:00	76.3	72.1	67.2	52.2	49.4	84.0	68.9
16:00:00	75.8	71.7	67.1	50.6	46.4	84.8	68.6
17:00:00	75.1	71.6	66.8	53.0	48.5	82.6	68.2
18:00:00	74.0	71.6	67.6	52.9	50.5	80.4	68.4
19:00:00	74.9	70.8	66.5	53.8	51.8	86.2	67.8
20:00:00	73.7	69.9	64.7	52.9	50.9	81.2	66.5
21:00:00	73.3	68.9	62.8	51.3	50.4	84.8	65.4
22:00:00	71.6	67.5	60.7	48.9	47.6	82.8	63.6
23:00:00	70.5	65.4	55.1	45.3	43.4	79.8	61.3
0:00:00	69.4	64.1	48.3	41.0	39.9	74.8	59.1

Table ~~37~~40 Hourly Noise Monitoring Results, Site LT-13, UCLA University Apartments (May 14–16, 2007)

Start Time	Hourly Sound Levels, dBA						
	L_1	L_{33}	L_{50}	L_{99}	L_{min}	L_{max}	L_{eq}
1:00:00	68.8	60.4	44.3	38.5	36.9	81.9	57.0
2:00:00	67.8	58.8	41.8	36.2	33.8	76.6	55.6
3:00:00	68.3	55.0	43.2	35.9	33.4	81.5	55.5
4:00:00	69.8	60.5	46.4	40.9	38.7	77.2	57.6
5:00:00	71.4	65.1	51.5	45.7	44.2	79.8	60.9
6:00:00	75.5	70.3	63.7	49.1	47.7	84.1	66.7
7:00:00	76.3	71.9	67.3	49.1	50.3	84.0	68.8
8:00:00	74.9	70.5	67.3	51.4	50.7	82.6	68.6
9:00:00	73.4	69.0	67.3	53.6	51.1	81.1	68.4
10:00:00	76.0	71.4	67.3	53.6	50.6	85.9	68.5
11:00:00	74.5	70.8	67.3	53.6	51.1	85.2	68.2
12:00:00	74.5	70.7	66.7	53.6	50.8	81.0	67.7
13:00:00	76.2	70.4	66.0	54.3	51.3	92.7	68.2
14:00:00	75.4	70.5	66.6	54.3	50.9	87.2	68.0
15:00:00	74.5	72.0	67.4	51.4	48.7	80.1	68.6
16:00:00	76.5	72.6	67.9	52.8	48.6	88.3	69.6
17:00:00	75.2	72.1	67.4	54.0	50.3	91.2	69.0
18:00:00	76.8	72.2	68.0	52.6	49.6	96.2	70.5
19:00:00	74.9	71.1	66.7	54.8	51.7	86.7	68.1
20:00:00	73.5	69.8	64.8	52.6	50.8	81.0	66.6
21:00:00	72.2	68.8	63.5	51.5	49.6	81.4	65.3
22:00:00	72.1	68.1	62.2	49.8	48.0	81.8	64.6
23:00:00	71.6	67.2	59.7	45.7	44.1	78.5	63.1
0:00:00	69.8	64.9	51.9	42.5	40.2	80.4	60.1
1:00:00	68.6	62.7	46.3	40.1	37.9	73.3	57.7
2:00:00	69.1	60.5	44.3	38.4	36.0	83.2	57.7
3:00:00	68.1	57.2	43.3	37.1	33.8	81.7	56.1
4:00:00	69.7	59.9	46.6	40.1	37.3	78.2	57.1
5:00:00	73.9	67.7	53.0	45.0	43.8	80.7	63.1
6:00:00	74.2	69.5	63.3	48.3	46.7	82.7	65.9
7:00:00	75.6	70.8	66.1	51.3	48.3	85.1	67.7
8:00:00	75.5	71.0	64.4	52.8	50.3	81.9	67.3
9:00:00	75.4	71.7	67.6	52.2	49.3	87.5	68.8

Table ~~37~~40 Hourly Noise Monitoring Results, Site LT-13, UCLA University Apartments (May 14–16, 2007)

Start Time	Hourly Sound Levels, dBA						
	L_1	L_{33}	L_{50}	L_{99}	L_{min}	L_{max}	L_{eq}
10:00:00	75.2	71.0	66.7	54.6	51.7	84.1	68.0

SOURCE: ATS Consulting, 2008.

Long Term Site 14, Colorado Avenue

The measurement was taken in the front yard of a business located on the south side of Colorado Avenue between 5th Street and 6th Street. The primary noise source in this area is vehicular traffic on Colorado Avenue. The measurement position was 25 feet from the nearest lane of Colorado Avenue. The noise measurement was performed for ten hours on May 5 2007, and fourteen hours on May 6 2007.

Including all of the weekday hours during the measurement, the measured L_{dn} was 68 dBA with the L_{eq} (day) and L_{eq} (night) being measured at 65 dBA and 60 dBA respectively. A maximum 1 hour L_{eq} of 70 dBA was recorded at 5 p.m. on the first day of the measurement.

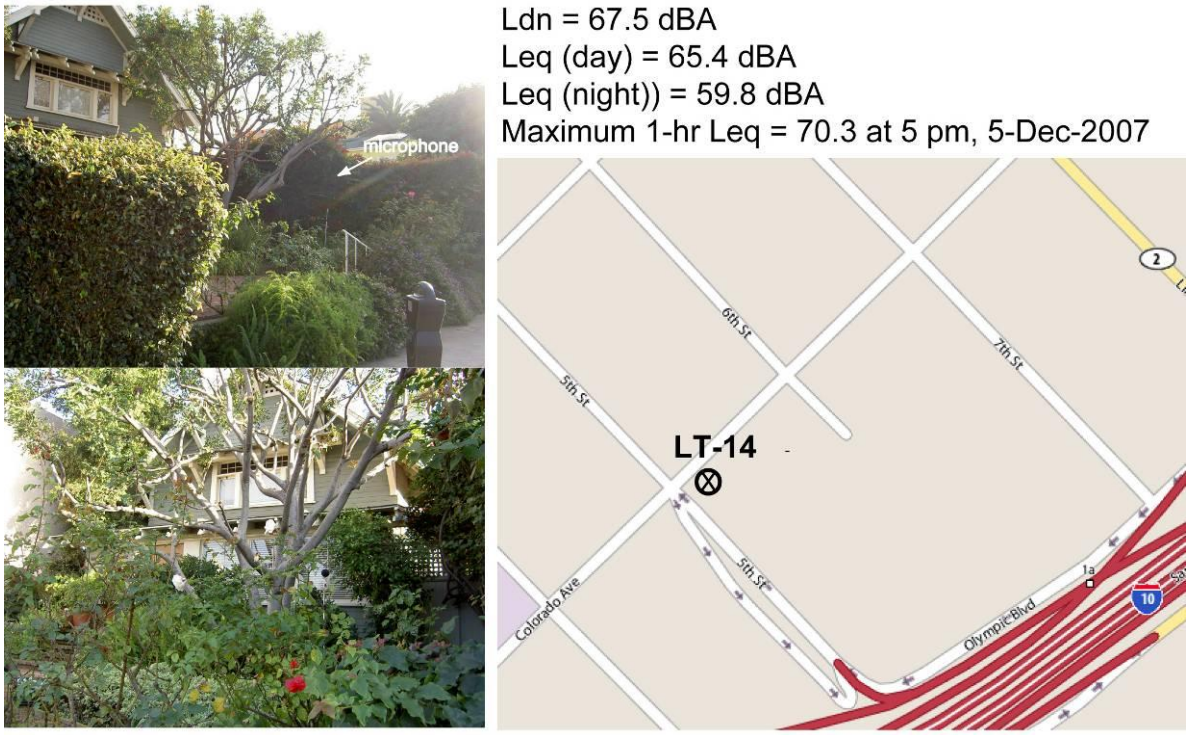


Figure ~~19~~43 Site LT-14, Colorado Avenue

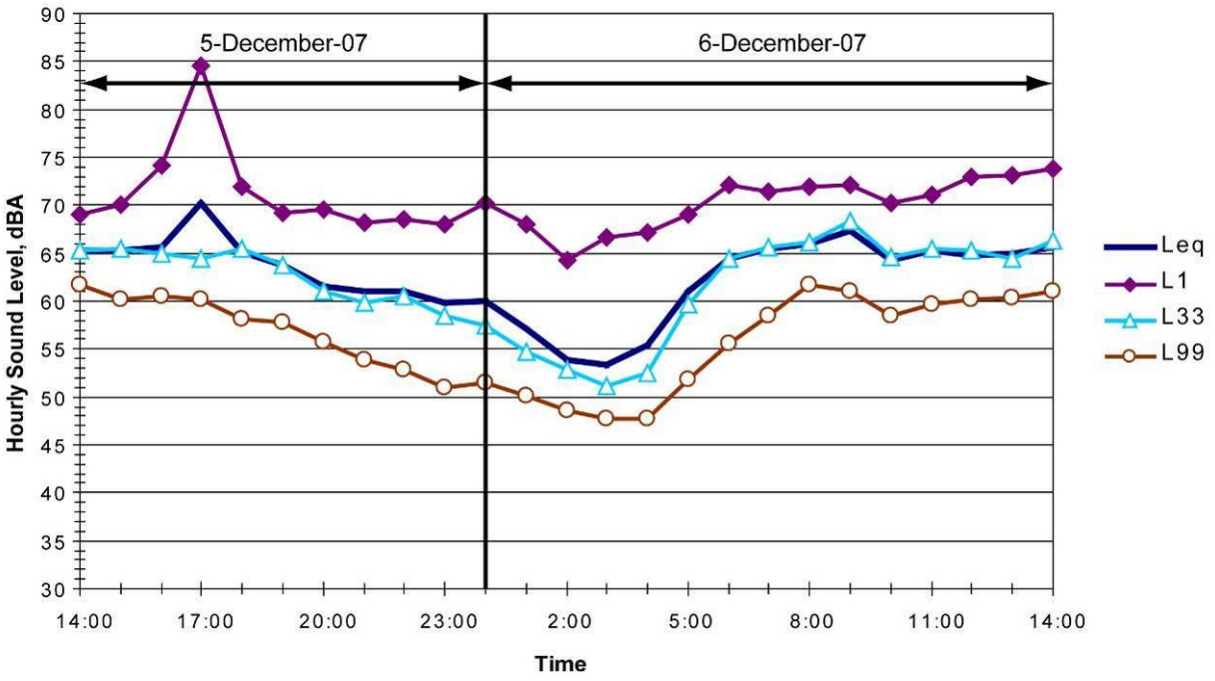


Figure ~~20~~44 Noise Monitoring Results, Site LT-14, Colorado Avenue (December 5–6, 2007)

Table ~~38~~41 Hourly Noise Monitoring Results, Site LT-14, Colorado Avenue (December 5–6, 2007)

Start Time	Hourly Sound Levels, dBA						
	L_1	L_{33}	L_{50}	L_{99}	L_{min}	L_{max}	L_{eq}
14:00:00	69.1	65.3	63.5	61.7	61.3	69.1	65.3
15:00:00	70.0	65.4	64.1	60.1	59.5	70.0	65.3
16:00:00	74.1	65.0	64.1	60.5	60.3	74.1	65.6
17:00:00	84.5	64.5	63.5	60.1	58.2	84.5	70.3
18:00:00	71.9	65.4	64.0	58.1	57.8	71.9	65.1
19:00:00	69.2	63.8	61.5	57.7	56.9	69.2	63.8
20:00:00	69.6	61.0	59.3	55.8	55.6	69.6	61.5
21:00:00	68.2	59.9	58.6	53.8	53.0	68.2	60.9
22:00:00	68.5	60.5	58.8	52.8	52.6	68.5	61.1
23:00:00	68.0	58.5	57.0	51.0	50.2	68.0	59.8
0:00:00	70.2	57.5	56.1	51.5	51.2	70.2	59.9
1:00:00	68.0	54.8	53.3	50.1	48.7	68.0	57.1
2:00:00	64.2	52.8	50.8	48.6	48.4	64.2	53.8

Table ~~38~~41 Hourly Noise Monitoring Results, Site LT-14, Colorado Avenue (December 5–6, 2007)

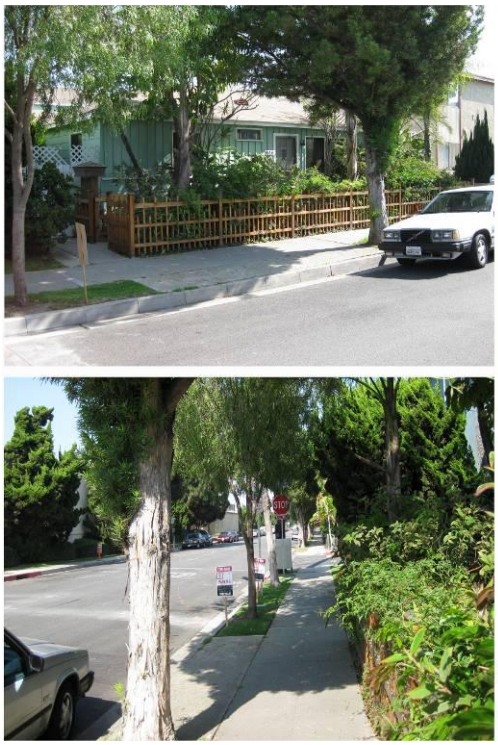
Start Time	Hourly Sound Levels, dBA						
	L_1	L_{33}	L_{50}	L_{99}	L_{min}	L_{max}	L_{eq}
3:00:00	66.6	51.1	49.3	47.7	47.5	66.6	53.3
4:00:00	67.2	52.5	51.6	47.8	47.2	67.2	55.5
5:00:00	69.1	59.6	57.1	51.8	50.5	69.1	61.0
6:00:00	72.1	64.4	62.9	55.5	54.7	72.1	64.4
7:00:00	71.4	65.7	63.9	58.5	58.2	71.4	65.5
8:00:00	72.0	66.1	65.1	61.7	61.6	72.0	66.0
9:00:00	72.1	68.4	66.1	61.1	60.7	72.1	67.4
10:00:00	70.3	64.6	63.3	58.4	57.5	70.3	64.3
11:00:00	71.1	65.4	63.3	59.6	59.3	71.1	65.3
12:00:00	73.0	65.2	63.5	60.1	59.8	73.0	64.8
13:00:00	73.2	64.5	63.2	60.4	60.1	73.2	65.0
14:00:00	73.8	66.3	64.7	61.0	60.4	73.8	65.7

SOURCE: ATS Consulting, 2008.

Long Term Site 15, Exposition Avenue, Proposed Maintenance Facility

The measurement was taken in the front yard of a residence on Exposition Boulevard just east of Stewart Street. The primary noise source in this area is vehicular traffic on Exposition Boulevard, Olympic Boulevard, and I-10. The measurement position was eight feet from the nearest lane of Exposition Boulevard. The noise measurement was performed for ten hours on June 26 2008, and fourteen hours on June 27 2008.

Including all of the weekday hours during the measurement, the measured L_{dn} was 58 dBA with the L_{eq} (day) and L_{eq} (night) being measured at 58 dBA and 48 dBA respectively. A maximum 1 hour L_{eq} of 61 dBA was recorded at 2 p.m. on the second day of the measurement.



Ldn = 57.9.5dBA
Leq (day) = 57.9 dBA
Leq (night)) = 47.8 dBA
Maximum 1-hr Leq = 60.9 at 2 pm, 27-Jun-2008

Figure ~~19~~45 Site LT-15, Exposition Avenue, Proposed Maintenance Facility

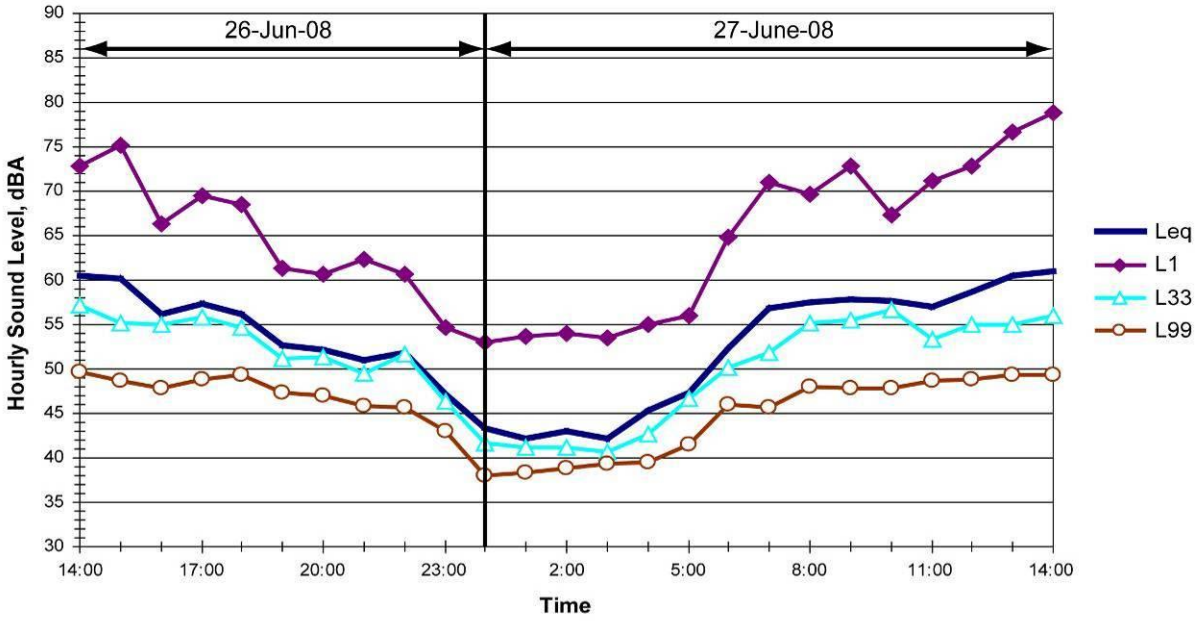


Figure ~~20~~46 Noise Monitoring Results, Site LT-15, Exposition Boulevard, Proposed Maintenance Yard (June 26–27, 2008)

Table ~~39~~42 Hourly Noise Monitoring Results, Site LT-15, Exposition Boulevard, Proposed Maintenance Yard (June 26–27, 2008)

Start Time	Hourly Sound Levels, dBA						
	L_1	L_{33}	L_{50}	L_{99}	L_{min}	L_{max}	L_{eq}
14:00:00	72.8	57.1	55.2	49.7	49.7	72.8	60.5
15:00:00	75.2	55.1	52.0	48.6	48.6	77.5	60.1
16:00:00	66.4	55.0	52.2	47.8	47.8	66.5	56.2
17:00:00	69.5	55.8	53.9	48.9	48.9	71.5	57.4
18:00:00	68.5	54.6	52.6	49.4	49.4	71.5	56.1
19:00:00	61.4	51.2	50.3	47.4	47.4	62.7	52.7
20:00:00	60.6	51.4	49.7	47.0	47.0	62.4	52.2
21:00:00	62.4	49.5	48.6	45.8	45.8	63.0	50.9
22:00:00	60.6	51.7	51.0	45.7	45.7	66.9	51.9
23:00:00	54.6	46.3	45.7	43.0	43.0	59.6	47.2
0:00:00	53.0	41.6	40.5	38.0	38.0	54.7	43.3
1:00:00	53.6	41.1	40.7	38.4	38.4	57.7	42.2
2:00:00	54.0	41.2	40.7	38.9	38.9	59.2	43.0
3:00:00	53.5	40.7	40.4	39.3	39.3	56.8	42.2
4:00:00	55.0	42.7	41.8	39.5	39.5	65.0	45.3

Table ~~39~~42 Hourly Noise Monitoring Results, Site LT-15, Exposition Boulevard, Proposed Maintenance Yard (June 26–27, 2008)

Start Time	Hourly Sound Levels, dBA						
	L_1	L_{33}	L_{50}	L_{99}	L_{min}	L_{max}	L_{eq}
5:00:00	56.0	46.6	45.6	41.5	41.5	59.3	47.4
6:00:00	64.9	50.1	48.9	46.0	46.0	65.1	52.4
7:00:00	71.0	51.8	49.7	45.7	45.7	73.8	56.8
8:00:00	69.7	55.1	52.9	48.0	48.0	71.1	57.6
9:00:00	72.9	55.5	51.7	47.8	47.8	74.5	57.9
10:00:00	67.3	56.7	54.2	47.9	47.9	71.2	57.7
11:00:00	71.2	53.3	51.4	48.7	48.7	75.0	57.0
12:00:00	72.8	55.0	52.2	48.9	48.9	73.5	58.7
13:00:00	76.6	55.0	52.6	49.3	49.3	79.2	60.5
14:00:00	78.8	56.0	53.1	49.3	49.3	78.8	60.9

SOURCE: ATS Consulting, 2008.

B.2 Short Term Noise Measurements

Short Term Site 1, Crossroads School

Site LT-1 was located at the intersection of Pennsylvania Avenue, 21st Street, and Olympic Boulevard, near the Crossroads School. The primary noise source in this area is vehicular traffic on Olympic Boulevard. The measurement position was 5 feet from the edge of 21st street and approximately 50 feet from Olympic Boulevard. The noise measurement was performed for 30 minutes on April 12, 2007 at 2:06 pm. The measured 30 minute L_{eq} is 66 dBA with a minimum and maximum L_{eq} of 56 dBA and 85 dBA respectively.

30 Minute Leq: 66.2 dBA
Lmax: 85.1 dBA
Lmin: 55.7 dBA

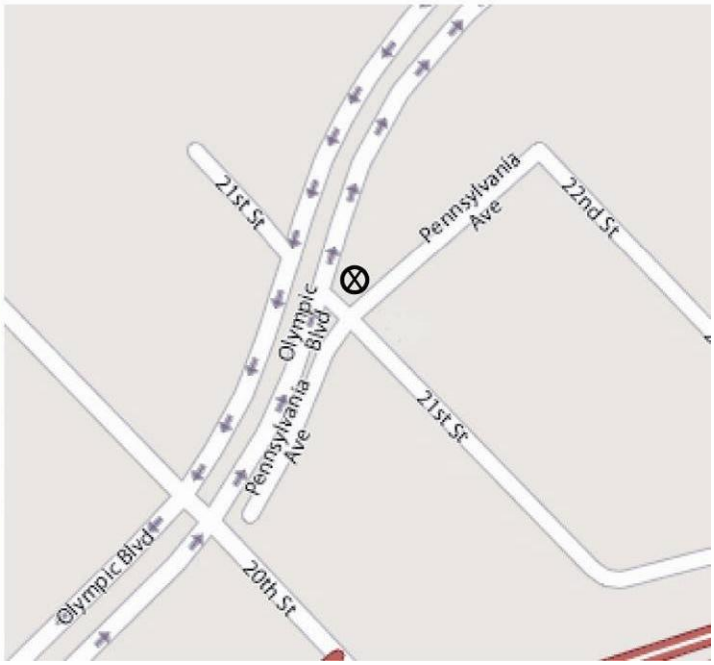


Figure ~~29~~47 Site ST-1, Olympic Boulevard

Short Term Site 2, Exposition Boulevard

The measurement site was located at the intersection of Exposition Boulevard and Westwood Boulevard. The primary noise source in this area is vehicular traffic on Westwood Boulevard. The measurement position was approximately 15 feet from the southeast corner of the intersection. The noise measurement was performed for 30 minutes on April 12, 2007 at 3:18 pm. The measured 30 minute L_{eq} is 67 dBA, with a minimum and maximum L_{eq} of 55 dBA and 81 dBA respectively.

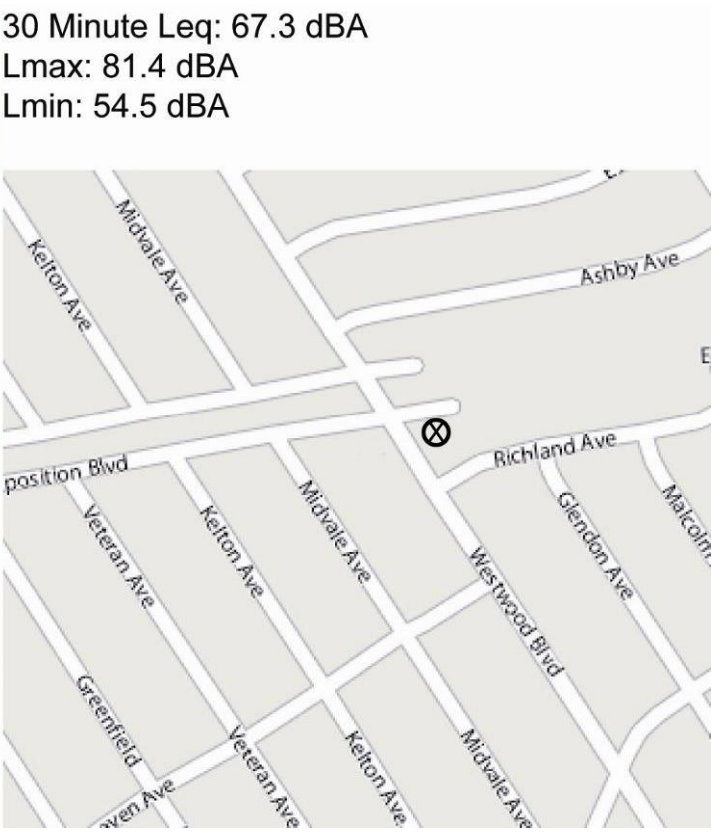


Figure ~~30~~48 Site ST-2, Exposition Boulevard

Short Term Site 3, Overland School

Site ST- 3 was located outside the Overland School, on the east side of Overland Avenue. The primary noise source in this area is vehicular traffic on Overland Avenue. The measurement position was approximately 15 feet Overland Avenue. The noise measurement was performed for 30 minutes on April 12, 2007 at 3:56 pm. The measured 30 minute L_{eq} is 67 dBA, with a minimum and maximum L_{eq} of 57 dBA and 85 dBA respectively.

30 Minute Leq: 67.0 dBA
Lmax: 85.1 dBA
Lmin: 56.5 dBA

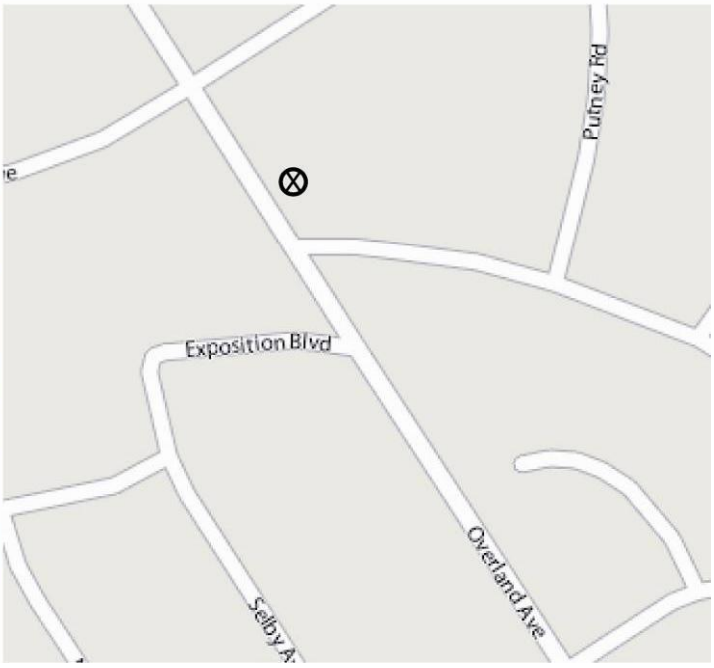
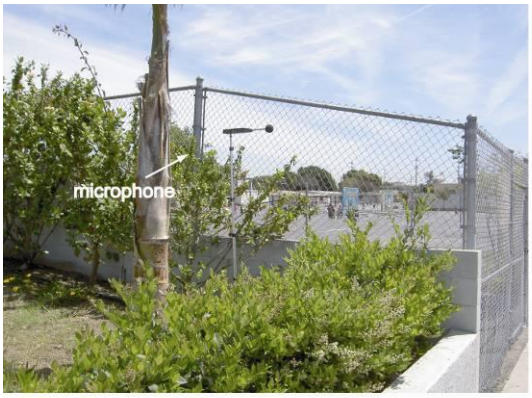


Figure ~~31~~49 Site ST-3, Overland School

Short Term Site 4, Sepulveda Boulevard

The measurement site was located on the east side of Sepulveda Boulevard near just south of Palms Boulevard. The primary noise source in this area is vehicular traffic on Sepulveda Boulevard. The measurement position was 25 feet from the edge of Sepulveda Boulevard. The noise measurement was performed for 30 minutes on April 13, 2007 at 12:53 pm. The measured 30 minute L_{eq} is 70 dBA with a minimum and maximum L_{eq} of 57 dBA and 81 dBA respectively.



30 Minute Leq: 70.0 dBA
Lmax: 80.8 dBA
Lmin: 57.4 dBA

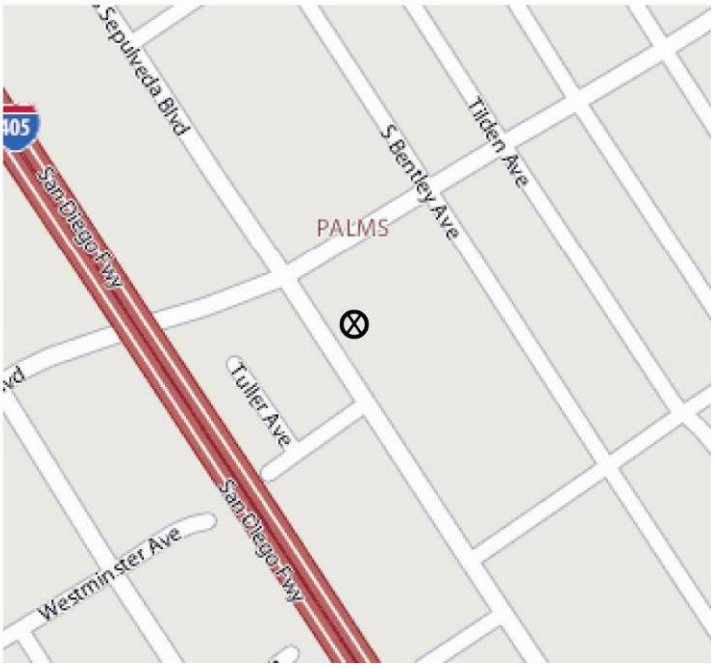


Figure ~~32~~50 Site ST-4, Sepulveda Boulevard

Short Term Site 5, Venice Boulevard

The measurement site was located on the south side of Venice Boulevard near its intersection with Mentone Avenue. The primary noise source in this area is vehicular traffic on Venice Boulevard. The measurement position was 25 feet from the edge of Venice Boulevard. The noise measurement was performed for 30 minutes on April 13, 2007 at 11:22 am. The measured 30 minute L_{eq} is 69 dBA with a minimum and maximum L_{eq} of 52 dBA and 82 dBA respectively.

30 Minute Leq: 68.9 dBA
Lmax: 82.3 dBA
Lmin: 52.3 dBA

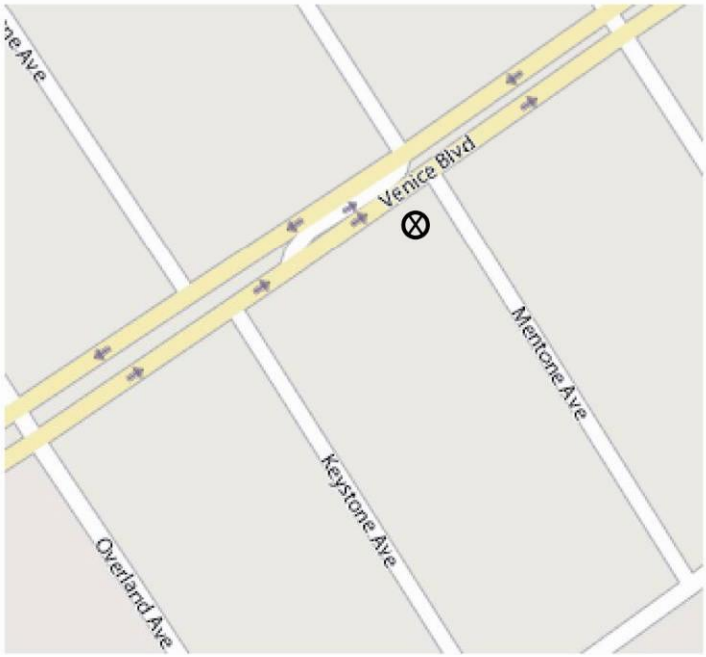


Figure ~~33~~51 Site ST-5, Venice Boulevard

Short Term Site 6, Venice Boulevard

Site ST-6 was located in a parking lot on the north side of Venice Boulevard between Watseka Avenue and Delmas Terrace. The primary noise source in this area is vehicular traffic on Venice Boulevard. The measurement position was 12 feet from the edge of Venice Boulevard. The noise measurement was performed for 30 minutes on April 13, 2007 at 10:32 am. The measured 30 minute L_{eq} is 71 dBA with a minimum and maximum L_{eq} of 50 dBA and 81 dBA respectively.

30 Minute Leq: 70.7 dBA
Lmax: 80.9 dBA
Lmin: 49.8 dBA

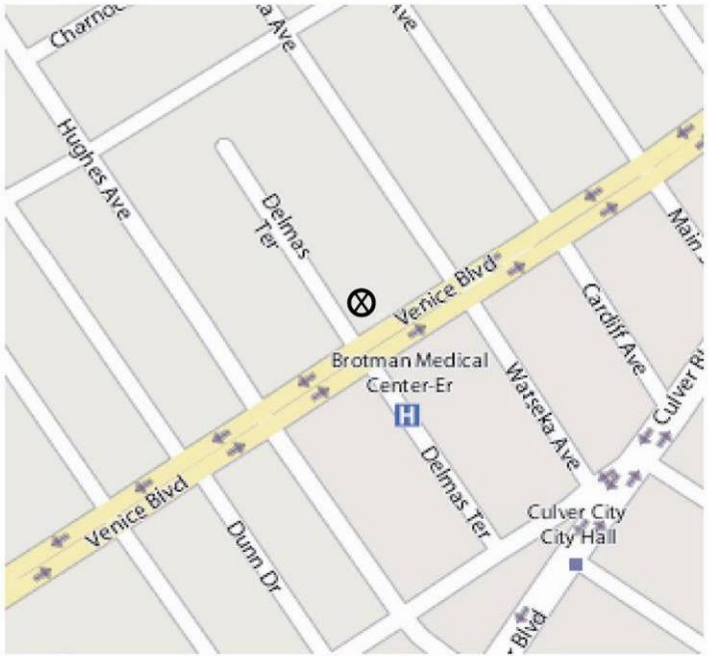


Figure ~~34~~52 Site ST-6, Venice Boulevard

APPENDIX C: VIBRATION MEASUREMENTS RESULTS

C.1 Vibration Propagation Test Sites

Vibration Test Site 1, Exposition Blvd and Watseka Ave

Site V1 was located at the intersection of Exposition Blvd and Watseka Ave, south of I-10. The impact line was along Exposition Blvd. The transducers were installed on the sidewalk of Watseka Blvd at distances of 25 ft, 50 ft, 75 ft, 100 ft, 150 ft, and 200 ft from the impact line.

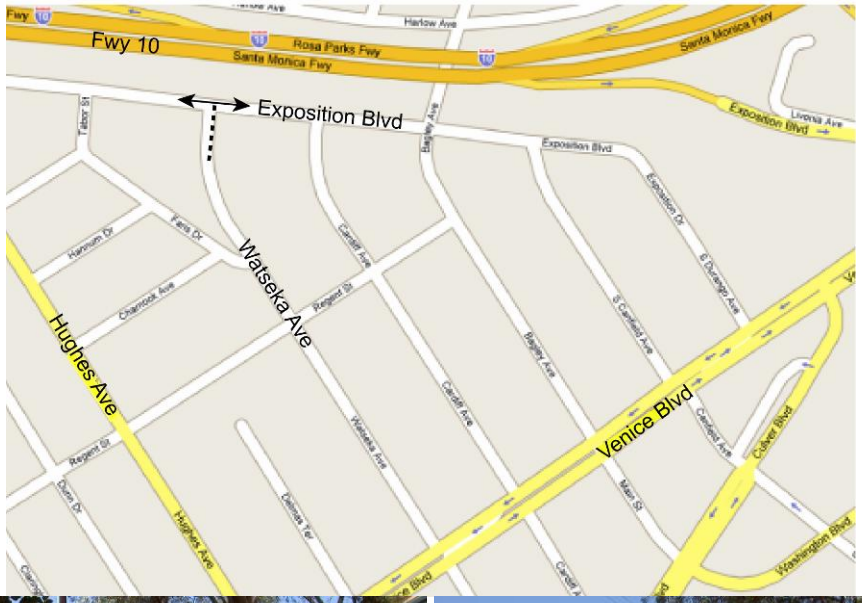


Figure ~~35~~53 Vibration Test Site V1, Exposition and Watseka

Vibration Test Site 2, Cheviot Hills / Northvale Rd

Site V2 was located in the Expo ROW at the bottom of the trench. The impact line was located along the existing tracks and some of the transducers were located on the slope of the eastside embankment abutting Northvale Road. Two transducers were installed across Northvale Road. The transducers were installed at distances of 25 ft, 37.5 ft, 50 ft, 62.5 ft, 75 ft, and 100 ft from the impact line.

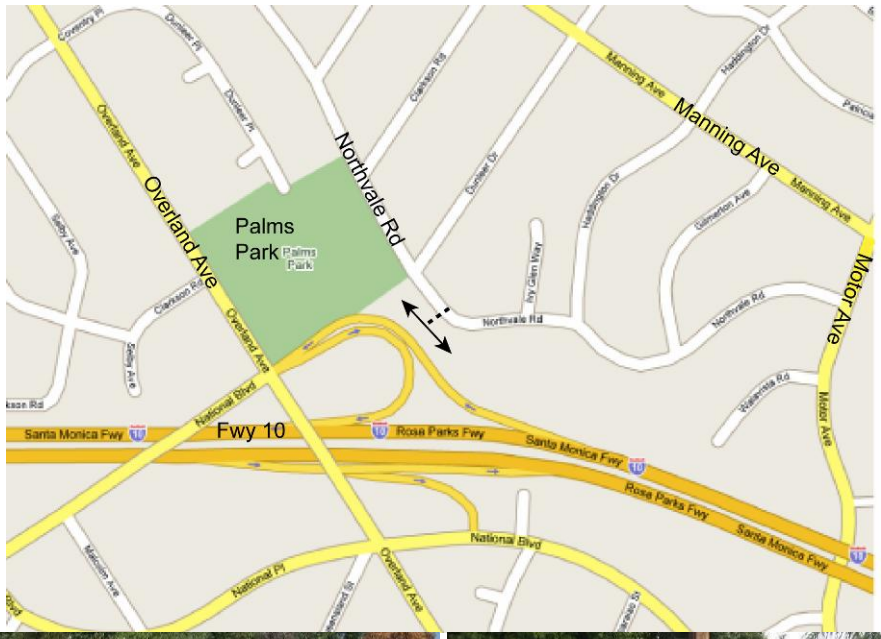


Figure ~~36~~54 Vibration Test Site V2, Northvale Road

Vibration Test Site 3, Palms Park

Site V3 was located in the Expo ROW at the bottom of the trench east of Palms Park. Two transducers were located on the slope of the embankment and four transducers were located in the park. The transducers were at distances of 10 ft, 20 ft, 55 ft, 75 ft, 100 ft, and 150 ft from the impact line.

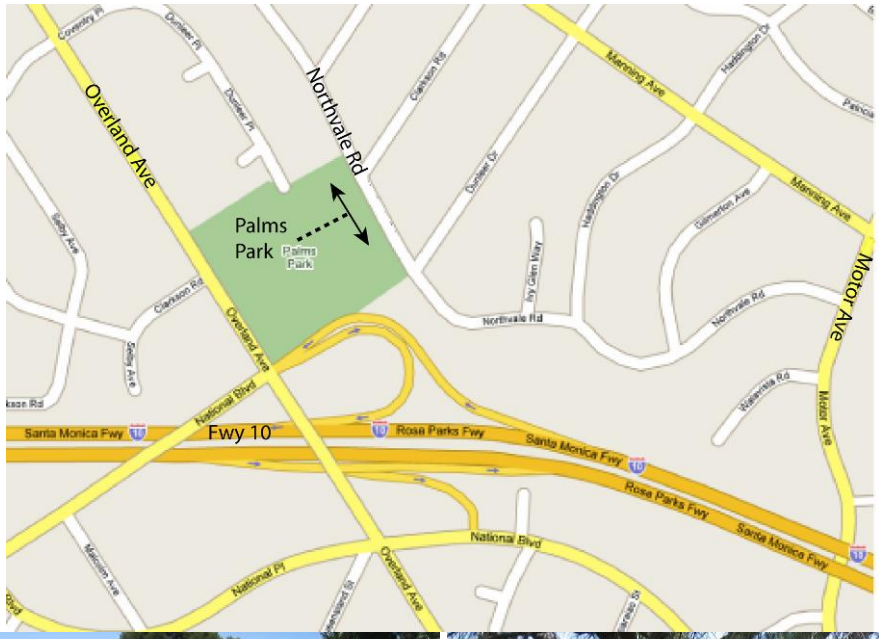


Figure ~~37~~55 Vibration Test Site V3, Palms Park

Vibration Test Site 4, Putney Road (Overland Elementary School)

The impacts for Suite V4 were located in the Expo ROW south of Overland School. The transducers were installed along Putney Road at distances of 25 ft, 50 ft, 60 ft, 105 ft, 150 ft, and 200 ft from the impact line.

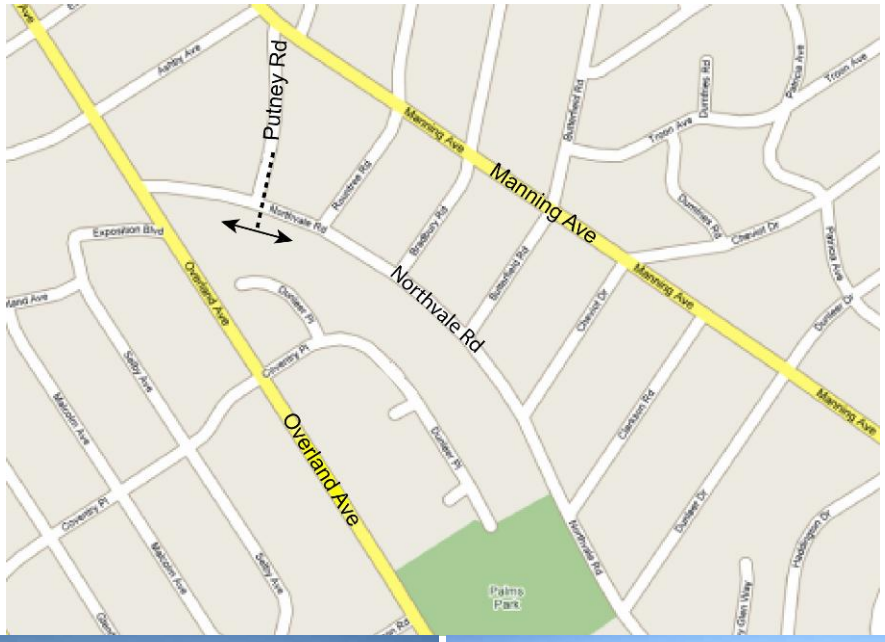


Figure ~~38~~56 Vibration Test Site V4, Putney Road

Vibration Test Site 5, Westwood Boulevard

This measurement was located in the Expo ROW west of Westwood Boulevard. The transducers were located in an alley perpendicular to the impact line at distances of 25 ft, 50 ft, 75 ft, 90 ft, 140 ft, and 180 ft.

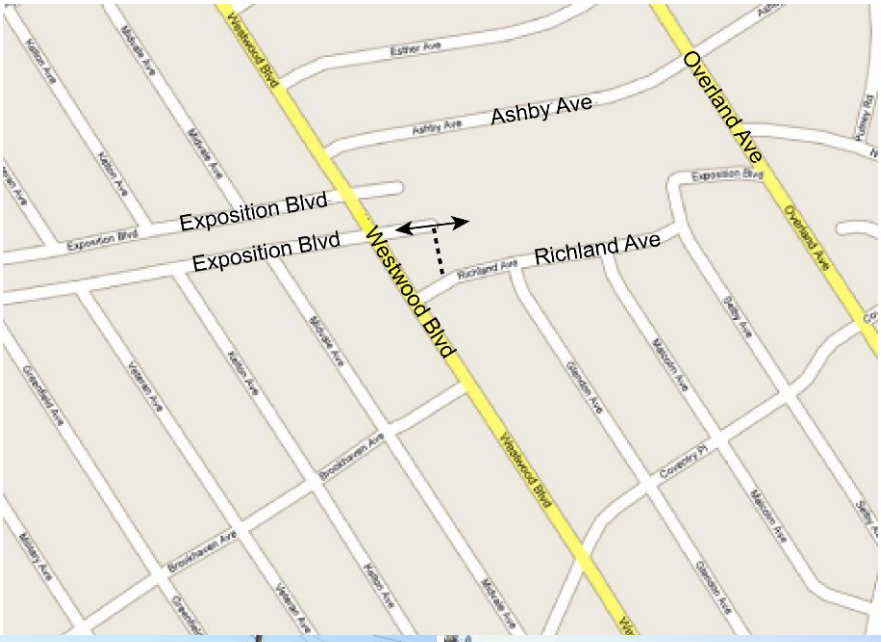


Figure ~~39~~57 Vibration Test Site V5, Westwood Boulevard

Vibration Test Site 6A, Westgate Avenue

This site was located between Bundy Drive and Barrington Avenue. The impact line was along Exposition Blvd and the transducers were mounted on the pavement of Westgate Avenue. The transducers were located at 25 ft, 50 ft, 75 ft, 100 ft, 150 ft, and 200 ft from the impact line.

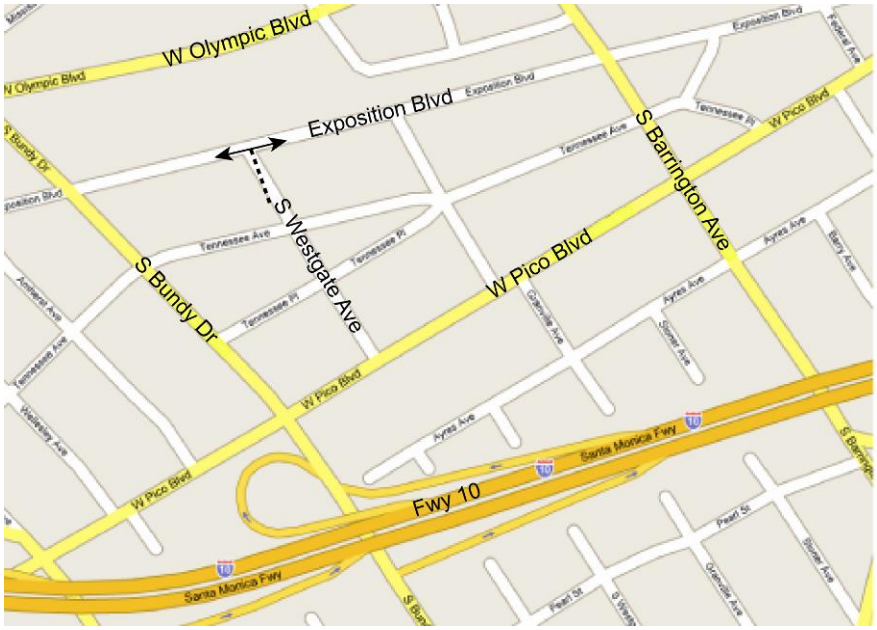


Figure ~~40~~58 Vibration Test Site V6A, Westgate Avenue

Vibration Test Site 6B, Granville Avenue

Site V6B was located one block east of Site V6A. The impact line was along Exposition Boulevard and the transducers were mounted on the pavement of Granville Avenue. The transducers were mounted at 25 ft, 50 ft, 75 ft, 100 ft, 150 ft, and 200 ft from the impact line. The reason for this test was to verify the results from Site V6A.

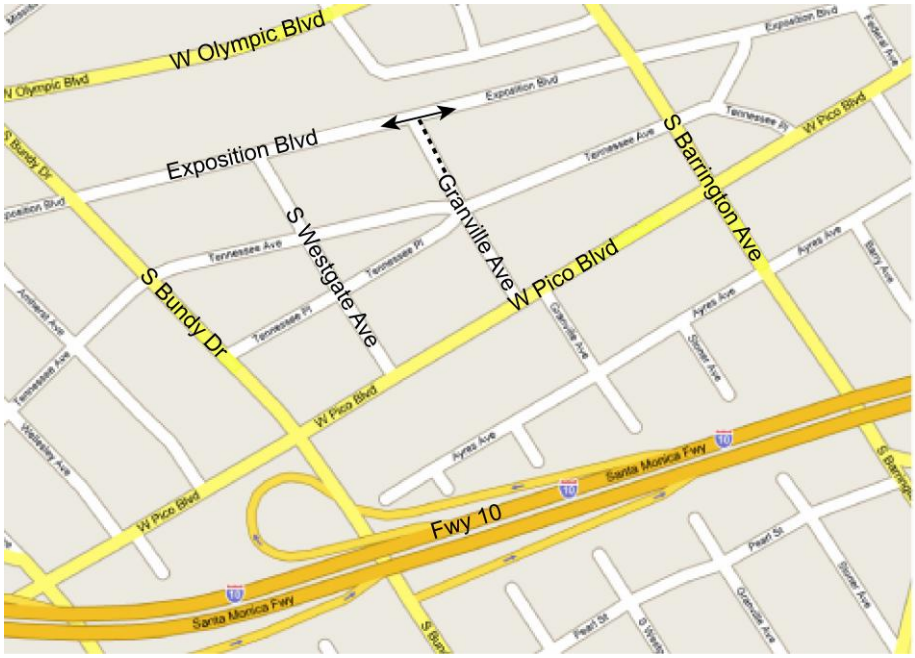


Figure ~~41~~59 Vibration Test Site V6B, Granville Avenue

Vibration Test Site 7, Olympic Boulevard and 18th Avenue

Site V7 was located at Olympic Avenue adjacent to the Crossroads School at 18th Avenue. The impact line was along Olympic Avenue and the transducers were mounted on the pavement of 18th Avenue at distances of 25 ft, 50 ft, 75 ft, 100 ft, 150 ft, and 200 ft from the impact line.

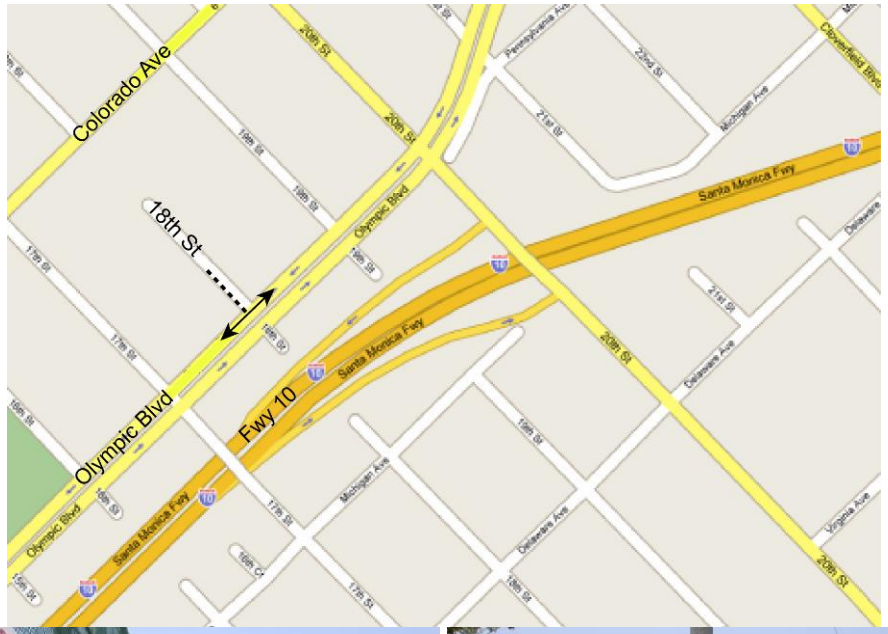


Figure 4260 Vibration Test Site V7, Olympic Boulevard and 18th Avenue

Vibration Test Site 8, Venice Boulevard and Spad Place

This measurement site was on Venice Blvd west of Overland Avenue. The impact line was on Venice Blvd and the transducers were installed on the pavement of Spad Place. The transducers were 25 ft, 50 ft, 75 ft, 100 ft, 155 ft, and 200 ft from the impact line.

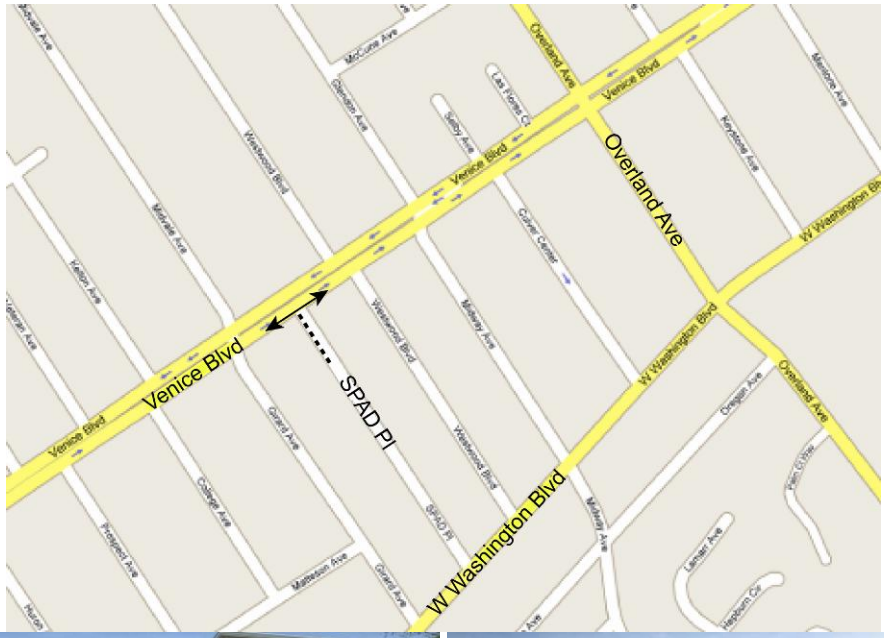
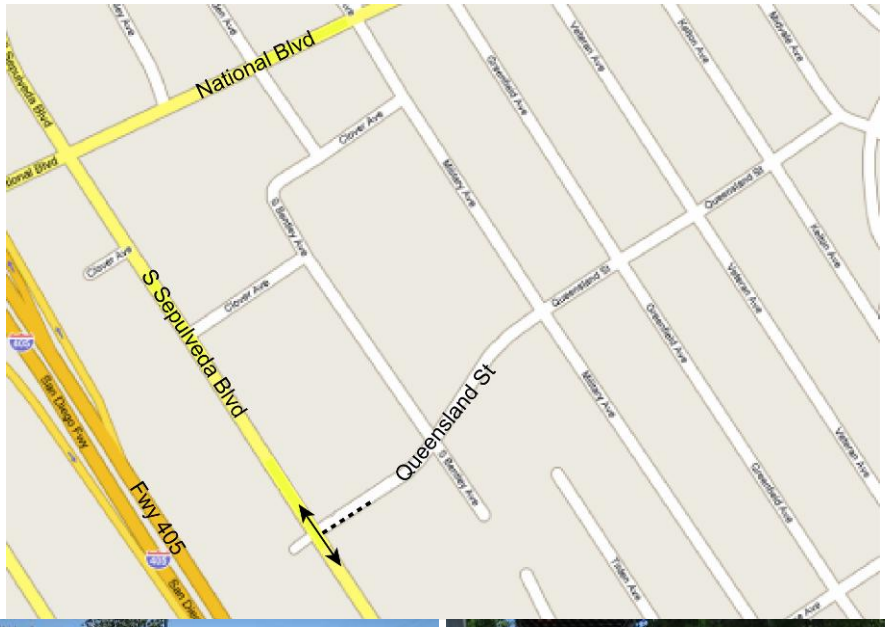
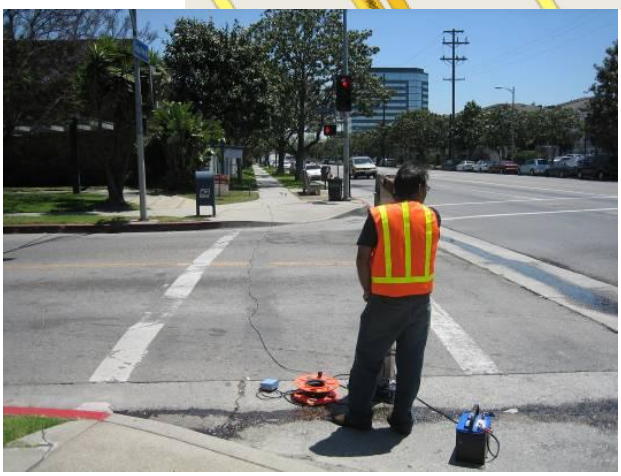


Figure 4361 Vibration Test Site V8, Venice Boulevard and Spad Place

Vibration Test Site 9, Sepulveda Boulevard and Queensland Street

Site V9 was at Sepulveda and Queensland Street. The impact line was on the east side of Sepulveda and the transducers were mounted on Queensland Street at 25 ft, 50 ft, 75 ft, 100 ft, 150 ft and 200 ft from the impact line.





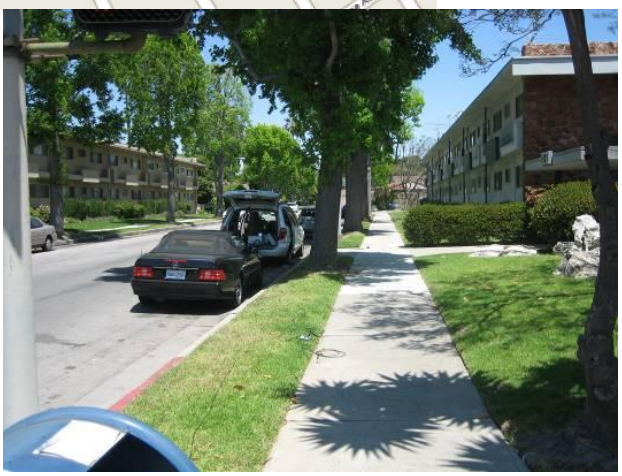


Figure 4462 Vibration Test Site V9, Sepulveda Boulevard and Queensland Street

Vibration Test Site 10, Colorado Avenue and 12th Court

Site V10 was on the north side of Colorado Avenue halfway between 12th Street and Euclid Street. The impact line was along the curb of Colorado Avenue and the transducers were mounted along 12th Court at 25 ft, 50 ft, 75 ft, 100 ft, 150 ft and 200 ft from the impact line.

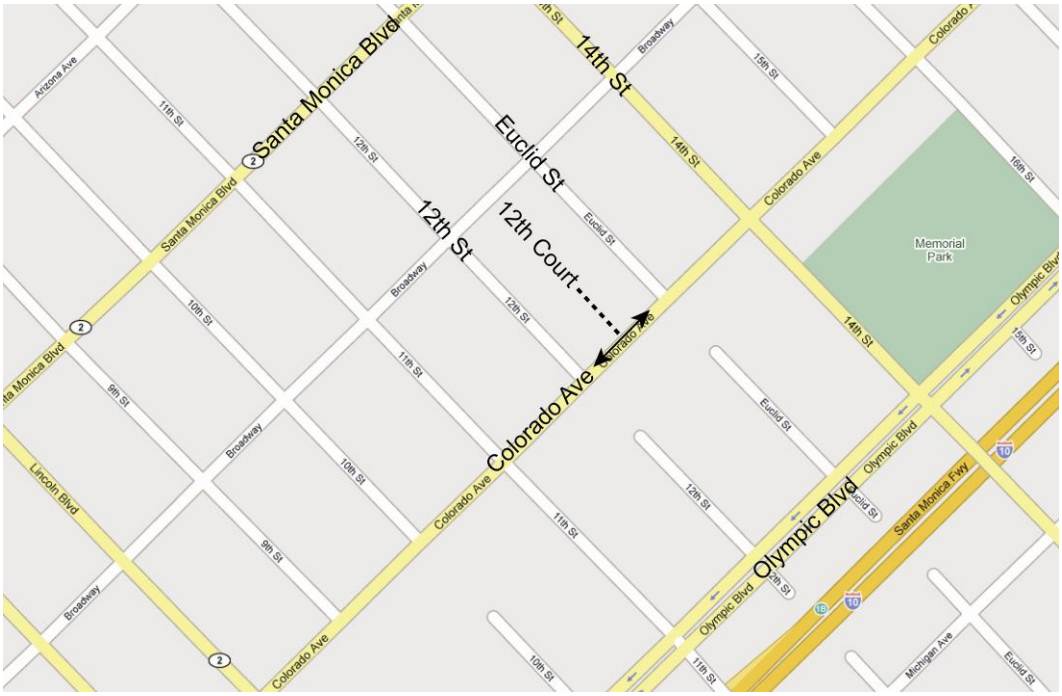
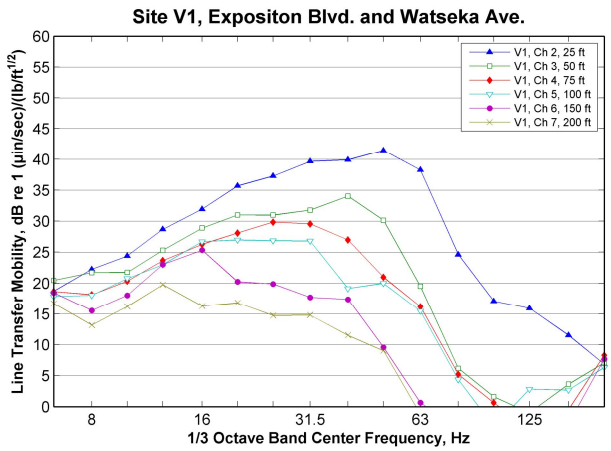
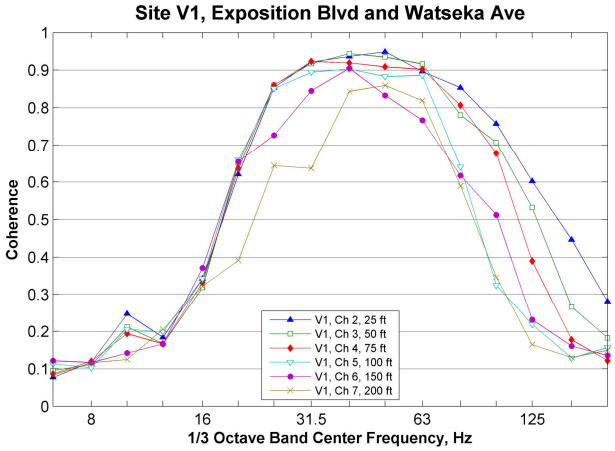


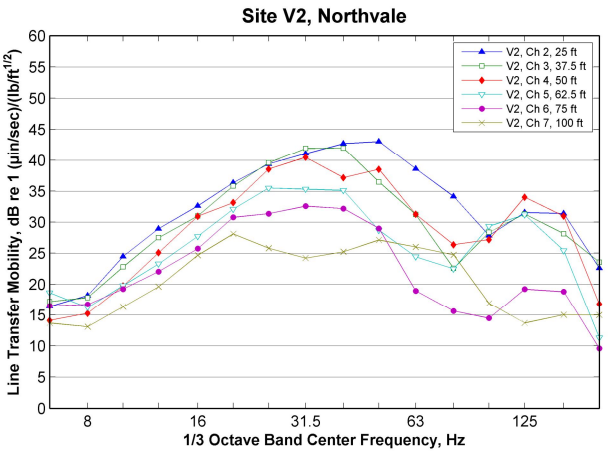
Figure ~~45~~63 Vibration Test Site V10, Colorado Avenue ~~and Queensland~~ 12th Court

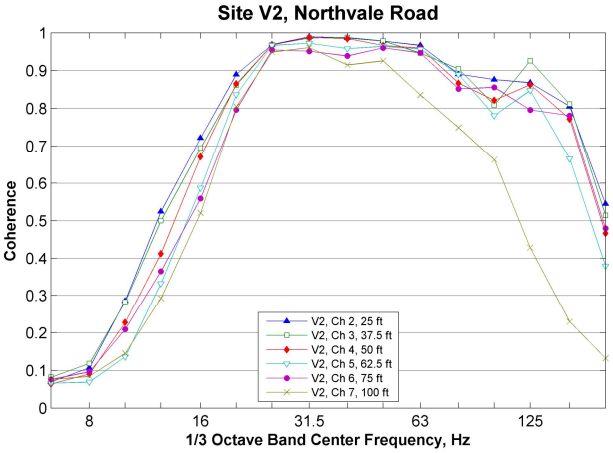
C.2 Vibration Propagation Test Results

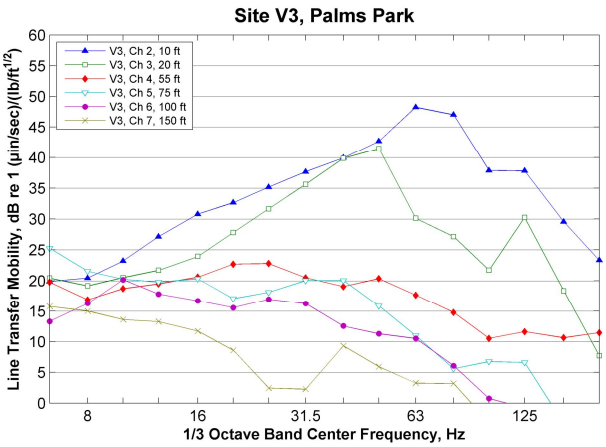
The following figures show the line-source transfer mobility measured at each of the vibration propagation test sites. The transfer mobility curves are on the left and the corresponding coherence curves are on the right. Coherence is a measure of the data "quality." When the coherence is close to 1, there is a strong relationship between the exciting force and the measured ground vibration. When the coherence is close to zero, there is little or no relationship between the exciting force and the measured ground vibration. When the coherence is low, the measured transfer mobility represents an "upper limit" estimate of the transfer mobility. In these cases, the transfer mobility is defined by background vibration that was higher than the vibration created by the impact force.

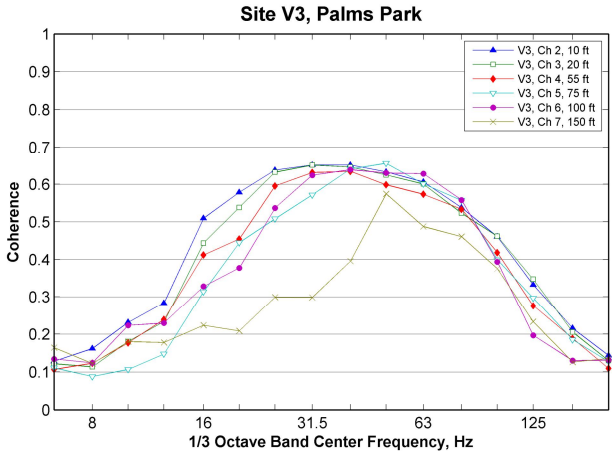


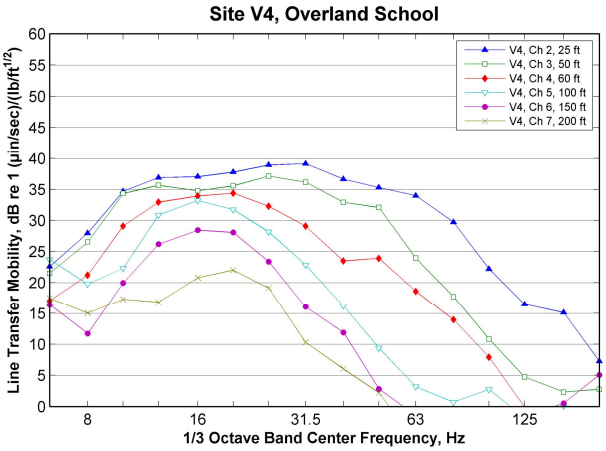


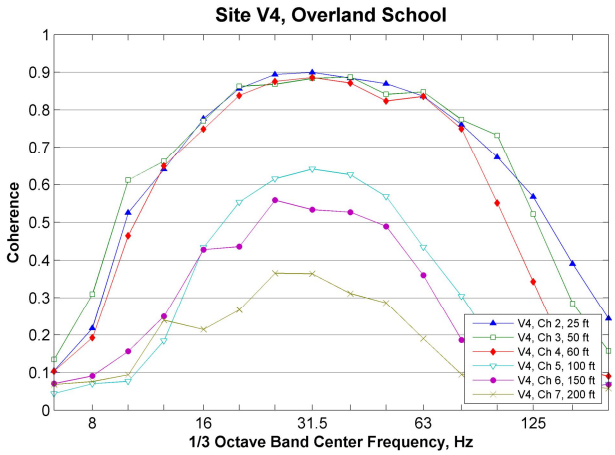


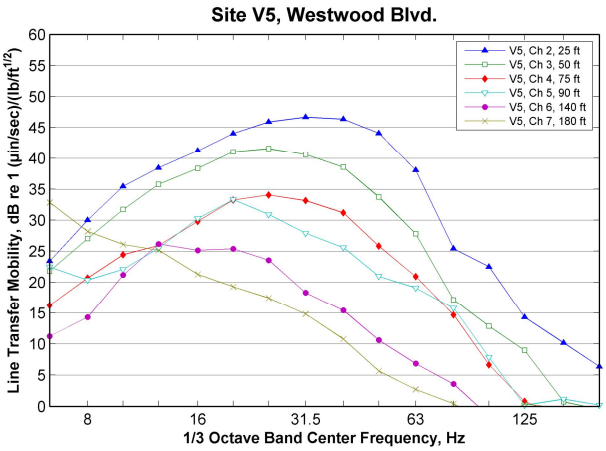


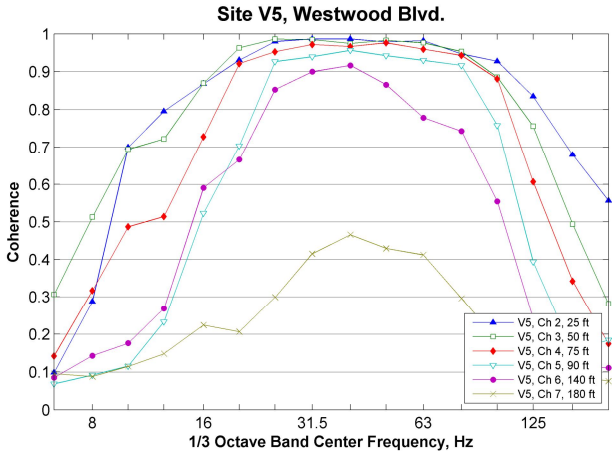

Site V3, Palms Park
Line Transfer Mobility, dB re 1 (µin/sec)/(lb/ft^1/2)
1/3 Octave Band Center Frequency, Hz
V3, Ch 2, 10 ft
V3, Ch 3, 20 ft
V3, Ch 4, 55 ft
V3, Ch 5, 75 ft
V3, Ch 6, 100 ft
V3, Ch 7, 150 ft

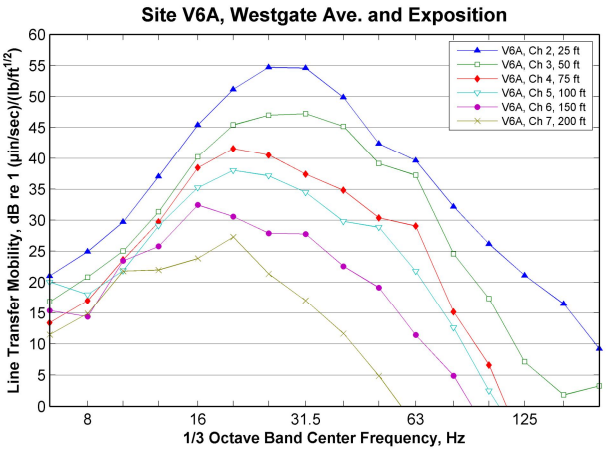

Site V3, Palms Park
Coherence
1/3 Octave Band Center Frequency, Hz
V3, Ch 2, 10 ft
V3, Ch 3, 20 ft
V3, Ch 4, 55 ft
V3, Ch 5, 75 ft
V3, Ch 6, 100 ft
V3, Ch 7, 150 ft

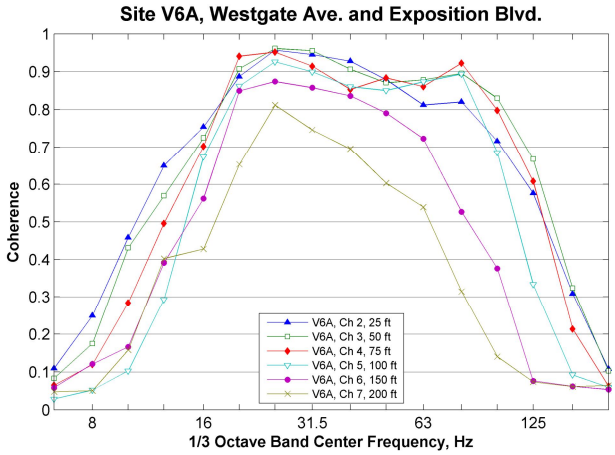

Site V4, Overland School
Line Transfer Mobility, dB re 1 (µin/sec)/(lb/ft^1/2)
1/3 Octave Band Center Frequency, Hz
V4, Ch 2, 25 ft
V4, Ch 3, 50 ft
V4, Ch 4, 60 ft
V4, Ch 5, 100 ft
V4, Ch 6, 150 ft
V4, Ch 7, 200 ft

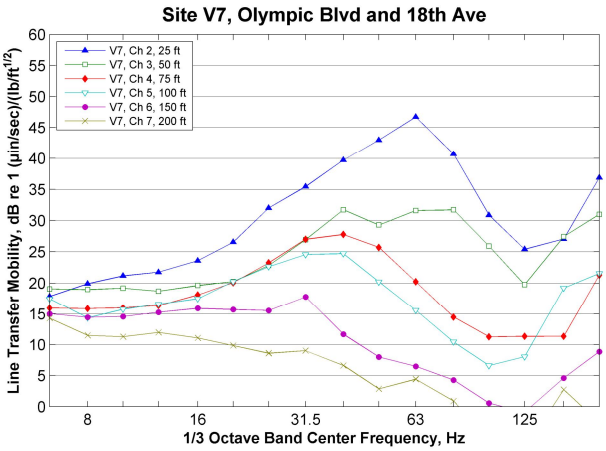

Site V4, Overland School
Coherence
1/3 Octave Band Center Frequency, Hz
V4, Ch 2, 25 ft
V4, Ch 3, 50 ft
V4, Ch 4, 60 ft
V4, Ch 5, 100 ft
V4, Ch 6, 150 ft
V4, Ch 7, 200 ft

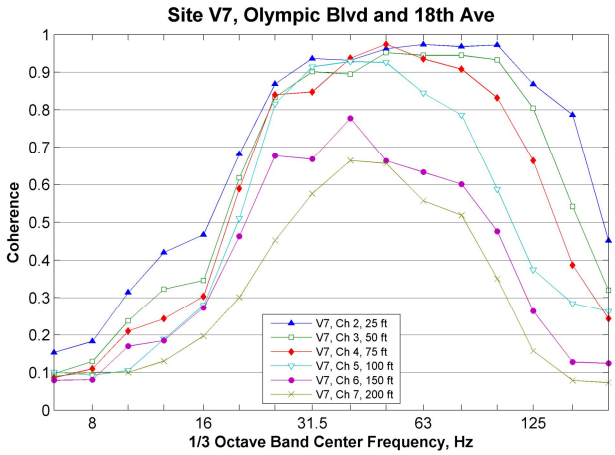

Site V5, Westwood Blvd.
Line Transfer Mobility, dB re 1 (µin/sec)/(lb/ft^1/2)
1/3 Octave Band Center Frequency, Hz
V5, Ch 2, 25 ft
V5, Ch 3, 50 ft
V5, Ch 4, 75 ft
V5, Ch 5, 90 ft
V5, Ch 6, 140 ft
V5, Ch 7, 180 ft

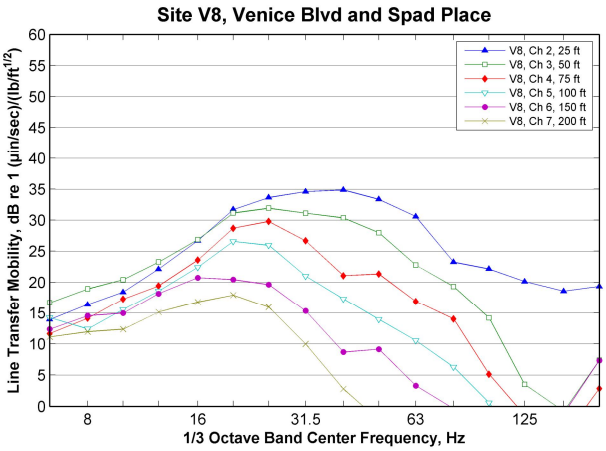

Site V5, Westwood Blvd.
Coherence
1/3 Octave Band Center Frequency, Hz
V5, Ch 2, 25 ft
V5, Ch 3, 50 ft
V5, Ch 4, 75 ft
V5, Ch 5, 90 ft
V5, Ch 6, 140 ft
V5, Ch 7, 180 ft

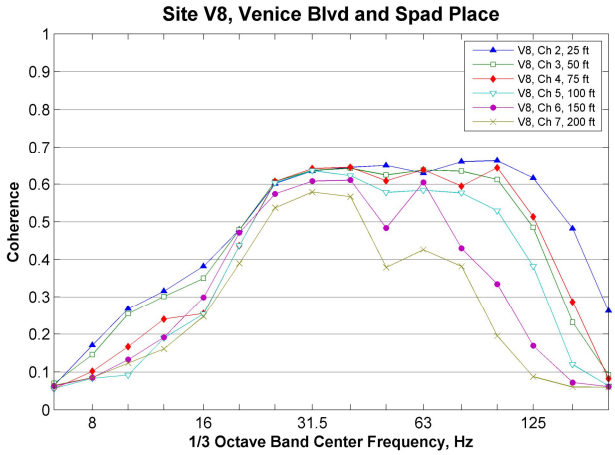

Site V6A, Westgate Ave. and Exposition
Line Transfer Mobility, dB re 1 (µin/sec)/(lb/ft^1/2)
1/3 Octave Band Center Frequency, Hz
V6A, Ch 2, 25 ft
V6A, Ch 3, 50 ft
V6A, Ch 4, 75 ft
V6A, Ch 5, 100 ft
V6A, Ch 6, 150 ft
V6A, Ch 7, 200 ft

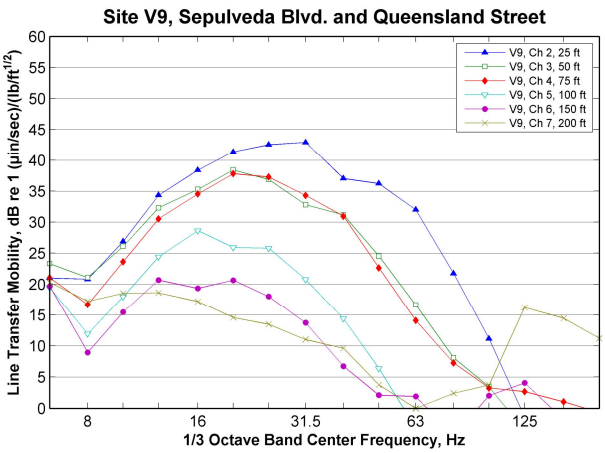

Site V6A, Westgate Ave. and Exposition Blvd.
Coherence
1/3 Octave Band Center Frequency, Hz
V6A, Ch 2, 25 ft
V6A, Ch 3, 50 ft
V6A, Ch 4, 75 ft
V6A, Ch 5, 100 ft
V6A, Ch 6, 150 ft
V6A, Ch 7, 200 ft

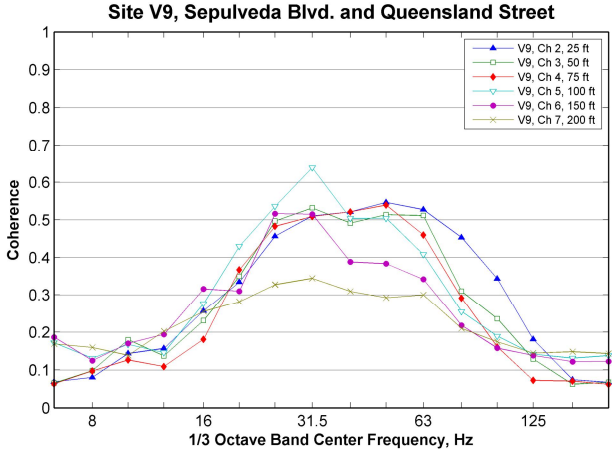

Site V7, Olympic Blvd and 18th Ave
Line Transfer Mobility, dB re 1 (µin/sec)/(lb/ft^1/2)
1/3 Octave Band Center Frequency, Hz
V7, Ch 2, 25 ft
V7, Ch 3, 50 ft
V7, Ch 4, 75 ft
V7, Ch 5, 100 ft
V7, Ch 6, 150 ft
V7, Ch 7, 200 ft

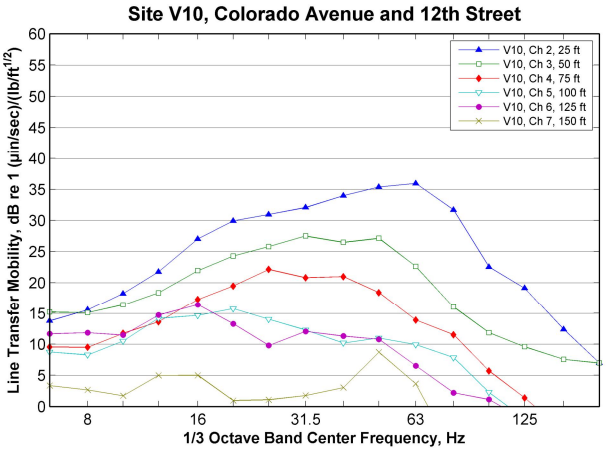

Site V7, Olympic Blvd and 18th Ave
Coherence
1/3 Octave Band Center Frequency, Hz
V7, Ch 2, 25 ft
V7, Ch 3, 50 ft
V7, Ch 4, 75 ft
V7, Ch 5, 100 ft
V7, Ch 6, 150 ft
V7, Ch 7, 200 ft

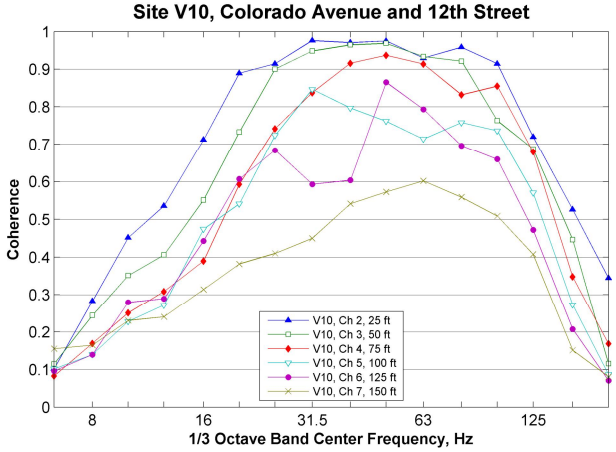

Site V8, Venice Blvd and Spad Place
Line Transfer Mobility, dB re 1 (µin/sec)/(lb/ft^1/2)
1/3 Octave Band Center Frequency, Hz
V8, Ch 2, 25 ft
V8, Ch 3, 50 ft
V8, Ch 4, 75 ft
V8, Ch 5, 100 ft
V8, Ch 6, 150 ft
V8, Ch 7, 200 ft


Site V8, Venice Blvd and Spad Place
Coherence
1/3 Octave Band Center Frequency, Hz
V8, Ch 2, 25 ft
V8, Ch 3, 50 ft
V8, Ch 4, 75 ft
V8, Ch 5, 100 ft
V8, Ch 6, 150 ft
V8, Ch 7, 200 ft









C.3 Force Density Measurements

The force density used for the vibration predictions was developed from measurements of Gold Line operations in the Historic Cornfield State Park just north of the Chinatown Station. Following is a summary of the procedures used to derive a representative LRT force density at two test locations, one at standard tangent track and the second directly perpendicular to a crossover:

1. LRT vibration was measured at seven distances ranging from 35 ft to 160 ft from the tracks.
2. The average LRT vibration at each measurement position was determined on a 1/3 octave band basis over the 5 Hz to 250 Hz frequency range. The process was to inspect graphs of the vibration time histories for each channel, eliminate the trains that were slower than normal, calculate the maximum 1-second rms value for each passby, and then average the 1-second rms values for each measurement position.
3. Transfer mobility using an impact line source was measured at the two LRT test sites. Impacts were performed at 11 locations at 15-foot intervals for a total line length of 150

feet. The same accelerometer positions were used for both the LRT vibration measurements and the transfer mobility measurements.

4. At each accelerometer position, the line of point-source transfer mobility measurements was combined into a single line-source transfer mobility. This was done on a 1/3 octave band basis, so the result is a series of line source transfer mobility spectrums.
5. The force density at each measurement position was calculated as the difference between the measured LRT vibration and the line transfer mobility. The result is a series of force density estimates which were averaged to provide a single force density spectrum for each of the test sites. Data points that were clearly spurious, typically at the more distant measurement positions, were deleted prior to the averaging.

The measured line transfer mobilities at the two sites are shown in Figure ~~46~~64 (Line Transfer Mobilities at Cornfield Test Sites). The trends show an expected decrease in transfer mobility with increasing distance.

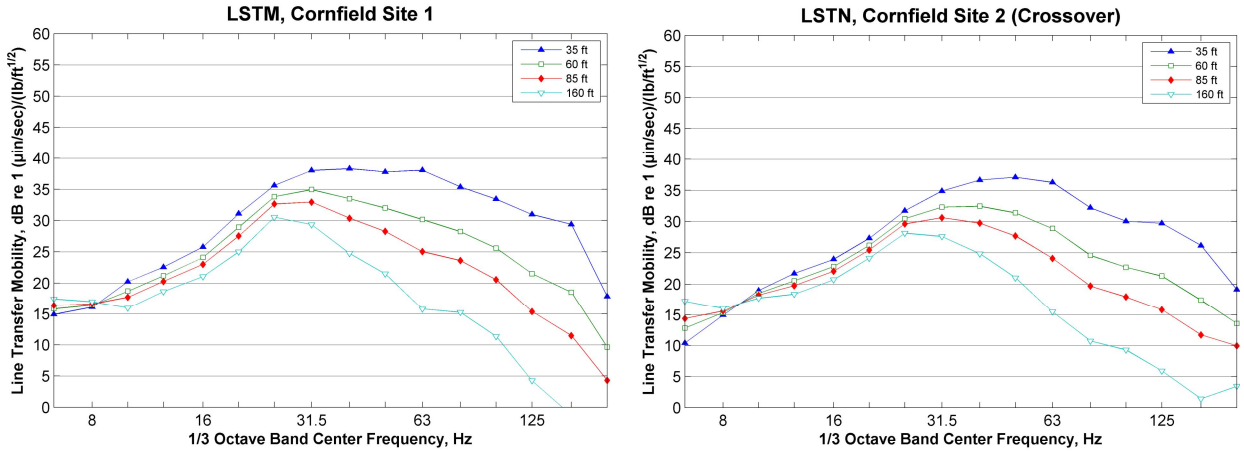


Figure ~~46~~64 Line Transfer Mobilities at Cornfield Test Sites

LRT vibration was measured at the same sites as the transfer mobility measurements. Measurements were taken at 35 ft, 60 ft, 85 ft and 160 ft from the near track centerline at both of the sites. A total of six trains each were measured at both of the sites at an average speed of 50 mph. The impact line was located 10 feet from the near track centerline.

The average vibration velocity spectra are presented in Figure ~~47~~65 (LRT Vibration, Site 1 [Cornfield]). The two measurement locations are close to each other and the difference is due to the crossover at Site 2.

The force density estimates derived from the LRT passby and the transfer mobility measurements are presented in Figure ~~49~~67 (Final FLDs used for Vibration Impact Assessment). The figure shows at the Cornfield State Historic Park for standard track (Site 1) and for a crossover (Site 2). For comparison purposes, a force density curve that was measured at the Trimet Light-Rail System in Portland is also shown at a speed of 50 mph.

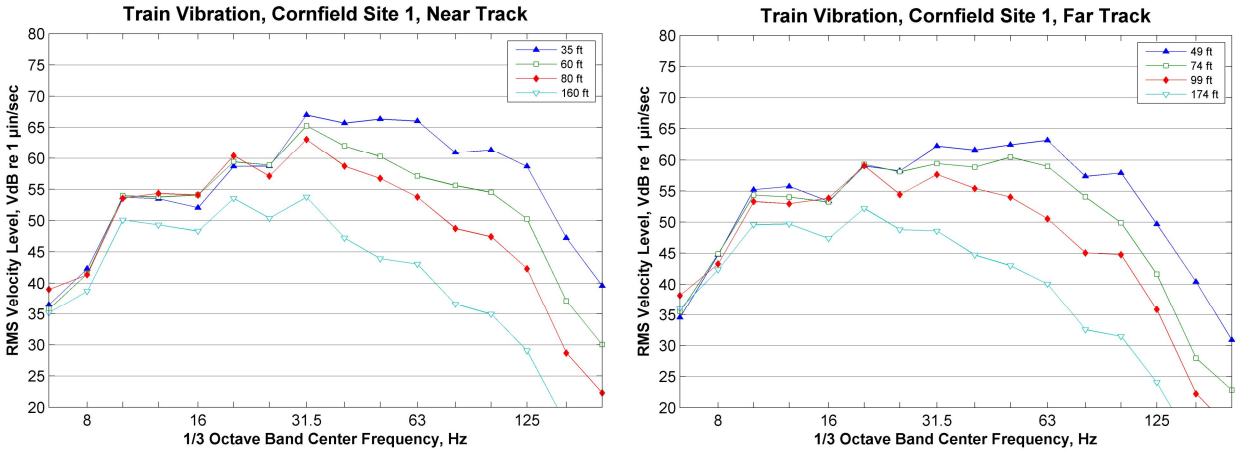


Figure ~~47~~65 LRT Vibration, Site 1 (Cornfield)

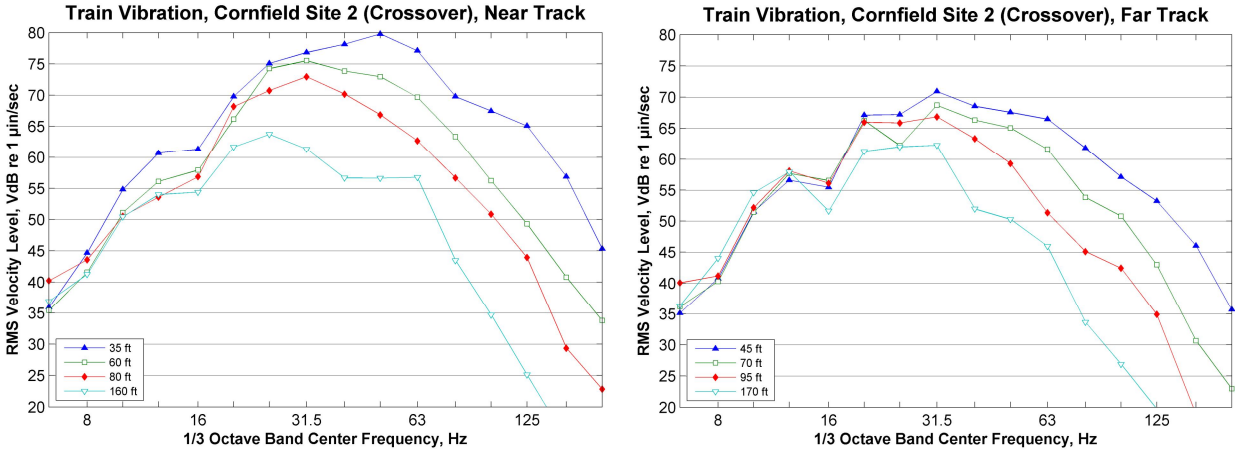


Figure ~~48~~66 LRT Vibration, Site 2 Near Track (Cornfield Crossover)

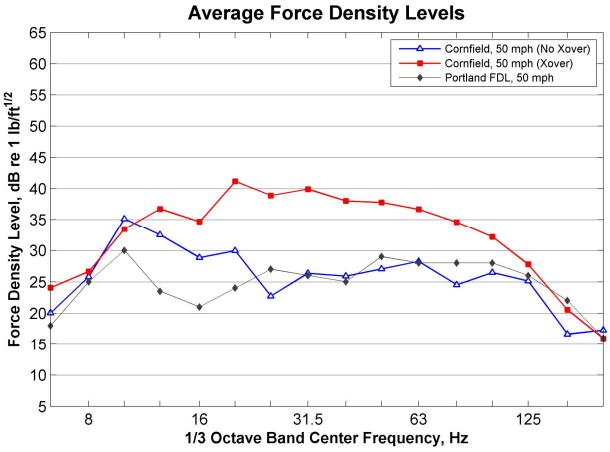


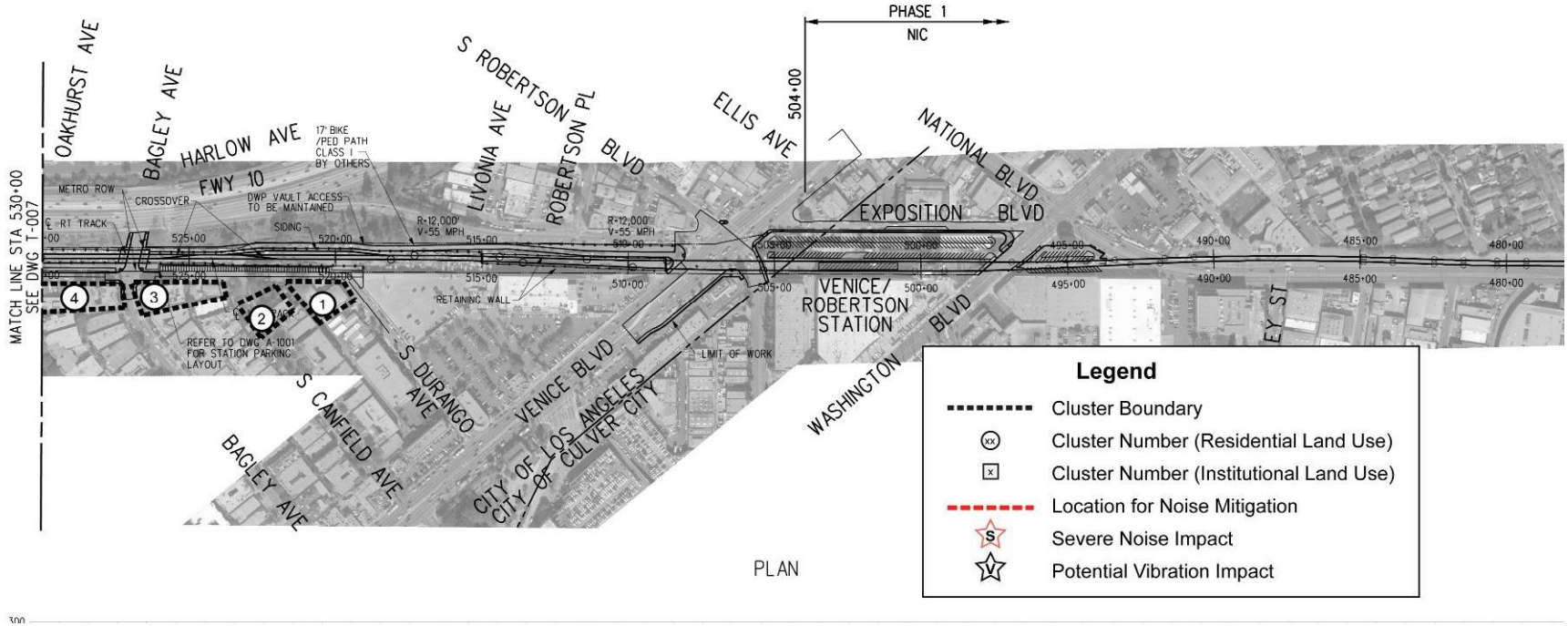
Figure ~~49~~67 Final FLDs used for Vibration Impact Assessment

APPENDIX D: SENSITIVE RECEPTORS AND IMPACT LOCATIONS

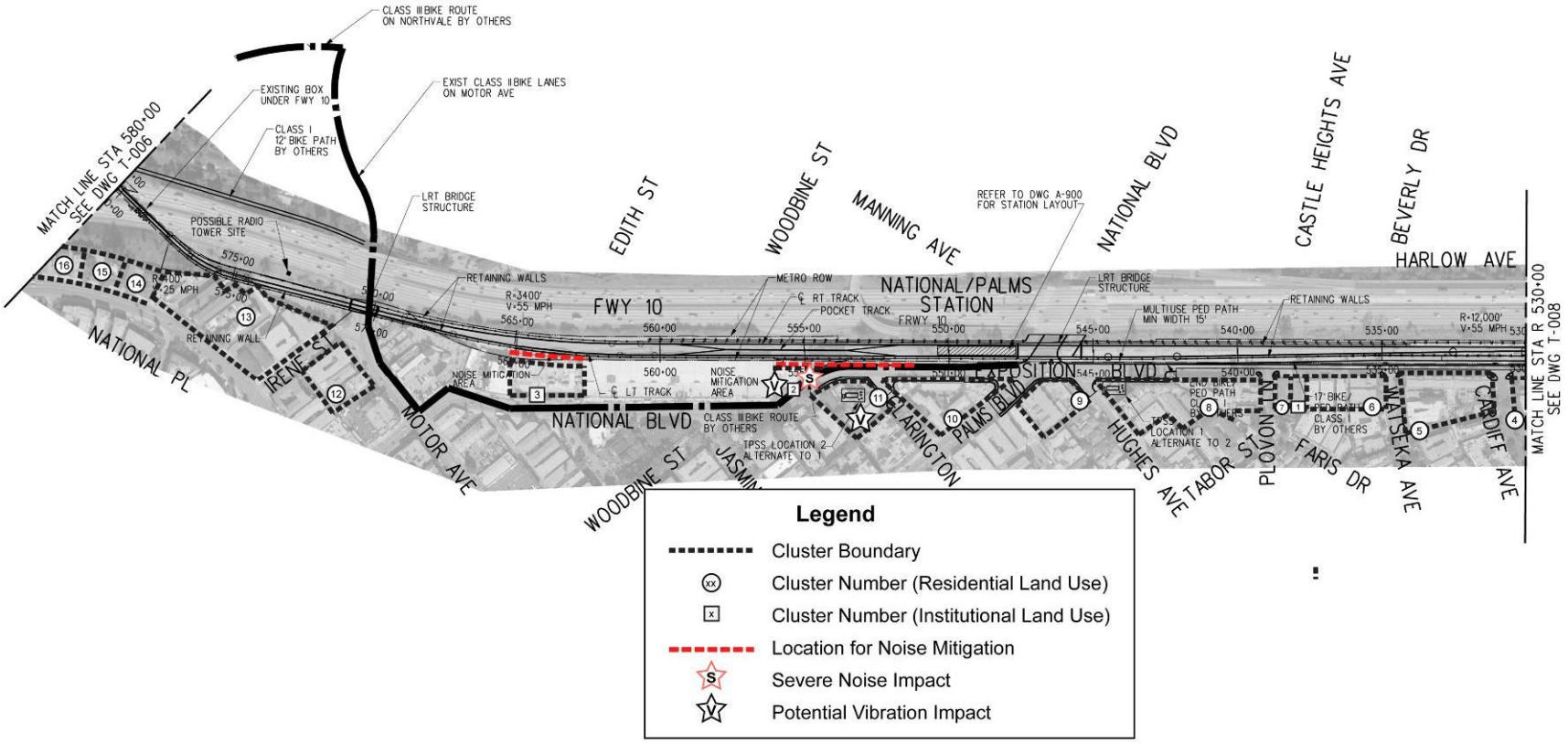
The following figures show the clusters of sensitive receptors used for the noise and vibration analysis, the locations where the predicted noise levels exceed the impact thresholds, and the locations where the predicted vibration levels exceed the vibration impact thresholds.

D.1 Segment 1

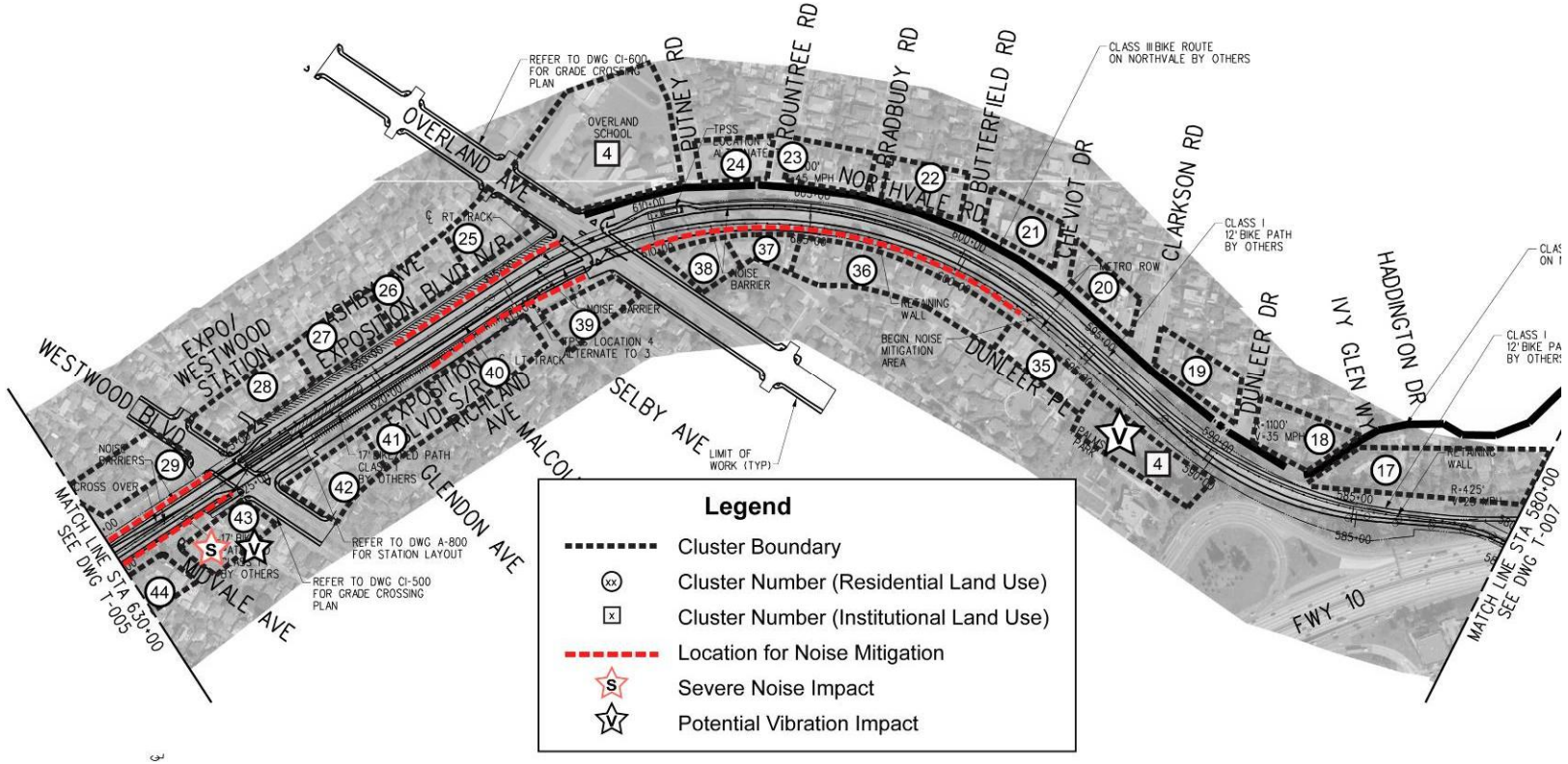
Segment 1: Robertson to Cardiff



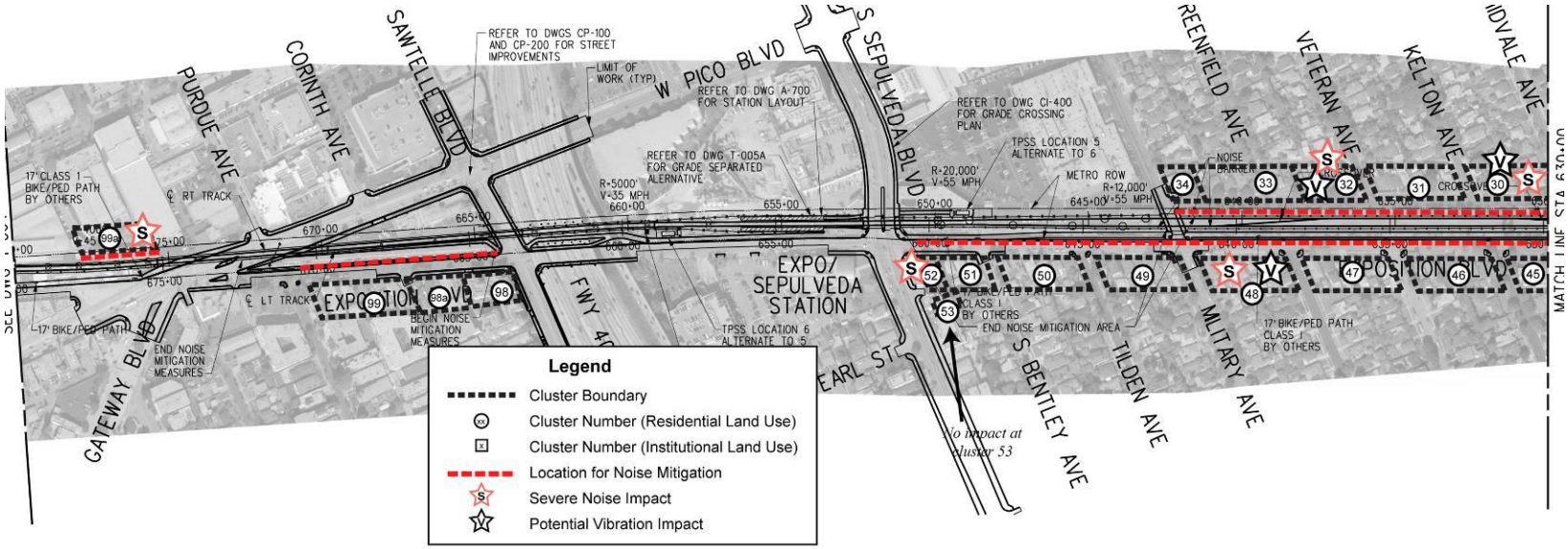
Segment 1: Cardiff to Santa Monica Freeway



Segment 1: Santa Monica Freeway to Midvale

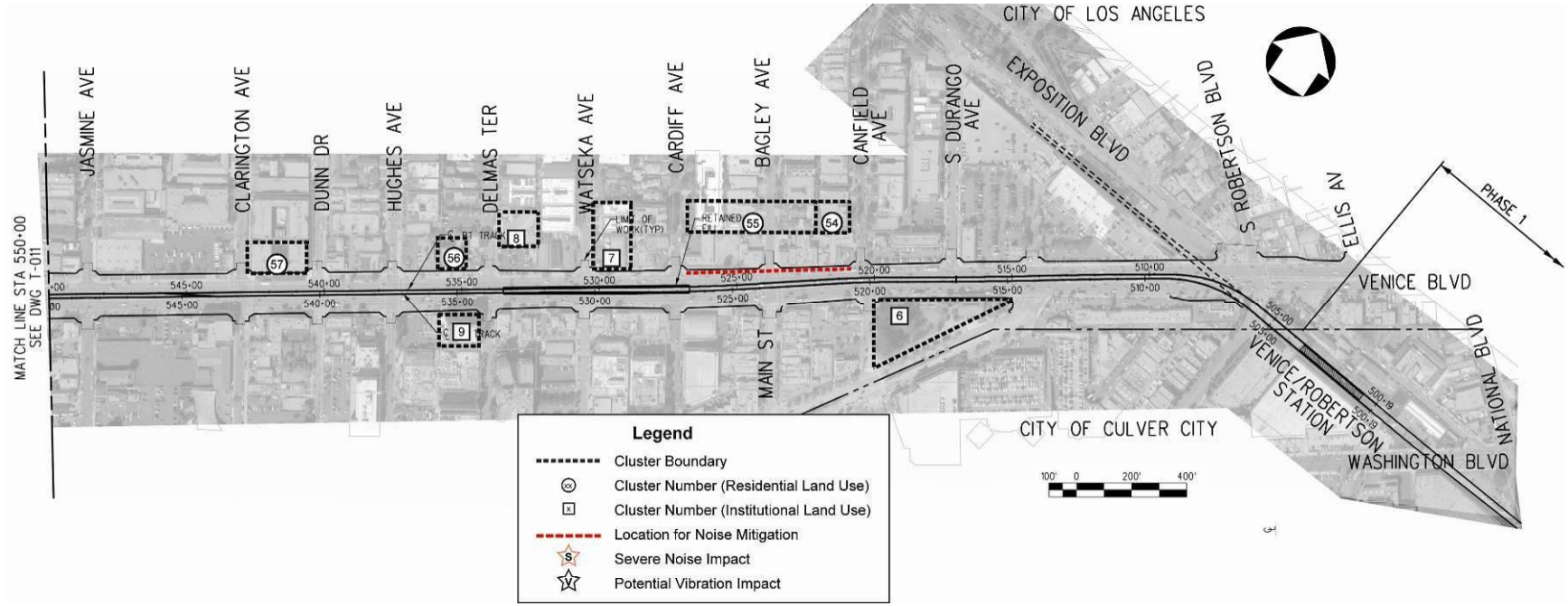


Segment 1: Midvale to Gateway Blvd.

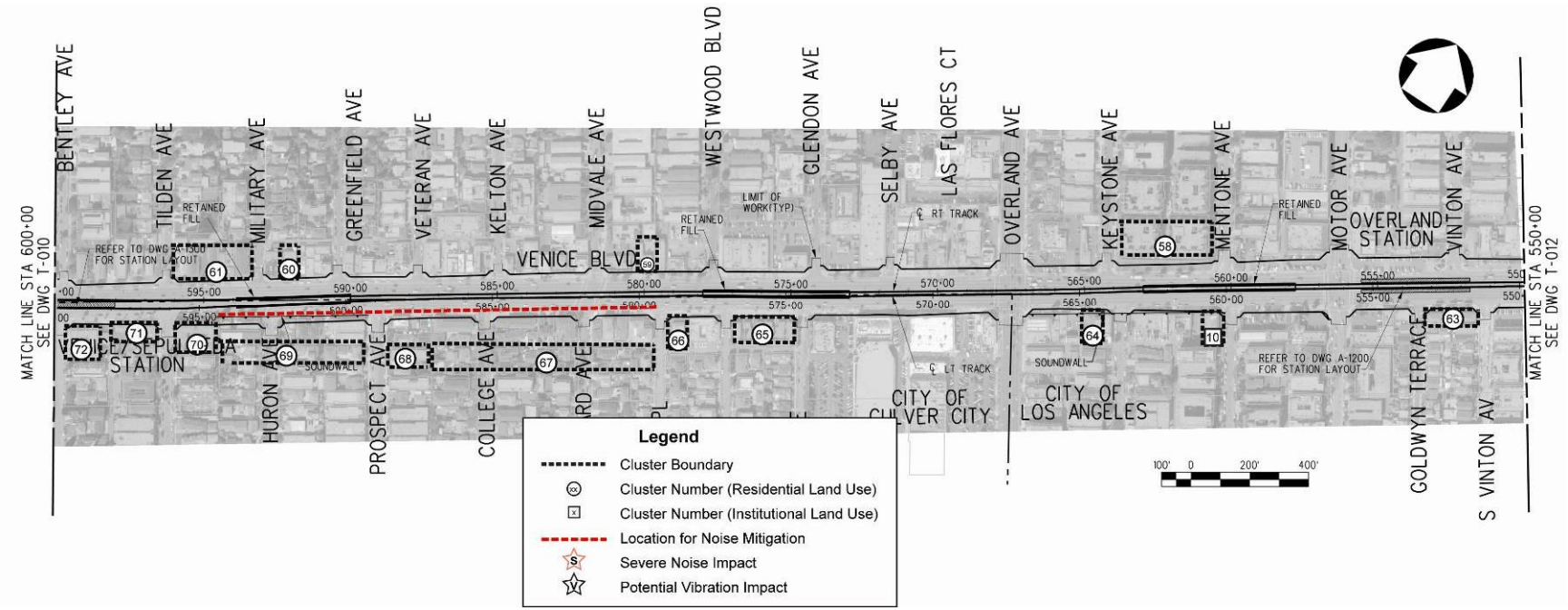


D.2 Segment 1a

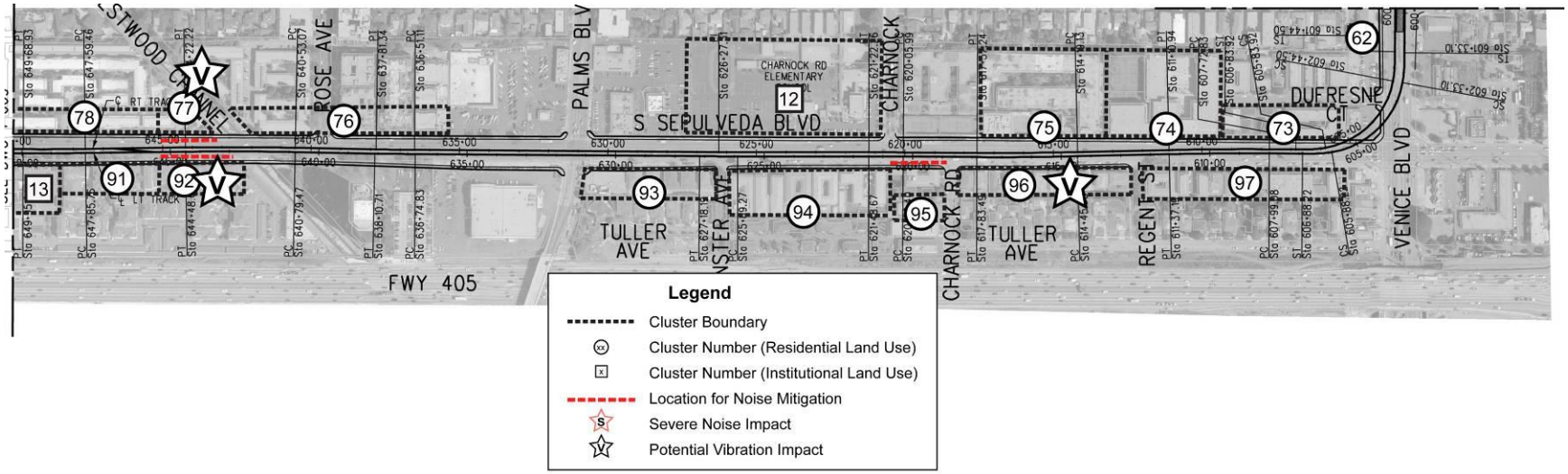
Segment 1a: Venice/Robertson Station to Jasmine Avenue



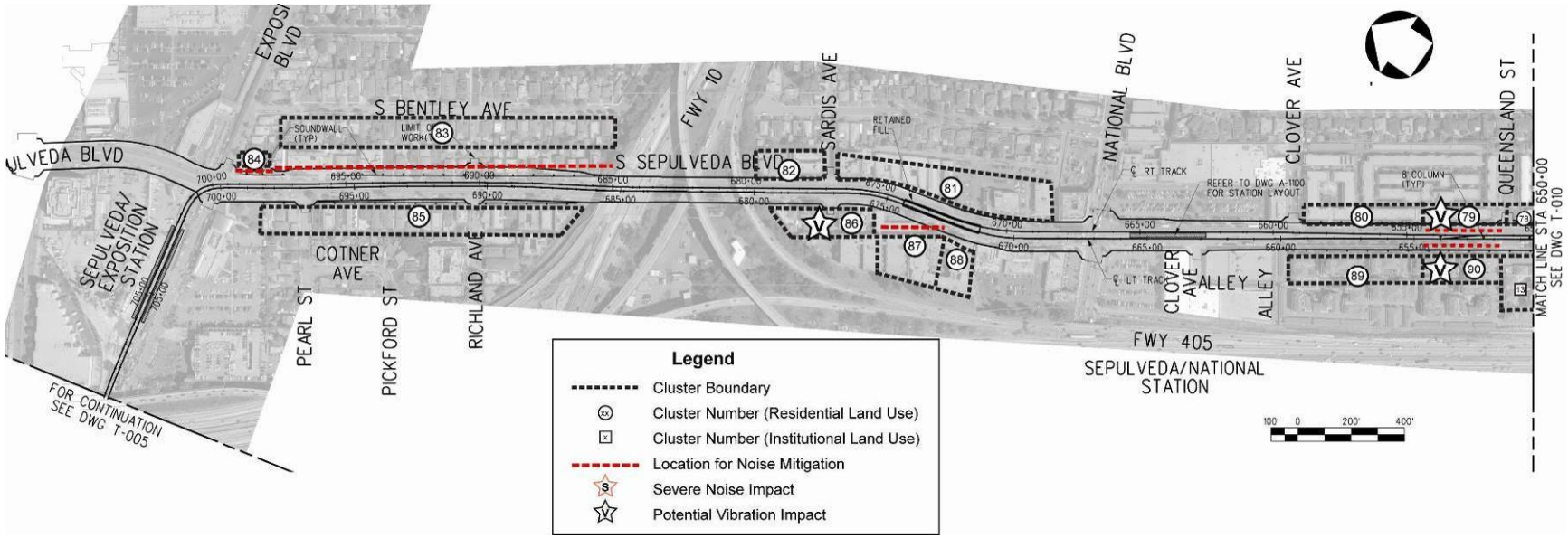
Segment 1a: Jasmine Avenue to Bentley/Sepulveda



Segment 1a: Bentley/Sepulveda to Queensland Street

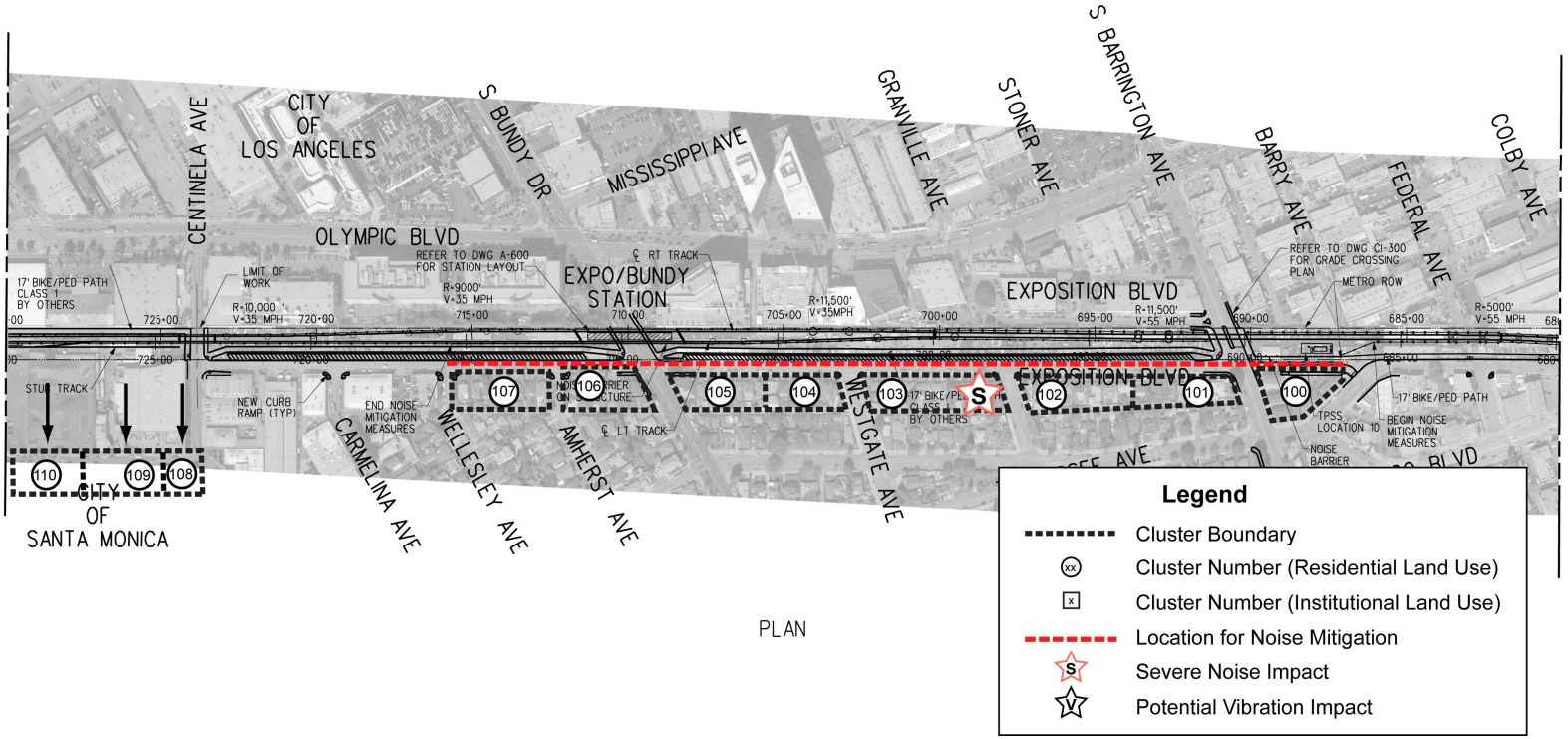


Segment 1a: Queensland Street to Segment 2

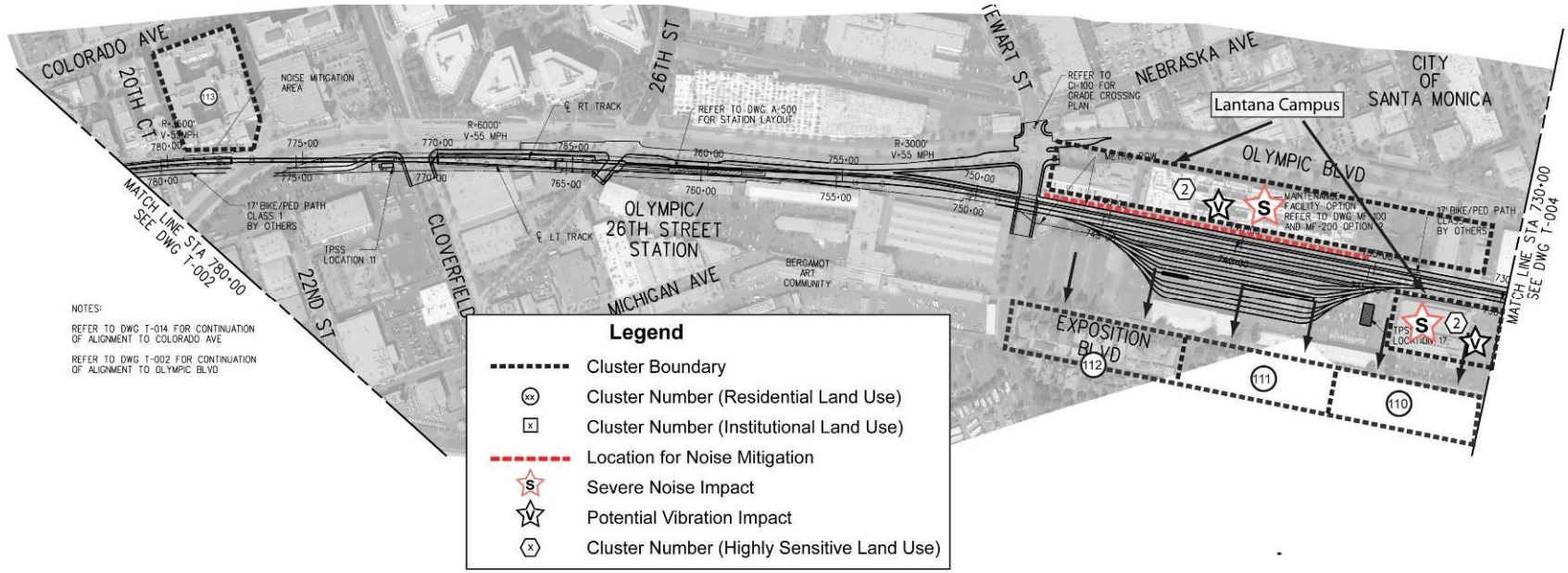


D.3 Segment 2

Segment 2: Sepulveda to Centinela

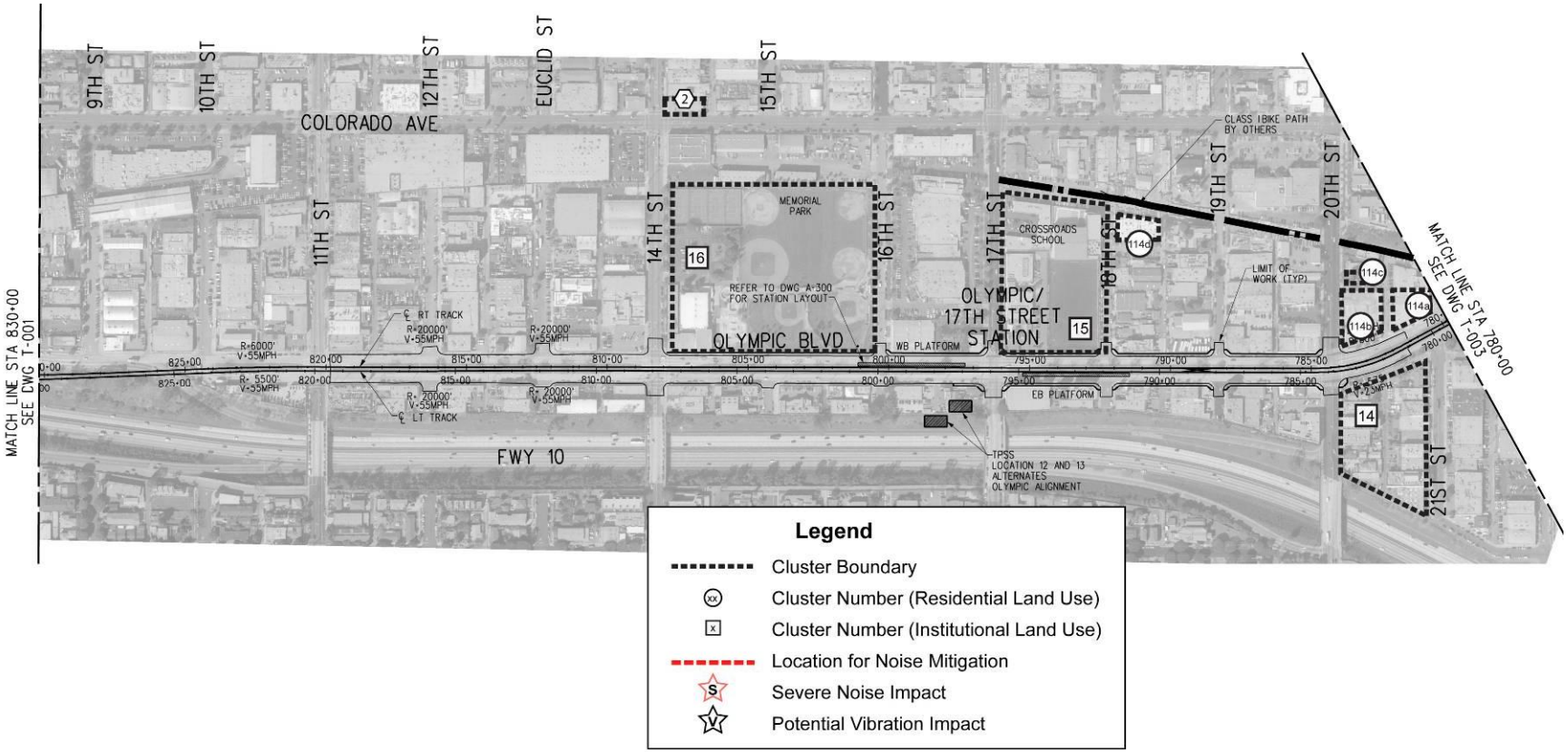


Segment 2: Centinela to Cloverfield/22nd Street

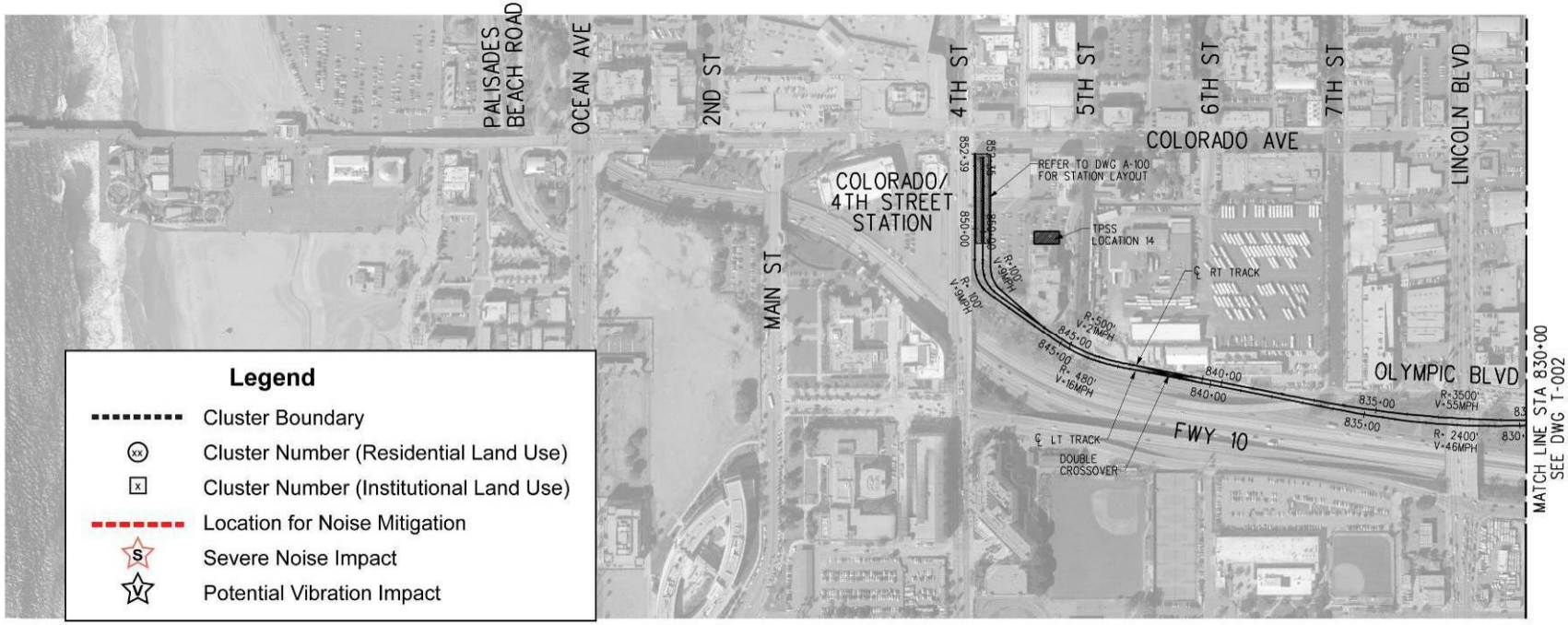


D.4 Segment 3

Segment 3: Segment 2/Cloverfield to 9th Street



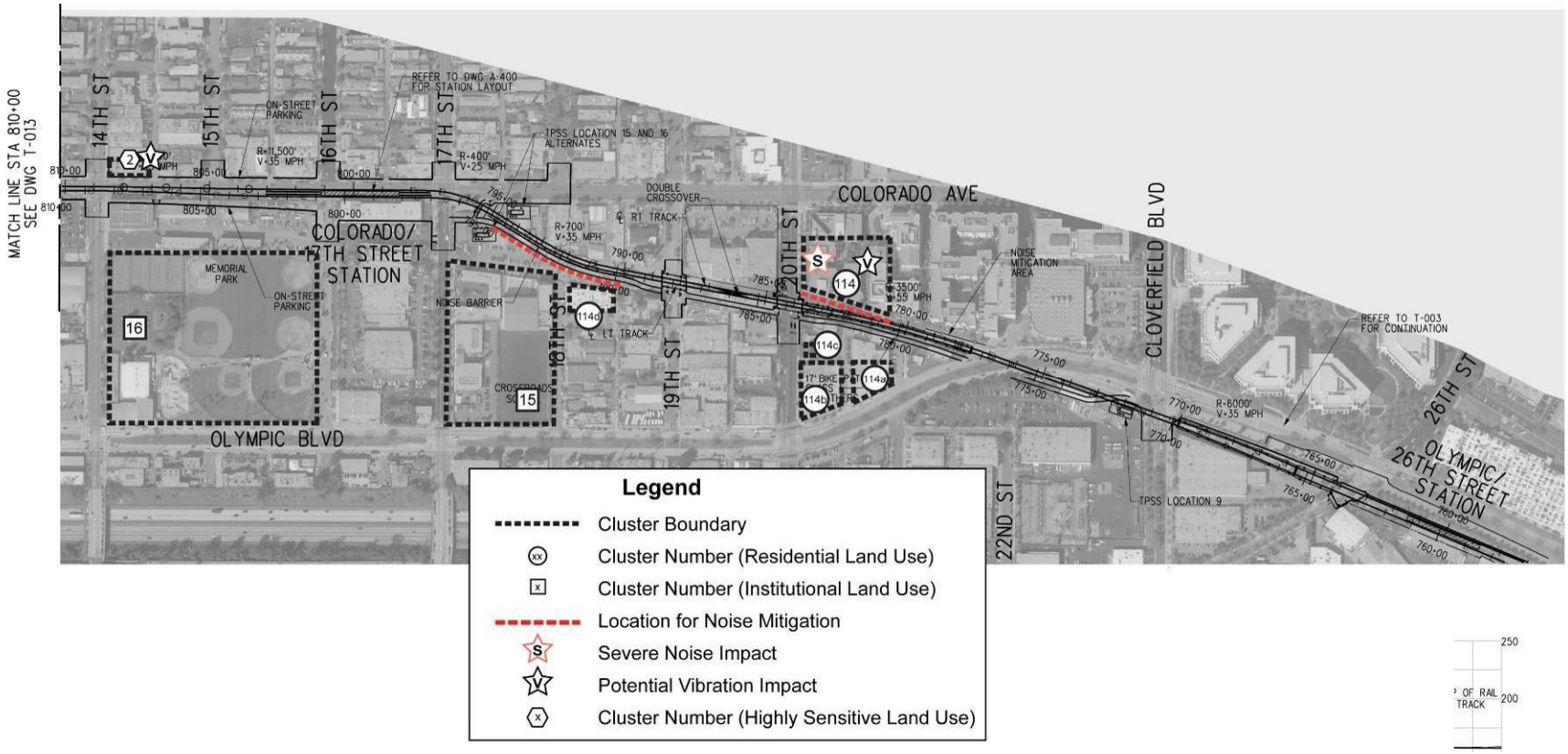
Segment 3: Euclid to Santa Monica Station



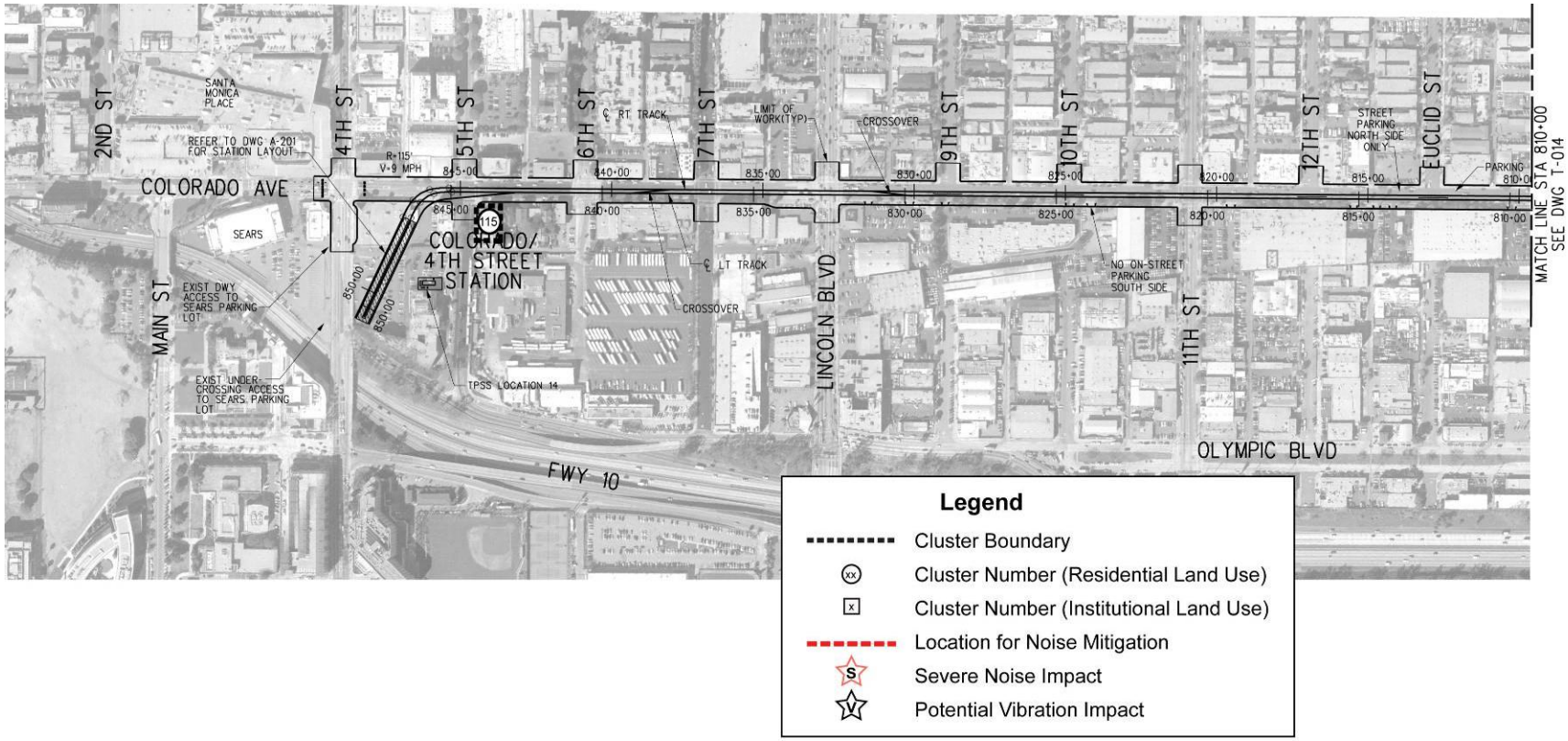
Note: No sensitive receptors identified in this segment

D.5 Segment 3a

Segment 3a: Segment 2/Cloverfield to 14th Street



Segment 3a: 14th Street to Terminus



APPENDIX E: ADDENDUM TO TECHNICAL BACKGROUND REPORT

This appendix presents the results of measurements and analyses related to noise and vibration that were performed subsequent to the Draft Environmental Impact Report. Since all of the information contained herein is new for the FEIR, it is not shown in track changes. The following sections cover:

- Groove Masters Studio: Groove Masters Studio is located at 14th Street and Colorado Avenue in Santa Monica. The assessment of potential noise and vibration impacts to studio operations included measurements of noise inside and outside the studio and vibration propagation testing.
- Lantana Campus: The Lantana Campus is an approximately ¼ mile row of low-rise buildings along Olympic Boulevard between Stewart Street and Centinela Avenue that has a number of tenants providing services to the entertainment media industry. Many of the spaces are used for film screening, recording studios, editing, and other activities that can be sensitive to external noise and vibration.
- 18th Street Arts Center: The 18th Street Arts Center is located between Olympic Boulevard and Colorado Avenue just east of the Crossroads Elementary School. It has studios that are used for meditation, occasional audio recordings, as well as visual and performance based art. In addition, parts of the facility are intermittently used as living facilities. The assessment has included measurements of existing noise levels and performing a vibration propagation test.
- Crossroads Elementary School: In response to comments, the DEIR noise and vibration assessment was refined to account for noise sensitive land uses toward the back of the campus, specifically an auditorium that is within 100 feet of the Expo right of way. The assessment included supplementary noise measurements and use of the vibration propagation test performed at the 18th Street Arts Center that is next to the school campus.
- Overland Elementary School: The Overland School is located on the east side of Overland Avenue just north of the Expo ROW. A number of comments were received from LAUSD and parents of Overland School students regarding the noise and vibration analysis. In response, a more detailed assessment of the potential noise and vibration impacts and the need for mitigation has been performed. The assessment has included measurements of existing noise levels on the part of the campus closest to the Expo ROW and vibration propagation tests from the Expo ROW to the school grounds and into four of the classrooms closest to the Expo ROW.
- Maintenance Yard Facility: There were a number of questions about noise from operation of the various facilities that would be located at the maintenance yard. The analysis of the maintenance yard has been expanded to include a series of noise measurements at the Metro Green Line Yard to supplement the previous measurements that had been performed at the Metro Gold Line Yard.

E.1 Groove Masters Studio

Groove Masters Studio is a recording studio located at the northeast corner of 14th Street and Colorado Avenue (see Figure 68 [Groove Masters Studio, Colorado Avenue and 14th Street]). The south façade is 12 feet from the curb of Colorado Avenue and traffic on Colorado Avenue is the dominant exterior noise source at the studio. This includes buses accelerating from the bus stop that is directly in front of the studio. The sensitive spaces at the studio include the main recording studio, a vocal booth, and the studio control room. The main studio is well insulated from traffic noise on Colorado Avenue. Figure 69 (Groove Masters Main Studio during Vibration Testing) is a photograph of the main studio taken during the vibration testing.

Figure 68 Groove Masters Studio, Colorado Avenue and 14th Street

Figure 69 Groove Masters Main Studio during Vibration Testing

E.1.1 Noise and Vibration Measurements at Groove Masters Studio

The measurements at Groove Masters consisted of:

- Noise measurements: A noise measurement inside the main studio with a simultaneous outdoor noise measurement on the sidewalk in front of the building.
- Vibration propagation test: The vibration propagation test was from the center lane of Colorado Avenue to the sidewalk and into four different studio spaces: the vocal booth, control room, and two positions in the main studio.
- Bus vibration: One issue that came up during discussions with Groove Masters was the vibration from buses when they pass over the concrete pad for the bus stop in front of the building. Figure 70 (Concrete Pad for Bus Stop in front of Groove Masters Studio) is a photograph of the bus stop and Figure 71 (Bus Stop Pad and Storm Drain in front of Groove Masters Studio) shows the storm drain that may be providing a structural connection between the concrete pad and the building foundation.

Figure 70 Concrete Pad for Bus Stop in front of Groove Masters Studio

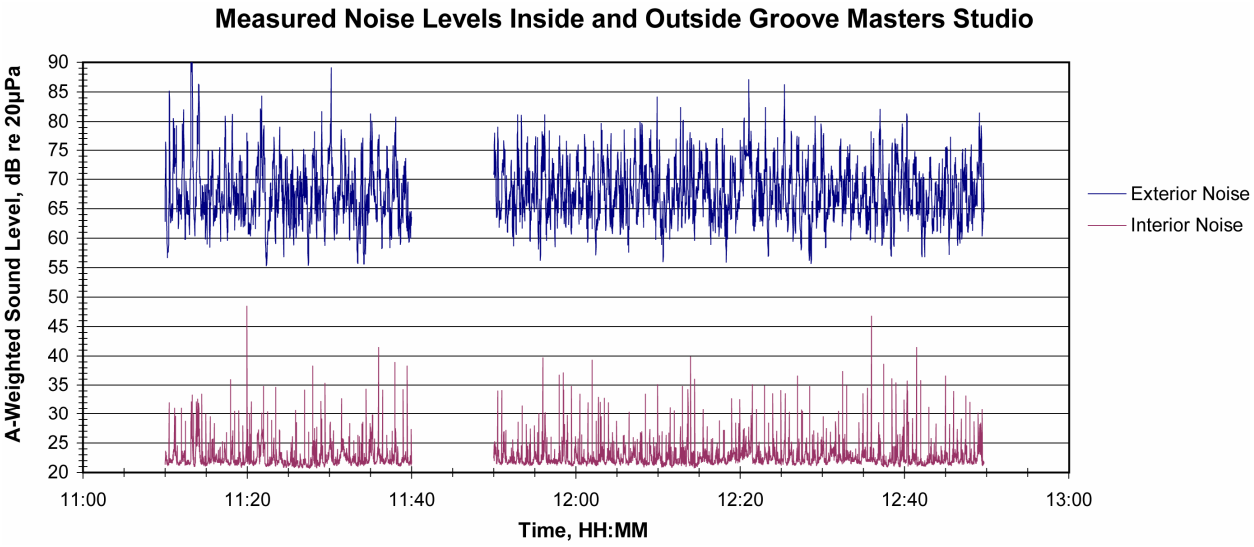
Figure 71 Bus Stop Pad and Storm Drain in front of Groove Masters Studio

Noise Measurements at Groove Masters Studio

The simultaneous indoor and outdoor measurements lasted for just under two hours. Figure 72 (Sound Level Time History for Simultaneous Noise Measurements Inside and Outside of Groove Masters Studio) shows the time history of the A-weighted sound levels over the measurement period. Two periods have been eliminated from the analysis because of activity within the studio. The energy average sound level (L_{eq}) over the period shown in Figure 72 (Sound Level Time History for Simultaneous Noise Measurements Inside and Outside of Groove Masters Studio) was 25 dBA inside the studio and 75 dBA outdoors. This indicates that the outdoor-to-indoor sound reduction is at least 50 dB. However, on close inspection of the sound level time histories, it is clear that the sound level peaks inside the studio do not correlate with the peaks outdoors. The indication is that most of the sound level peaks inside the studio were due to activities within the building and that the true outdoor-to-indoor sound reduction is greater than 50 dBA.

The bottom graph in Figure 72 (Sound Level Time History for Simultaneous Noise Measurements Inside and Outside of Groove Masters Studio) covers the 5-minute period during the two hour measurement when the loudest outdoor noise occurred. This is one of the few times that the sound levels inside the studio appear to have been affected by the outdoor sound levels. The outdoor sound level reached a maximum of just under 100 dBA. At the same instants, the sound level inside the studio was 30 to 33 dBA, indicating a sound level reduction of just less than 70 dBA. Figure 73 (Spectrograms of Indoor and Outdoor Sound over 1-minute Period with Loud Event) is a spectrogram of the 1-minute period when the loud event occurred. The horizontal axis on the spectrogram is time, the vertical axis is frequency, and the amplitudes are indicated by color. The color scales are to the right of the spectrograms. The spectrograms clearly demonstrate that the loud outdoor event affected indoor sound levels and that, except for the single event, the outdoor and indoor sound levels are uncorrelated.

Figure 74 (Spectra of Outdoor minus Indoor Sound Levels) shows the difference between the outdoor and indoor sound levels on a frequency basis. The curves shown are estimates of the outdoor-to-indoor sound attenuation that the building structure provides. The four curves in Figure 74 (Spectra of Outdoor minus Indoor Sound Levels) are:



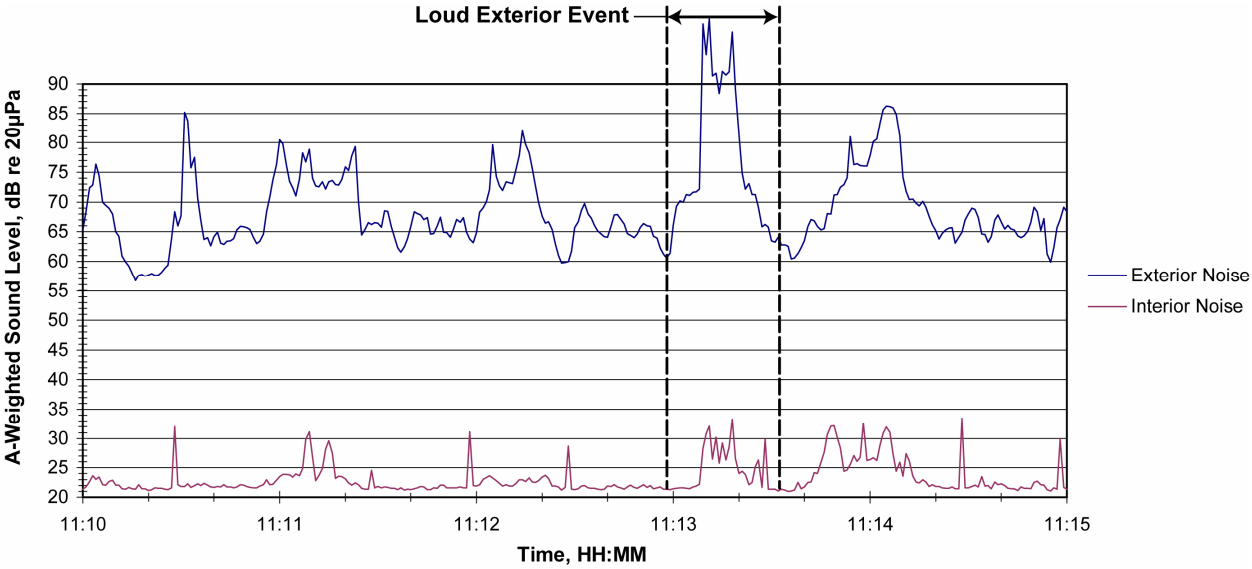


Figure 72 Sound Level Time History for Simultaneous Noise Measurements Inside and Outside of Groove Masters Studio

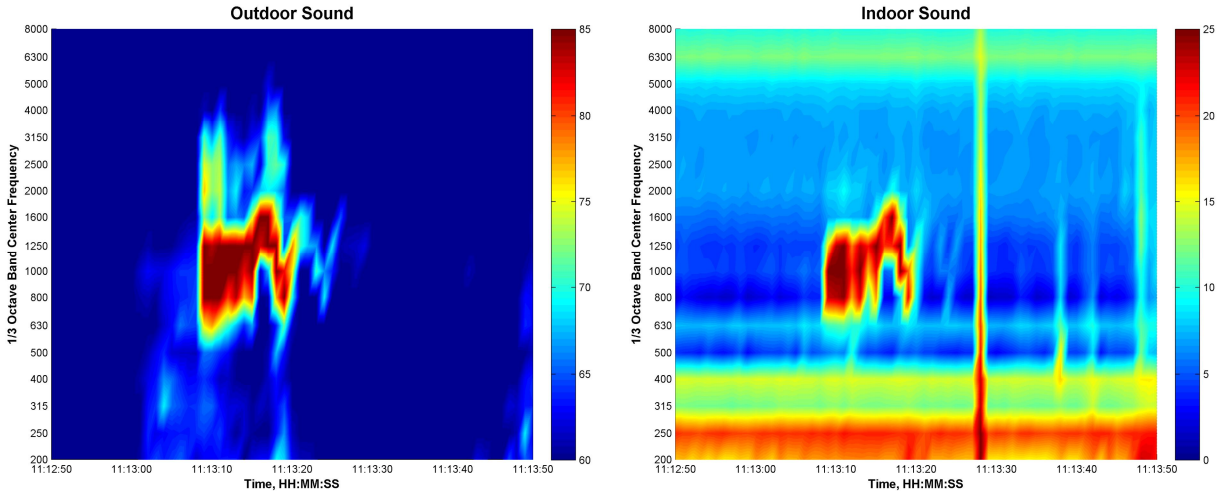


Figure 73 Spectrograms of Indoor and Outdoor Sound over 1-minute Period with Loud Event

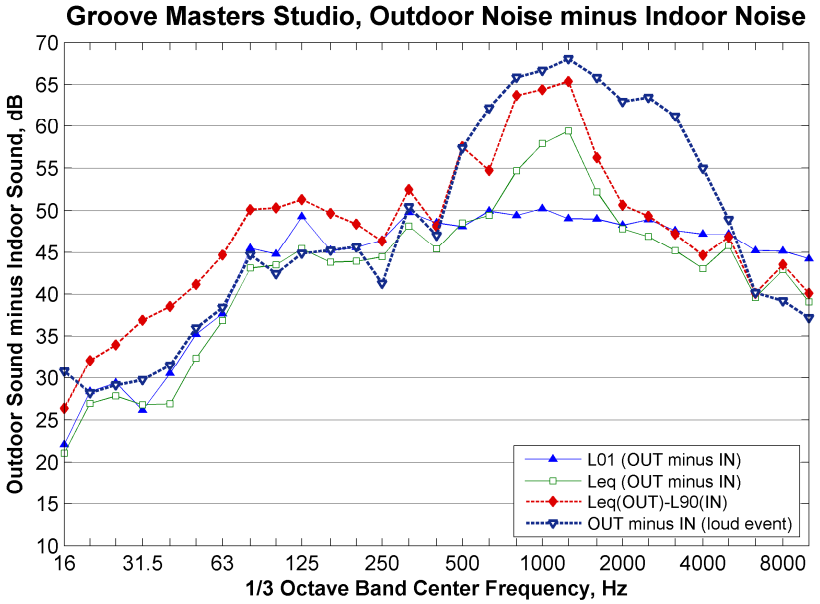


Figure 74 Spectra of Outdoor minus Indoor Sound Levels

- L_{01} (OUT minus IN): This is the difference between the L_{01} (the sound level exceeded 1 percent of the time) outdoors and indoors. L_{01} is representative of the typical maximum sound levels during a measurement. For the outdoor measurement, L_{01} represents typical maximum noise levels from buses. Because the bus noise did not exceed the background noise inside the studio, the L_{01} inside the studio represents typical maximum noise levels from activities inside the studio and the difference represents a low estimate of the outdoor-to-indoor sound reduction.
- L_{eq} (OUT minus IN): L_{eq} is the energy average sound level over the measurement period. If the indoor sound levels were affected by the outdoor sound, this difference would provide an estimate of the outdoor-to-indoor sound reduction.
- L_{eq} (OUT) minus L_{90} (IN): Leq (OUT) is the energy average sound level for the outdoor measurement and L_{90} (IN) is the sound level exceeded 90 percent of the time during the measurement. Because the outdoor sound levels do not appear to have affected indoor sound levels, the logical conclusion is that the indoor sound caused by the outdoor sound was lower than the normal indoor background noise levels (e.g., buses on Colorado Avenue were inaudible). The background sound level is the sound that occurs when human activities within the studio building are at a minimum and can be represented by L_{90}. The background sound at Groove Masters Studio probably is caused by HVAC and other mechanical equipment within the building. Although this curve is expected to be a better estimate of the outdoor-to-indoor sound reduction, it is probably still an underestimate.
- OUT minus IN (loud event): The final curve in Figure 74 (Spectra of Outdoor minus Indoor Sound Levels) is the difference between outdoor and indoor sound levels during the loud event that occurred between 11:13:00 and 11:13:30. From the spectrograms shown in Figure 73, the event dominated the indoor and outdoor sound levels for approximately 10 seconds over the frequency range of 500 to 1,600 Hz. As shown in

Figure 74, this curve shows the greatest difference between outdoor and indoor sound levels over this frequency range.

As discussed below, the curves in Figure 74 (Spectra of Outdoor minus Indoor Sound Levels) have been used to predict indoor sound levels that will be generated by light-rail operations on Colorado Avenue.

Vibration Propagation Testing, Groove Masters Studio

The impact line for the vibration propagation tests was in the center of the westbound number 1 lane of Colorado Avenue at a distance of 29 feet from the building façade. Accelerometers to measure the vibration were located at the following positions:

- Channel 2: South side of Main Studio (channel 1 is used for the force signal)
- Channel 3: North side of Main Studio
- Channel 4: Control Room inside the Studio
- Channel 5: Vocal Booth inside the Studio
- Channel 6: 2 ft from building façade, adjacent to 0 ft impact location
- Channel 7: 2 ft from building façade, adjacent to +30 ft impact location

The measured line source transfer mobility curves are shown in Figure 75 (Measured Line Source Transfer Mobility and Coherence, Groove Master Studio). The measurements were performed in the early morning hours when traffic was very light. As a result, ambient vibration was low, which is one of the reasons why the coherence is relatively high over the 6.3 Hz to 125 Hz frequency range. The LSTM curves for the two measurements in the main studio and the one in the control room are quite similar. However, the LSTM for the vocal booth shows distinctly different characteristics at frequencies of 50 Hz and higher. The measurements indicate that vibration levels in the vocal booth are likely to exceed those on the sidewalk in the 50 and 63 Hz 1/3 octave bands. It is not clear what is different at the vocal booth measurement position. One possibility is that the higher levels in the 50 and 63 Hz bands are related to a resonance in the floor in this frequency range.

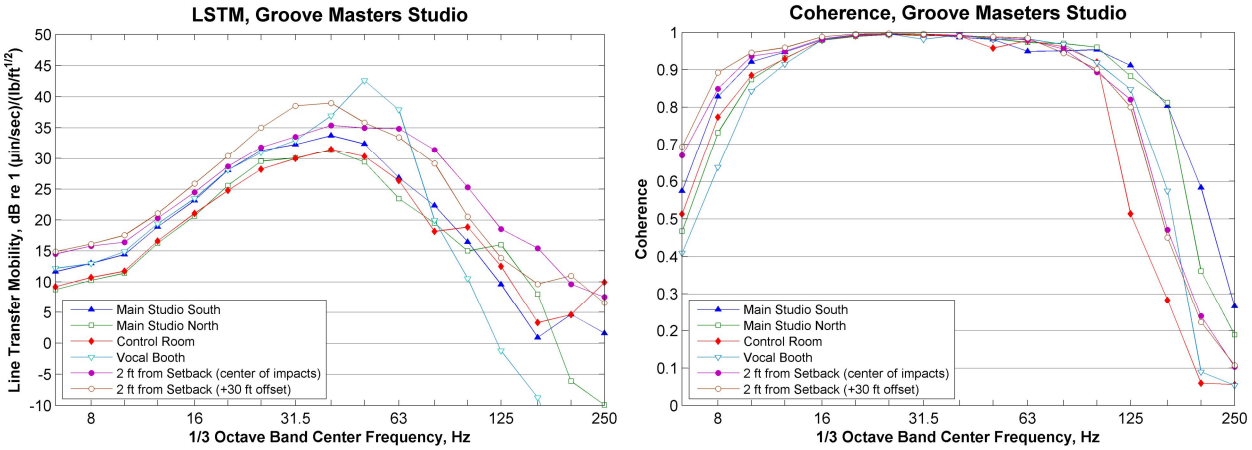


Figure 75 Measured Line Source Transfer Mobility and Coherence, Groove Master Studio

Two of the test positions were on the sidewalk of Colorado Avenue at a distance of 2 feet from the side of the building. The position at the “center of impacts” was east of the bus pad and the one at the “+30 foot offset” was near the middle of the bus pad. One purpose of the measurements at these two positions was to determine whether the bus pad had any influence on the vibration propagation. Referring to Figure 75 (Measured Line Source Transfer Mobility and Coherence, Groove Master Studio), it can be seen that the LSTM for the measurement near the center of the bus pad is about 5 dB higher than the LSTM east of the bus pad over 20 to 40 Hz range. At frequencies of 63 Hz and higher, the LSTM east of the bus pad is slightly higher. The conclusion is that the bus pad could be resulting in slightly more efficient vibration propagation at frequencies of 40 Hz and lower.

Ambient Vibration

A measurement of ambient vibration inside the studio was performed at the same time as the ambient noise measurement was performed. The time history of the vibration levels is shown in Figure 76 (Time History of Ambient Vibration Measurement inside Groove Master Studio) and the spectra of the vibration are shown in Figure 77 (Frequency Spectra of Ambient Vibration Measurement inside Groove Master Studio). As a point of reference, the threshold of human perception for floor vibration is approximately 65 VdB, which is also the FTA vibration impact threshold for recording studios. The measured levels of existing vibration were well below 65 VdB.

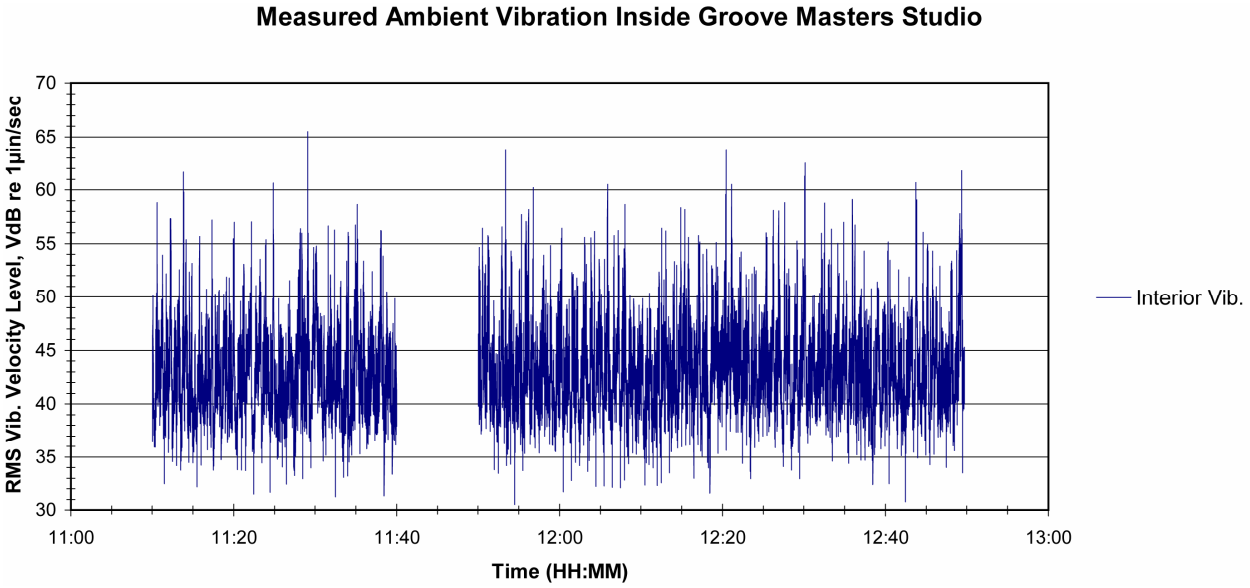


Figure 76 Time History of Ambient Vibration Measurement inside Groove Master Studio

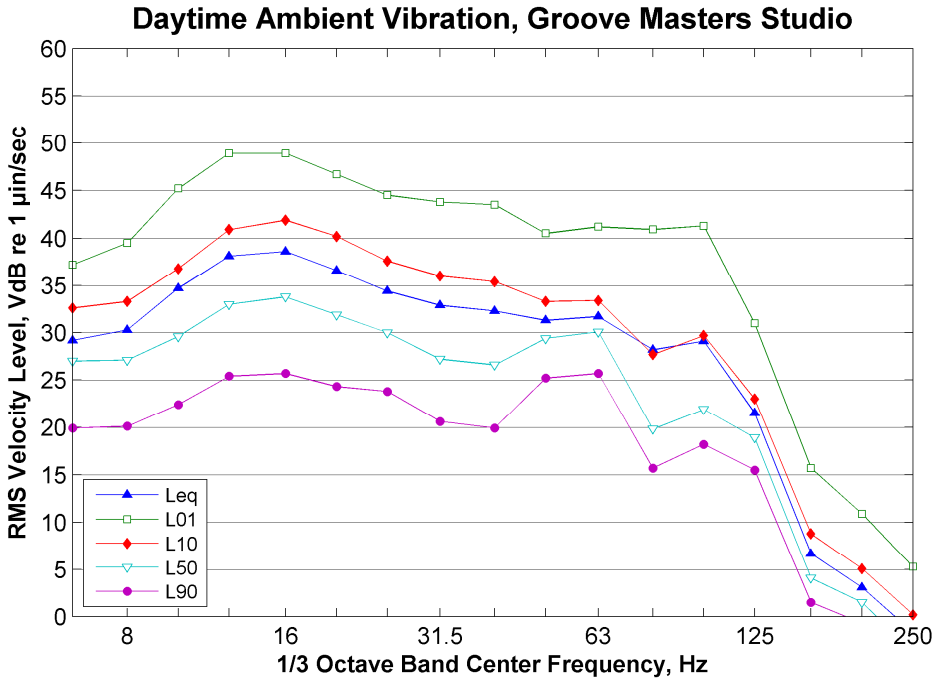


Figure 77 Frequency Spectra of Ambient Vibration Measurement inside Groove Master Studio

Bus Vibration Measurements

The measurements of ambient vibration during the mid-day period were inspected to determine the vibration from buses and trucks passing over the concrete pad for the bus stop in front of Groove Masters Studio. The results shown in Figure 78 (Examples of Bus and Truck Vibration inside Groove Master Studio) indicate that buses and trucks passing over the concrete pad generate substantially higher vibration than buses and trucks in the through lanes of Colorado Avenue. The results shown in Figure 78 (Examples of Bus and Truck Vibration inside Groove Master Studio) are for buses and trucks that pass over the concrete pad without stopping, which is relatively rare for buses because most buses stop at the bus stop. The conclusions drawn from Figure 78 (Examples of Bus and Truck Vibration inside Groove Master Studio) and the vibration propagation test results shown in Figure 75 (Measured Line Source Transfer Mobility and Coherence, Groove Master Studio) are:

- The concrete pad is responsible for higher levels of bus vibration, particularly for buses that pass over the pad without stopping.
- The pad has a relatively minor effect on the propagation of vibration from the through lanes of Colorado Avenue into the studio spaces. This is indicated by both the results of the vibration propagation tests and the lower levels of vibration from through traffic on Colorado Avenue.
- It is unlikely that the concrete bus pad will have any effect on vibration from light-rail operations.

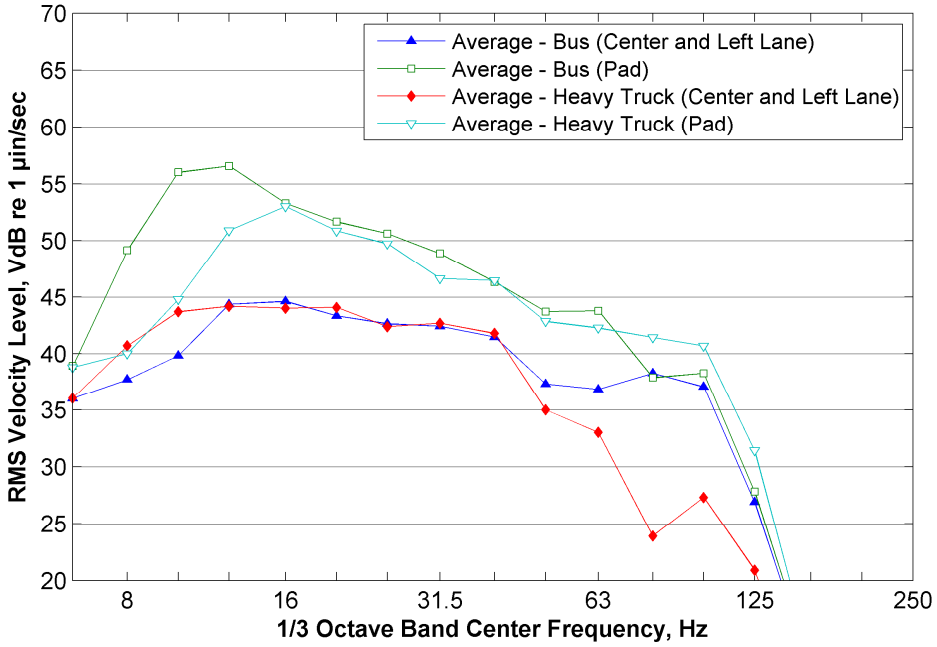


Figure 78 Examples of Bus and Truck Vibration inside Groove Master Studio

E.1.2 Predicted Light-Rail Transit Noise, Groove Masters Studio

Based on the maximum expected operating speed of 35 mph and distance of the tracks from the building, the predicted noise levels from light-rail operations are:

Maximum 1-hour L_{eq}: 67 dBA
L_{max} from train operations: 79 dBA

The measured level of existing noise outside the Groove Masters facility was 71 dBA L_{eq} and noise from buses and other loud vehicles often exceeded 80 dBA. The Groove Masters Studio falls under FTA land use Category 1. With an existing L_{eq} of 71 dBA, the FTA noise impact thresholds for Category 1 land uses are a maximum 1-hour L_{eq} of 65 dBA for moderate impact and 70 dBA for severe impact. These thresholds are applicable to the exterior façades of the recording studio building. The predicted future L_{eq} of 67 dBA from light-rail operations exceeds the moderate impact threshold by 2 decibels.

Predicted levels exceeding the moderate impact threshold would normally indicate that noise mitigation is warranted. However, the studio already has very good outdoor-to-indoor sound insulation and the existing bus noise exceeds the noise that will be generated by light-rail operations. The simultaneous outdoor/indoor noise measurements showed that the outdoor-indoor sound reduction of the studio exceeds 50 dBA. Therefore, no noise mitigation is recommended for this site because the light-rail operations should not have any negative effects on studio operations.

E.1.3 Predicted Groundborne Vibration, Groove Masters Studio

The LSTM results in Figure 75 (Measured Line Source Transfer Mobility and Coherence, Groove Master Studio) and the force density level used for the other Expo vibration predictions

(see Section 4.3, Vibration Prediction Models) have been used to predict the levels of groundborne vibration and groundborne noise that will be generated by light-rail operations. The key assumptions made for the predictions are:

Maximum train speed: 35 mph
Distance to near track centerline: 29 ft
Maximum train length: 3 cars
Safety factor: 3 dB
Relationship between noise and vibration: -5 dB

Groundborne noise is the sound that is generated by the vibration of room floors, ceilings, and other surfaces. The final assumption listed above is the relationship between the average vibration of the room surfaces and the radiated sound pressure level. The relationship can vary widely depending on factors such as the amount of acoustical absorption inside the room. The use of -5 dB is appropriate for rooms, such as the studio, that have a relatively high level of acoustical absorption.

The resulting predicted levels without mitigation and with several mitigation options are shown in Table 43 (Predicted Groundborne Vibration and Groundborne Noise at Groove Master's Studio with and without Mitigation). Without mitigation, the predicted levels of groundborne vibration exceed the FTA impact threshold of 65 dBA at one of the measurement positions in the main studio and in the vocal booth. The predicted levels of groundborne noise exceed the FTA impact threshold of 25 dBA at all of the measurement positions. The conclusion is that mitigation is required to reduce predicted levels of groundborne noise and vibration to below the FTA impact thresholds.

The mitigation options investigated are:

- High resilience direct fixation rail fasteners (HRDF): The track system for street running in Colorado Avenue would be rails embedded in concrete. A common method of constructing embedded track is to pour an initial concrete slab, enclose the rails in a rubber "boot", put the rails into the final position, and do a second pour of concrete to enclose the tracks and hold the rails in place. An alternative is to use direct fixation fasteners to attach the rails to the first concrete pour and then fill in the space around the tacks with precast concrete panels. There are several models of highly resilient direct fixation fasteners available that can be effective at controlling vibration. For this assessment, use of direct fixation fasteners with a vertical stiffness of 50klb/in or lower has been assumed.

Table 43 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				
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.

- Floating slab track: In this approach, the track is constructed on a concrete slab that is supported by resilient elements. In essence, the track slab is "floating" on resilient pads, either discrete pads 8 to 12 inches in diameter or a continuous resilient mat. This type of track construction tends to be very expensive per track foot. It is typically used where substantial vibration mitigation is needed.

- Floating studio floors: This approach is similar to the floating slab track except that it is the studio floor that is supported on resilient elements rather than the track. This is a standard measure used to improve the acoustical isolation of recording studios and other facilities.
- HRDF+Floating floors: Where the floating floors or resilient fasteners are not sufficient individually, both could be used to provide a greater level of vibration mitigation.

Referring to Table 43 (Predicted Groundborne Vibration and Groundborne Noise at Groove Master's Studio with and without Mitigation), with HRDF the predicted levels of vibration and noise are below the impact threshold except in the vocal booth and Main Studio North. With floating floors, the predicted levels are below or within 3 dB of the impact thresholds except in the vocal booth. The only mitigation measure that results in all predicted vibration levels being below the impact threshold is the floating slab.

Because of the higher level of the measured LSTM in the vocal booth, the predicted impact is substantially higher in the vocal booth than for the other measurement positions. It is possible that the higher LSTM is due to vibration amplification that is in some manner related to the floor construction. Through closer inspection of the construction of the vocal booth it may be possible to identify simple construction retrofits that will eliminate this amplification and reduce the requirements for vibration mitigation.

E.2 18th Street Arts Center

The 18th Street Arts Center is located between Olympic Boulevard and Colorado Avenue just east of the Crossroads Elementary School (see Figure 82 [Location of 18th Street Arts Studio]). It has studios that are used for meditation, occasional audio recordings, as well as visual and performance based art. In addition, parts of the facility are intermittently used as living facilities. The noise and vibration impact assessment is based the residential use of the space. Testing at the Arts Center included vibration propagation from the Expo ROW into several Art Center spaces and several short-term noise measurements.

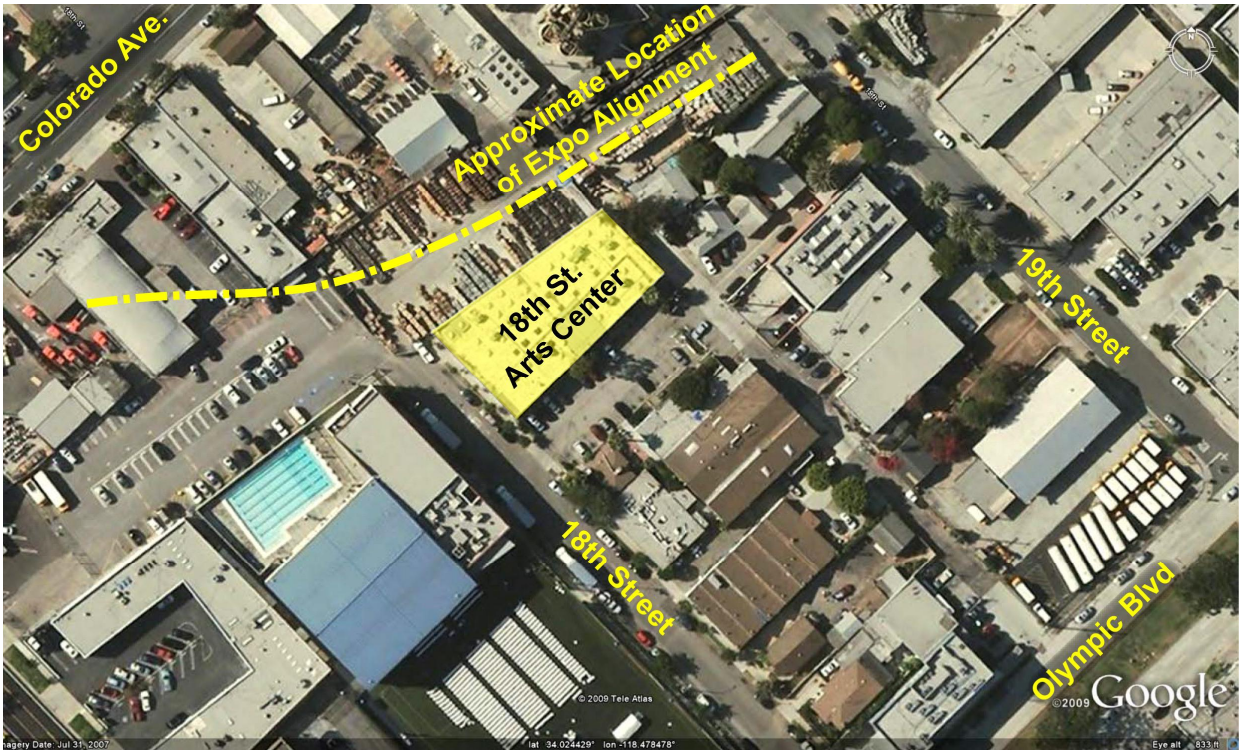


Figure 82 Location of 18th Street Arts Studio

E.2.1 Noise Impact Assessment, 18th Street Arts Center

The noise impact analysis for the Arts Center is based on the residential use of the space, which means that the FTA noise impact threshold is based on the existing L_{dn}. The existing L_{dn} has been estimated based on a 12-hour noise measurement performed in the parking lot behind the Crossroads Elementary School and adjacent to the Arts Center. The measured L_{eq} was 57 dBA between 8 AM and 8 PM. The average difference between the measured L_{dn} and the daytime L_{eq} for the 15 sites in the project corridor where 24-hour measurements were performed was 2.4 dB. Therefore, based on the daytime L_{eq} of 57 dBA, the L_{dn} is expected to be between 59 and 60 dBA. With an existing noise environment of L_{dn} 59 dBA, the FTA impact thresholds for residential land uses are L_{dn} 57 dBA for moderate impact and L_{dn} 63 dBA for severe impact. The thresholds are applicable to the L_{dn} generated by the light-rail operations.

The predicted future noise from light-rail operations is 61 dBA, which exceeds moderate noise impact threshold by 4 decibels. The prediction is based on a maximum train speed of 35 mph and a distance of 75 feet from the near track centerline to the rear of the Arts Center. The impact can be completely mitigated with a 6-foot- to 8-foot-high sound wall located along the Expo ROW.

E.2.2 Vibration Impact Assessment, 18th Street Arts Center

A major concern expressed by the Arts Center's management was whether vibration from light-rail operations would adversely affect meditation sessions that take place within the large studio that abuts the proposed alignment. The vibration assessment is based on a propagation test that was performed at the 18th Street Arts Center. The impact line was at the approximate location of the future track centerline and the accelerometers were located at the following positions:

- Channel 2: Close to building setback at the middle of the impact line
- Channel 3: At the northeast edge of the Arts Center building
- Channel 4: In a hallway inside the Arts Center
- Channel 5: Inside Studio 12
- Channel 6: In the parking lot south of the Arts Center 25 feet from the building
- Channel 7: In the parking lot south of the Arts Center 70 feet from the building

The measured line source transfer mobility (LSTM) and coherence are shown in Figure 83 (Measured LSTM and Coherence, 18th Street Arts Studio).

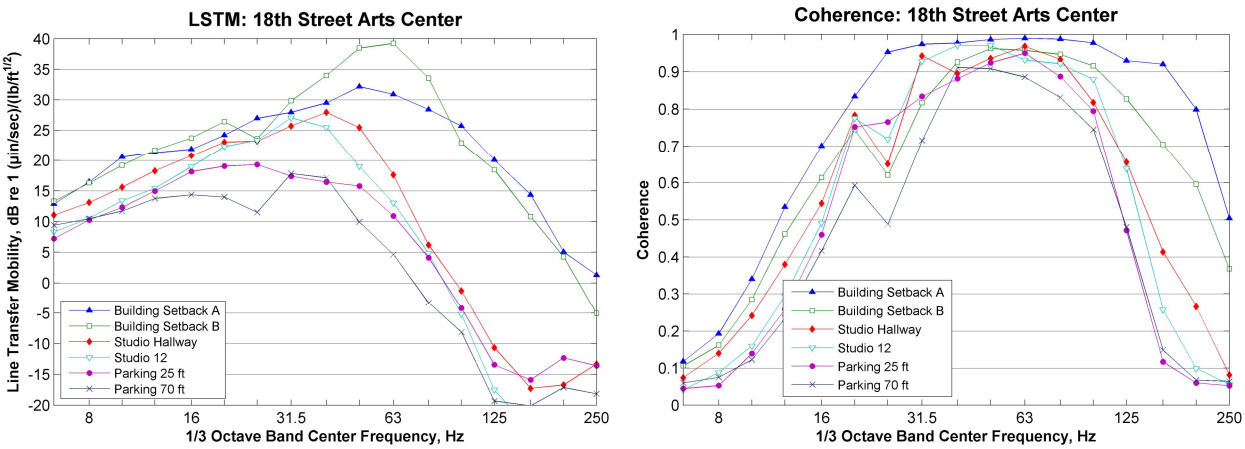


Figure 83 Measured LSTM and Coherence, 18th Street Arts Studio

The predicted vibration levels from light-rail operations inside the Arts Center are:

Studio Hallway: 61 VdB
Studio 12: 59 VdB.

This is well below the FTA impact threshold for groundborne vibration of 72 VdB for residential land uses. The predicted 1/3 octave band spectra at the two interior measurement sites are shown in Figure 84 (Predicted Vibration at 18th Street Arts Center). As can be seen, the predicted vibration levels are at least 20 decibels below the FTA impact threshold at all frequencies. The conclusion is that no vibration mitigation is required for the 18th Street Arts Center.

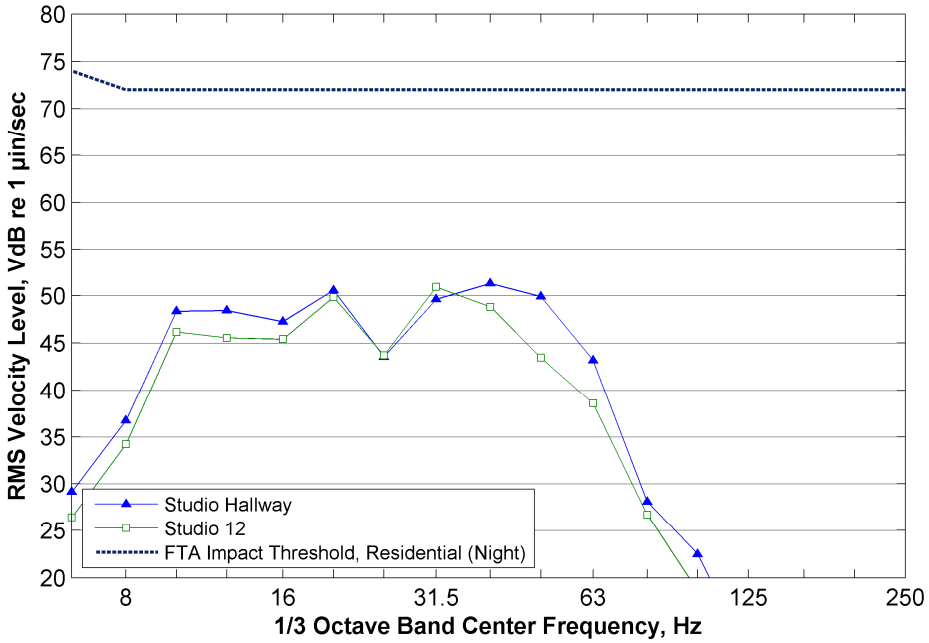


Figure 84 Predicted Vibration at 18th Street Arts Center

E.3 Crossroads Elementary School

Crossroads Elementary School is located on 17th Street and Olympic Boulevard in Santa Monica. The major concern for the school was the potential for noise from the project interfering with activities and performances within the school's auditorium on the second floor in the northeast corner of the property. Figure 85 (Aerial View of Crossroads Elementary School Campus) is an aerial view of the campus showing the location of the auditorium, the 12-hour noise measurements that was taken in the school parking lot, and the approximate location of the proposed Expo LRT alignment.

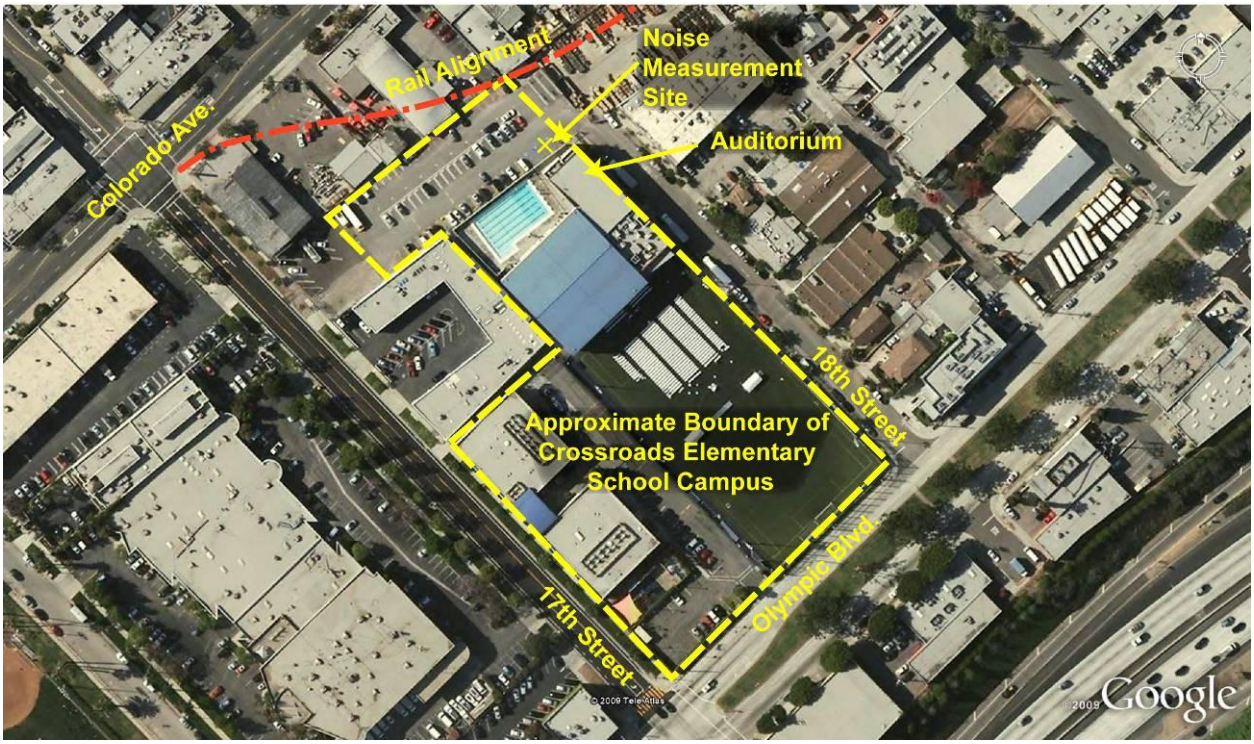


Figure 85 Aerial View of Crossroads Elementary School Campus

E.3.1 Noise Measurements, Crossroads Elementary School

The noise measurements taken at Crossroads Elementary School included a 12-hour measurement outside the auditorium, a 1-hour measurement inside the auditorium, and several other short-term measurements at other sites on the campus. The results for the 12-hour measurement are shown graphically in Figure 86 (Hourly Sound Levels at in Crossroads Elementary School Parking Lot) and are tabulated in Table 45 (Hourly Sound Levels, Crossroads Elementary School). The hourly L_{eq} was consistently around 55 dBA except for the first 30 minutes after the measurement started in the morning and between 15:00 and 16:00 (3 to 4 PM) in the afternoon. It is likely that these higher noise levels were due to activities in the parking lot at the start and end of the school day.

The L_{eq} for the entire measurement period was 59 dBA. Without the louder periods at the start and end of the school day, the L_{eq} is 56 dBA. Because L_{eq} 56 dBA is representative of the ambient noise during the school day, this level has been used for the noise assessment.

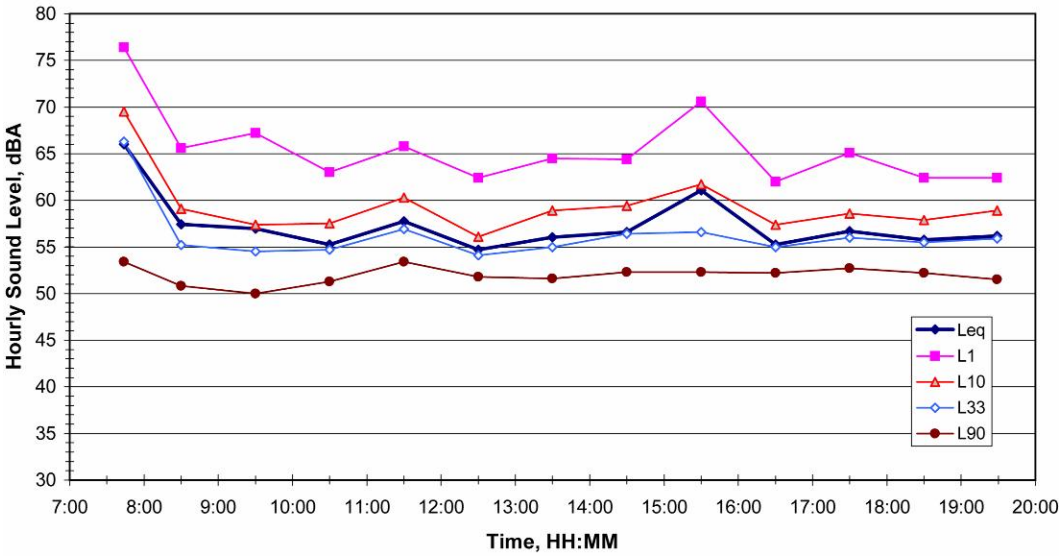


Figure 86 Hourly Sound Levels at in Crossroads Elementary School Parking Lot

Table 45 Hourly Sound Levels, Crossroads Elementary School

Start Time	Hourly Sound Levels, dBA							
	L_{eq}	L_1	L_{10}	L_{33}	L_{50}	L_{90}	L_{max}	L_{min}
7:27:50	66.0	76.4	69.5	66.3	60.1	53.4	83.1	48.6
8:00:00	57.4	65.6	59.1	55.2	53.8	50.8	83.8	47.2
9:00:00	57.0	67.2	57.4	54.5	53.5	50	85.5	47.1
10:00:00	55.3	63.0	57.5	54.7	53.7	51.3	73.2	48.1
11:00:00	57.8	65.8	60.3	56.9	55.8	53.4	76.1	50.9
12:00:00	54.7	62.4	56.1	54.1	53.4	51.8	70.9	48.9
13:00:00	56.1	64.5	58.9	55.0	54.0	51.6	70.9	49
14:00:00	56.6	64.4	59.4	56.4	55.1	52.3	68.4	49.7
15:00:00	61.1	70.6	61.7	56.6	55.0	52.3	90.8	49.9
16:00:00	55.2	62.0	57.4	55.0	54.1	52.2	66.7	50.0
17:00:00	56.7	65.1	58.6	56.0	54.9	52.7	74.3	50.4
18:00:00	55.8	62.4	57.9	55.5	54.5	52.2	70.3	48.5
19:00:00	56.2	62.4	58.9	55.9	54.4	51.5	73.5	47.8

SOURCE: ATS Consulting, 2009.

A 1-hour measurement inside the auditorium was made during the period when the 12-hour measurement was being performed. The time histories of the indoor and outdoor sound levels over this period are shown in Figure 87 (Time History of Auditorium Noise Measurement). The minimum background noise in the auditorium was around 37 dBA with several short-duration peaks that approach 50 dBA and two peaks that exceeded 50 dBA. The peaks in the outdoor noise did not correlate with the peaks in the indoor noise, which indicates that most of the

outdoor peaks were inaudible inside the auditorium. The L_{eq} over the 1-hour measurement in the auditorium was 38 dBA. The L_{90} over the measurement period was 36 dBA. The noise inside the auditorium was primarily from the HVAC system with some noise from activities inside the building.

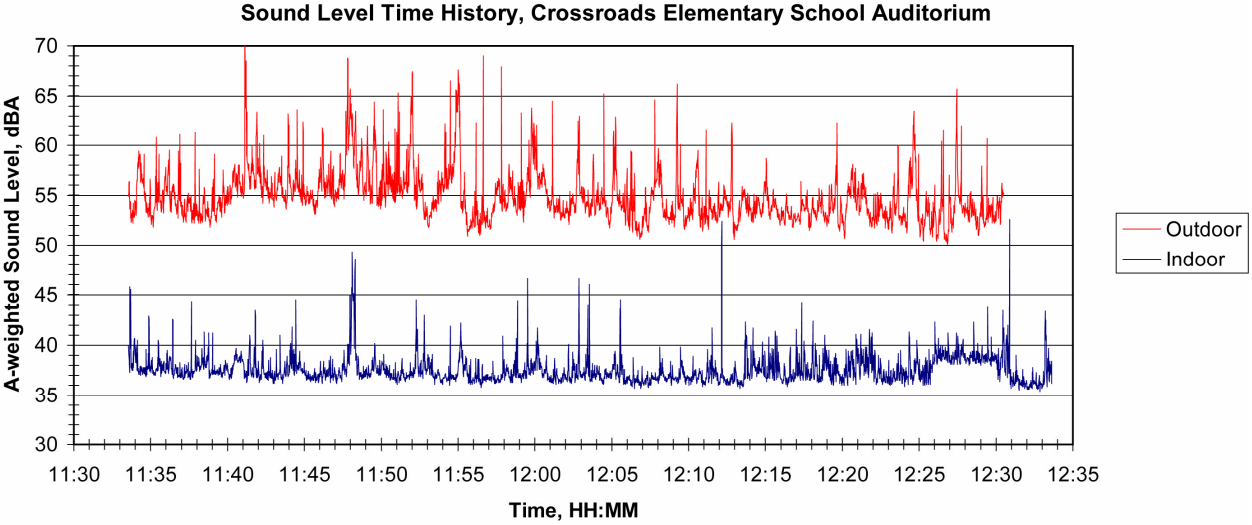


Figure 87 Time History of Auditorium Noise Measurement

Because the outdoor sounds were generally not audible inside the auditorium, the sound insulation of the auditorium cannot be estimated as the difference in the outdoor and indoor L_{eq}s (19 dB). The actual sound reduction of the auditorium is expected to be closer to 30 decibels. To be conservative, a sound level reduction of 25 dBA has been assumed.

E.3.2 Noise and Vibration Impact Assessment, Crossroads Elementary School

Based on the noise measurements, the noise levels outside the auditorium are typically L_{eq} 55 dBA when school is in session. Given this level of existing noise, the FTA impact thresholds for institutional land uses (including schools) are 60 dBA for moderate impact and 66 dBA for severe impact. This applies to the maximum 1-hour L_{eq} created by light-rail operations during periods when the school's facilities are in use. The predicted future noise from light-rail operations is L_{eq} 62 dBA, which exceeds the moderate impact threshold by 2 decibels.

The predicted noise impact can be mitigated with a sound wall along the Expo ROW that is 6 feet to 8 feet high. The sound wall will reduce the light-rail noise levels to 3 to 5 decibels below the impact threshold.

The predicted hourly L_{eq} from train operations is a maximum of 62 dBA outside the auditorium with no sound wall and approximately 54 dBA with a sound wall at the rail right of way. As discussed above, the auditorium building should be providing a minimum of 25 decibels of outdoor-to-indoor sound reduction, which means that with the sound wall the levels of train noise inside the auditorium should be less than 30 dBA. The conclusion is that levels of train noise inside the auditorium at Crossroads Elementary School will not exceed existing levels. Also, with the recommended sound wall, there will also be no significant increase in noise at any locations on the Crossroads Elementary School Campus.

There are curves near the Crossroads Elementary School on Segment 3A. The curves on 17th Street and 18th Street have radii of 400 and 700 feet, respectively. Because the potential for wheel squeal is usually limited to curves with radius less than 600 feet, potential wheel squeal is anticipated only from the curve at 17th Street. Wheel squeal from the curve at 17th Street could cause noise impact at the Crossroads School buildings closest to the curve, and the impacts can be mitigated using mitigation measure MM NOI-3. Mitigation measure MM NOI-3 will reduce the light-rail noise levels to below the FTA moderate impact threshold.

The vibration impact assessment for the Crossroads Elementary School auditorium is based on the vibration propagation test that was performed at the 18th Street Arts Center that is just east of the auditorium. Based on those measurements and assuming a train speed of 35 mph, the predicted level of groundborne vibration inside the auditorium is 56 VdB. This is well below the FTA impact threshold for auditoriums of 65 VdB. The predicted groundborne noise level inside the auditorium is 21 dBA, which is well below the FTA impact threshold for auditoriums of 25 dBA.

E.4 Overland Elementary School

Overland Elementary School is located on Overland Avenue between Northvale Road and Ashby Avenue. An aerial view of the Overland School Campus is shown in Figure 88 (Aerial View of Overland Elementary School). The Overland School classrooms most likely to be affected by noise and vibration from light-rail operations are the bungalows along Northvale Road at the southern property line of the campus. The supplementary analysis has included measurements of noise outside and inside one of the bungalow classrooms and vibration propagation tests from the Expo ROW into several of the classrooms.

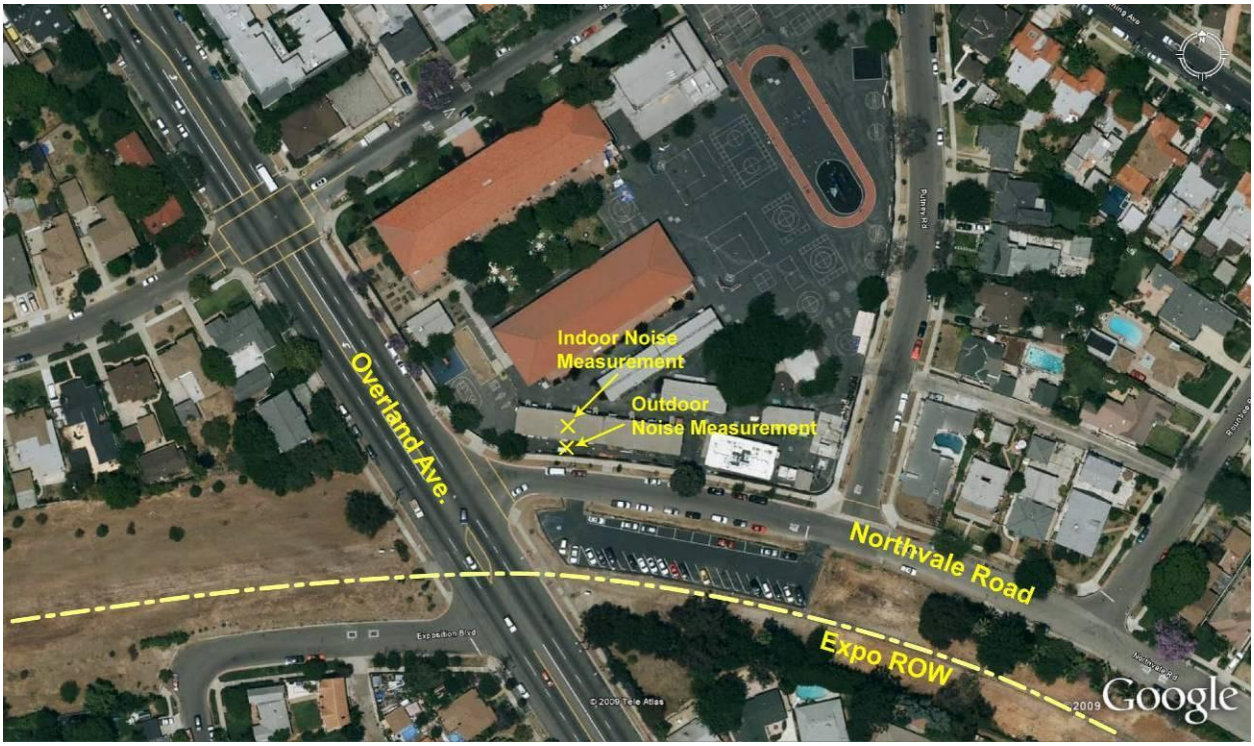


Figure 88 Aerial View of Overland Elementary School

E.4.1 Noise Measurements, Overland School

Long-term noise measurements were conducted over a period of 54 hours inside one of the bungalow classrooms (#20) and outside the classroom in the space between the bungalow and Northvale Road. The approximate locations of the measurements are shown in Figure 88. The hourly sound levels for the indoor measurement are presented in Table 46 (Hourly Noise Levels Measured Inside Overland School, Classroom 20) and for the outdoor measurements are presented in Table 47 (Hourly Noise Levels Measured Outside Inside Overland School, Classroom 20). The hourly levels are shown graphically in Figure 89 (Hourly Sound Levels, Overland School Noise Monitoring) and Figure 90 (One-Minute L_{eq} Noise Monitoring Results, Overland School) shows the sound level variation in more detail.

The average daytime L_{eq} (7 AM to 7 PM) was 62 dBA outdoors and 39 dBA indoors. This excludes the two hours on Tuesday when the equipment was being installed in the classrooms

for the vibration propagation test and the last hour of the measurement when the air conditioning was turned on.

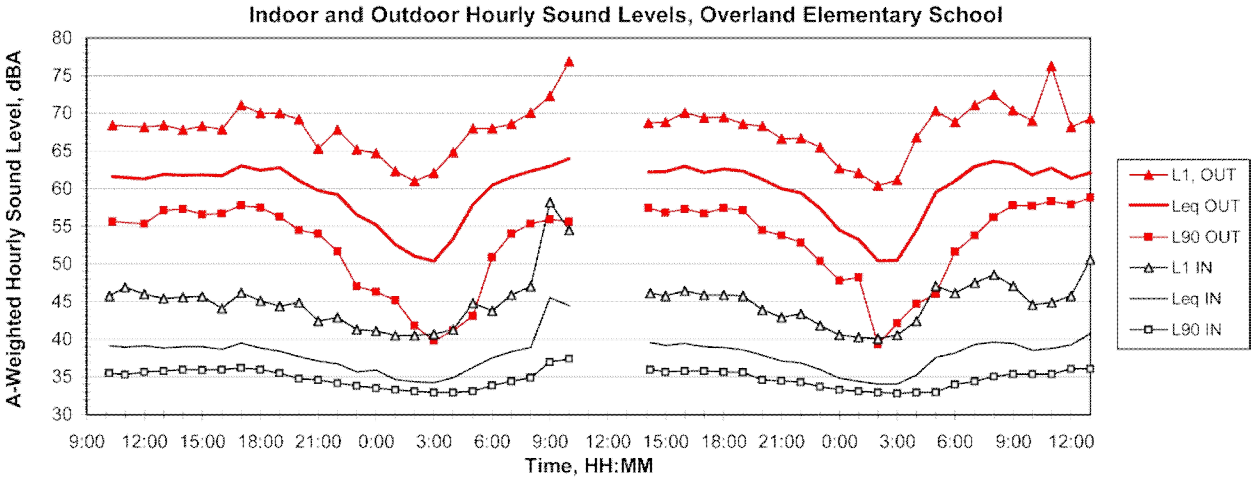
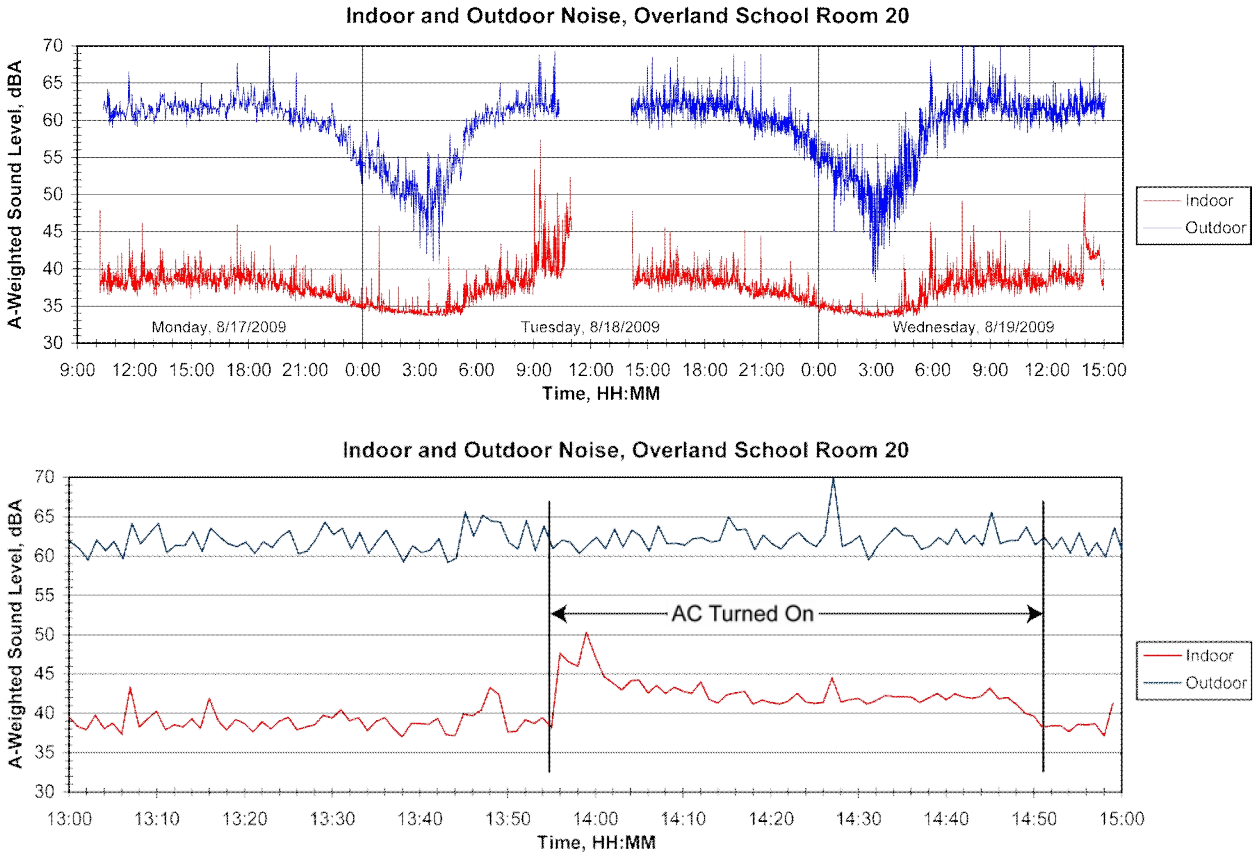


Figure 89 Hourly Sound Levels, Overland School Noise Monitoring

Observations from the measurement data shown in the figures and tables are:

- Except for the period when the vibration equipment was being installed, the hourly L_{eq} inside the classroom was in the 35 to 40 dBA range.
- Typical noise levels (1-minute averages) inside the classroom are 38 to 39 dBA with frequent peaks in the 40 to 43 dBA range and intermittent peaks exceeding 45 dBA. The peaks were probably caused by relatively noisy vehicles on Overland Avenue.
- When a controlled test with the air conditioner operation was performed, the classroom sound level increased from 38 to 39 dBA to 45 to 50 dBA for about four minutes, and then slowly decreased to a relatively constant sound level of 42 dBA.
- The outdoor sound levels were typically around 62 dBA with peaks that frequently exceeded 70 dBA. The daytime L_{eq} was usually in the range of 61 to 64 dBA. The noise levels started to drop around 19:00 (7 PM) reaching a minimum of 40 dBA around 3:00 AM and then immediately started to increase reaching the daytime levels at about 6 AM.
- The primary outdoor noise source was traffic on Overland Avenue.
- Looking at periods when the peaks in the indoor sound level correlated to a peak in the outdoor sound level, it appears that the outdoor-to-indoor sound level reduction is approximately 25 dBA. That is, when traffic causes a 75 dBA sound level outside classroom 20, the indoor sound level will be approximately 50 dBA. This is consistent with what is expected for the type of construction used for most bungalows.



Notes for Figure 90:

1. The top graph shows the full 54 hours of noise monitoring and the bottom graph shows the last two hours of the measurement. The room air conditioning was turned on at 13:54.
2. The interior measurement was inside Room 20 and the outdoor measurement was between Room 20 and the sidewalk for Northvale Road.
3. The gap on Tuesday 8/18/2009 between 11:00 and 14:00 was when the equipment was reset and vibration measurements were performed. The higher interior noise levels for the two hours prior to the gap were due to setting up equipment for the vibration testing.

Figure 90 One-Minute L_{eq} Noise Monitoring Results, Overland School

Table 46 Hourly Noise Levels Measured Inside Overland School, Classroom 20

Start Time	A-Weighted Hourly Sound Level, dBA							
	L_{eq}(hr)	Max	Min	L_1	L_{10}	L_{33}	L_{50}	L_{90}
Monday, August 17, 2009								
10:11:03	39.2	60.0	33.8	45.8	41.2	38.4	37.5	35.5
11:00:00	38.9	55.3	33.7	46.9	40.9	38.2	37.4	35.3
12:00:00	39.1	56.3	34.1	46.0	40.9	38.6	37.7	35.7
13:00:00	38.9	54.1	34.0	45.4	40.8	38.5	37.8	35.8
14:00:00	39.0	53.9	34.4	45.6	41.0	38.7	38.0	36.0

Table 46 Hourly Noise Levels Measured Inside Overland School, Classroom 20

Start Time	A-Weighted Hourly Sound Level, dBA							
	L_{eq}(hr)	Max	Min	L_1	L_{10}	L_{33}	L_{50}	L_{90}
15:00:00	39.0	54.2	34.3	45.7	40.9	38.8	38.0	35.9
16:00:00	38.7	49.3	34.3	44.1	40.6	38.6	37.8	36.0
17:00:00	39.5	57.1	34.4	46.2	41.2	39.0	38.3	36.2
18:00:00	38.8	53.2	34.7	45.1	40.5	38.6	37.9	36.0
19:00:00	38.4	59.0	34.0	44.4	40.0	38.1	37.4	35.5
20:00:00	37.7	52.3	33.5	44.9	39.1	37.2	36.5	34.8
21:00:00	37.1	47.4	33.5	42.4	38.9	37.1	36.3	34.6
22:00:00	36.8	50.4	33.0	42.9	38.3	36.5	35.7	34.2
23:00:00	35.7	48.1	33.1	41.3	37.2	35.3	34.6	33.8
0:00:00	35.9	59.2	32.9	41.1	36.6	34.7	34.2	33.5
Tuesday, August 18, 2009								
1:00:00	34.7	48.1	32.7	40.5	35.6	34.0	33.8	33.3
2:00:00	34.4	46.0	32.6	40.5	35.2	33.7	33.5	33.1
3:00:00	34.3	50.9	32.3	40.7	34.8	33.5	33.3	32.9
4:00:00	34.9	54.6	32.3	41.3	36.1	33.6	33.4	32.9
5:00:00	36.3	50.8	32.3	44.8	38.3	35.5	34.3	33.1
6:00:00	37.5	53.0	33.1	43.8	39.9	37.1	36.1	33.9
7:00:00	38.4	54.2	33.2	45.9	40.8	37.9	36.9	34.4
8:00:00	38.9	54.1	33.3	47.0	41.3	38.3	37.4	34.9
9:00:00	45.5	69.9	34.8	58.2	45.2	41.5	40.2	37.0
10:00:00	44.4	61.1	34.6	54.5	46.9	42.9	41.1	37.4
14:11:36	39.5	61.5	33.8	46.1	41.1	38.9	38.0	36.0
15:00:00	39.2	59.8	33.9	45.8	41.0	38.8	37.9	35.7
16:00:00	39.5	57.8	34.2	46.4	41.7	38.9	38.0	35.8
17:00:00	39.0	52.1	34.3	45.9	41.2	38.8	37.9	35.8
18:00:00	38.9	54.8	34.2	45.9	40.3	38.7	37.8	35.7
19:00:00	38.6	51.2	34.0	45.8	40.5	38.3	37.5	35.6
20:00:00	37.9	57.1	33.2	43.9	39.2	37.3	36.5	34.6
21:00:00	37.1	48.7	33.4	42.9	38.8	37.0	36.2	34.5
22:00:00	36.9	50.6	33.4	43.4	38.4	36.5	35.7	34.3
23:00:00	36.0	51.1	32.9	41.8	37.4	35.5	34.7	33.7
Wednesday, August 19, 2009								
0:00:00	34.8	43.2	32.6	40.6	36.2	34.4	33.9	33.3

Table 46 Hourly Noise Levels Measured Inside Overland School, Classroom 20

Start Time	A-Weighted Hourly Sound Level, dBA							
	L_{eq}(hr)	Max	Min	L_1	L_{10}	L_{33}	L_{50}	L_{90}
1:00:00	34.4	45.0	32.6	40.3	35.5	33.8	33.6	33.1
2:00:00	34.1	46.8	32.2	40.1	34.8	33.5	33.3	32.9
3:00:00	34.1	43.5	32.1	40.6	34.9	33.4	33.2	32.8
4:00:00	35.3	52.9	32.2	42.4	36.2	33.6	33.3	32.9
5:00:00	37.6	54.8	32.4	47.1	40.3	36.0	34.5	33.0
6:00:00	38.2	56.7	32.9	46.1	40.8	37.6	36.5	34.0
7:00:00	39.3	60.9	33.0	47.5	41.1	38.0	36.9	34.4
8:00:00	39.6	58.2	32.9	48.6	41.5	38.7	37.7	35.1
9:00:00	39.5	54.2	33.4	47.1	41.7	38.8	37.8	35.4
10:00:00	38.5	49.9	33.6	44.6	40.7	38.5	37.5	35.4
11:00:00	38.8	61.2	33.6	44.9	40.1	38.2	37.4	35.4
12:00:00	39.2	53.5	33.9	45.8	41.4	39.0	38.1	36.1
13:00:00	40.8	61.5	34.6	50.6	42.2	38.9	38.0	36.1

Source: ATS Consulting, 2009

Table 47 Hourly Noise Levels Measured Outside Inside Overland School, Classroom 20

Start Time	A-Weighted Hourly Sound Level, dBA							
	L_{eq}(hr)	Max	Min	L_1	L_{10}	L_{33}	L_{50}	L_{90}
Monday, August 17, 2009								
10:21	61.6	78.7	47.4	68.4	64.3	61.6	60.2	55.6
12:00	61.3	76.0	50.1	68.2	63.9	61.3	60.0	55.3
13:00	61.9	73.8	51.5	68.4	64.3	61.9	61.0	57.1
14:00	61.8	72.2	52.1	67.8	64.1	61.9	60.9	57.3
15:00	61.9	76.4	52.4	68.3	64.2	62.1	60.9	56.6
16:00	61.7	74.4	52.3	67.9	64.2	62.1	60.9	56.7
17:00	63.0	80.3	53.9	71.1	65.0	63.1	61.9	57.8
18:00	62.4	75.1	53.1	70.0	64.7	62.6	61.4	57.5
19:00	62.8	88.2	51.3	70.0	64.2	61.9	60.7	56.3
20:00	61.1	79.4	51.4	69.2	63.3	60.6	59.3	54.5
21:00	59.8	69.6	51.2	65.3	62.7	60.3	58.7	54.0
22:00	59.2	72.1	46.7	67.8	62.1	59.2	57.4	51.7

Table 47 Hourly Noise Levels Measured Outside Inside Overland School, Classroom 20

Start Time	A-Weighted Hourly Sound Level, dBA							
	L_{eq}(hr)	Max	Min	L_1	L_{10}	L_{33}	L_{50}	L_{90}
23:00	56.5	71.8	43.6	65.2	60.1	56.7	53.3	47.0
Tuesday, August 18, 2009								
0:00	55.2	72.2	43.8	64.7	59.0	53.9	50.1	46.3
1:00	52.6	67.1	41.9	62.3	56.7	49.7	48.1	45.2
2:00	51.0	68.6	39.8	61.0	55.4	46.9	45.5	41.8
3:00	50.4	69.8	37.8	62.1	53.9	43.2	42.0	39.8
4:00	53.3	70.7	38.9	64.8	57.8	48.3	45.1	41.2
5:00	57.9	71.3	40.3	68.0	61.8	57.8	53.5	43.1
6:00	60.5	72.2	45.2	68.0	63.8	60.7	58.8	50.9
7:00	61.6	74.8	45.6	68.6	64.5	61.7	60.3	54.0
8:00	62.3	75.0	49.0	70.1	64.8	62.3	61.0	55.3
9:00	63.0	82.3	48.5	72.3	64.8	62.2	60.8	55.9
10:00	64.0	81.3	47.5	76.9	64.5	61.7	60.3	55.6
14:06	62.2	77.3	52.2	68.7	64.6	62.2	61.2	57.4
15:00	62.3	81.2	52.6	68.8	64.5	62.3	61.1	56.8
16:00	62.9	78.9	52.4	70.1	65.1	62.7	61.5	57.3
17:00	62.2	73.0	52.2	69.4	64.7	62.5	61.1	56.7
18:00	62.6	78.2	52.8	69.5	64.6	62.7	61.7	57.4
19:00	62.3	78.0	52.8	68.6	64.3	62.4	61.2	57.1
20:00	61.2	82.0	50.2	68.3	63.3	61.0	59.7	54.5
21:00	60.0	72.1	49.6	66.6	62.8	60.5	59.0	53.8
22:00	59.4	73.3	50.5	66.7	62.4	59.6	57.8	52.8
23:00	57.4	72.1	47.2	65.5	60.5	57.2	54.8	50.4
Wednesday, August 19, 2009								
0:00	54.5	67.0	43.3	62.7	58.5	53.3	50.8	47.8
1:00	53.3	69.1	44.7	62.1	57.1	51.0	49.9	48.2
2:00	50.5	68.2	37.2	60.4	54.5	47.4	45.8	39.3
3:00	50.5	64.9	37.5	61.1	54.5	46.6	45.5	42.1
4:00	54.5	71.9	42.5	66.8	58.0	49.3	47.3	44.7
5:00	59.5	76.2	42.1	70.3	63.0	58.3	54.8	46.0
6:00	61.0	72.9	44.6	68.8	64.1	61.2	59.4	51.6
7:00	62.9	83.7	46.1	71.1	64.6	62.0	60.3	53.8
8:00	63.7	83.8	48.0	72.5	65.2	62.7	61.4	56.2

Table 47 Hourly Noise Levels Measured Outside Inside Overland School, Classroom 20

Start Time	A-Weighted Hourly Sound Level, dBA							
	L_{eq}(hr)	Max	Min	L_1	L_{10}	L_{33}	L_{50}	L_{90}
9:00	63.3	76.0	50.6	70.4	65.2	63.1	62.1	57.8
10:00	61.8	70.7	51.7	69.0	64.2	62.1	61.1	57.7
11:00	62.8	78.3	54.1	76.3	63.9	62.0	61.3	58.3
12:00	61.4	68.9	54.6	68.2	63.1	61.6	60.8	57.9
13:00	62.1	70.0	56.0	69.3	64.2	62.0	61.0	58.8
14:00	62.6	75.4	54.9	68.8	64.2	62.4	61.8	59.3

Source: ATS Consulting, 2009.

E.4.2 Vibration Propagation Test, Overland School

The vibration propagation test at Overland Elementary School was performed from the Expo ROW into four of the bungalow classrooms. The impact line for the vibration propagation tests was in the center of the existing railroad tracks at a distance of 40 ft from the closest edge of the parking lot on the south side of Northvale. Vibration measurements were made at the following positions:

- Channel 2: Parking Lot, 40 feet from tracks
- Channel 3: North Side of Northvale, 120 feet from tracks
- Channel 4: Classroom 21
- Channel 5: Classroom 20
- Channel 6: Classroom 19
- Channel 7: Classroom 18

The measured LSTM and coherence are shown in Figure 91 (Measured LSTM and Coherence, Overland School). The LSTM values are relatively low, indicating inefficient propagation of vibration energy from the Expo ROW to the classrooms. Classroom 21 shows a stronger response than the three other classrooms and only classroom 21 shows any indication of floor resonances causing vibration amplification. The apparent amplification occurs at 16 Hz.

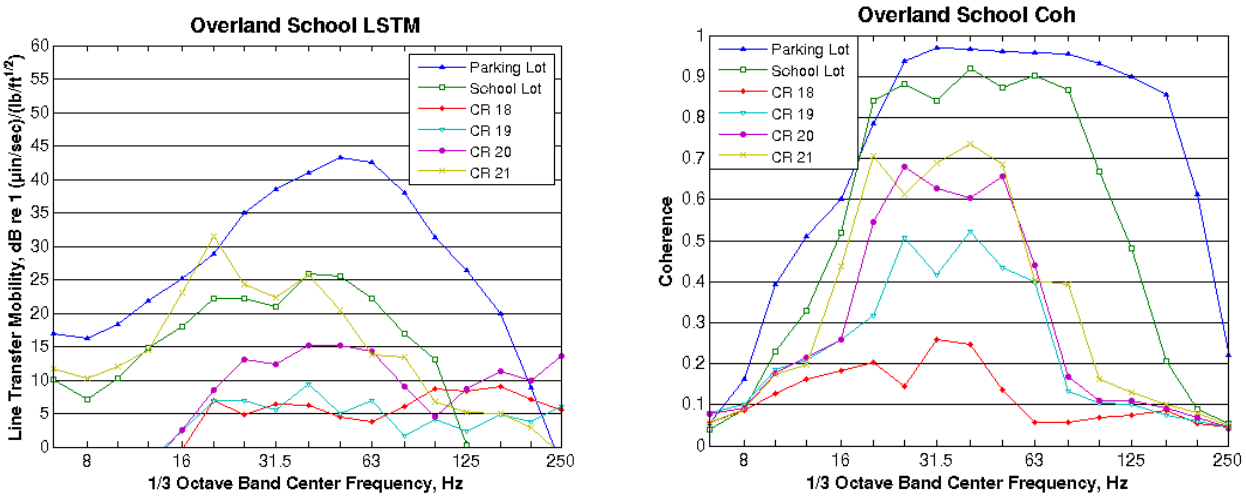


Figure 91 Measured LSTM and Coherence, Overland School

E.4.3 Noise and Vibration Impact Assessment, Overland School

The measured daytime L_{eq} outside of classroom 20 was 62 dBA. Given this level of ambient noise, the FTA impact thresholds for institutional land uses are L_{eq} 64 dBA for moderate impact and L_{eq} 70 dBA for severe impact. The predicted maximum 1-hour L_{eq} from future light-rail operations is 62 dBA, which is 2 decibels below the threshold for moderate impact. Note that this is a change from the assessment that was performed for the DEIR. The difference is due to assuming a lower level of existing noise in the DEIR assessment because detailed information on the noise levels at the classrooms closest to the Expo ROW was not available.

The noise impact assessment uses a receiver position between the bungalows and Northvale Avenue. This space does not appear to be used for student activities. Basing the impact assessment on the outdoor spaces north of the bungalows where most of the outdoor activities occur also does not result in impact. This is because the extra distance to the Expo ROW and the acoustic shielding provided by the bungalows and other structures along the southern boundary of the Overland campus.

Another consideration is whether the predicted levels of light-rail noise would cause a substantial change in the classroom noise levels. The measurements indicate that the outdoor-to-indoor sound level reduction is at least 25 decibels. The predicted maximum hourly L_{eq} is 62 dBA immediately outside the bungalow classrooms, which means that indoor sound levels would be less than L_{eq} 37 dBA. This is approximately equal to the existing daytime noise level measured inside classroom 20 and is 5 to 7 decibels lower than the classroom noise when the air conditioner is operating. The conclusion is that although the noise from light-rail operations will be audible, it will have a minimal effect on the overall noise environment inside the classrooms.

Another question is whether the predicted levels of light-rail noise would exceed LAUSD standards for classroom noise. The LAUSD standards are that exterior levels should not exceed L_{eq} 67 dBA and that interior levels should not exceed L_{eq} 45 dBA. The existing noise outside the bungalows is 64 dBA and the predicted noise from light-rail operations is 62 dBA. The decibel sum of 64 dBA and 62 dBA is 66 dBA, which is below the LAUSD standard of 67 dBA. The

noise level measured inside classroom 20 was L_{eq} 39 dBA and the measurements indicate that the outdoor-to-indoor noise reduction is at least 25 decibels. This means that light-rail noise could be as high as L_{eq} 37 dBA inside classroom 20. The decibel sum of 37 dBA and 39 dBA is 41 dBA, which is 4 decibels below the LAUSD standard of L_{eq} 45 dBA.

Using the same FDL curve that has been used for the other vibration predictions and the LSTM curves shown in Figure 91, the predicted vibration levels inside the Overland School classrooms are:

Classroom 21:	65 VdB
Classroom 20:	50 VdB
Classroom 19:	45 VdB
Classroom 18:	42 VdB

The predictions assume a maximum train speed of 40 mph and include a safety factor of 3 dB to account for uncertainties. The FTA impact threshold for groundborne vibration is 75 VdB for institutional land uses such as schools. All of the predicted levels of groundborne vibration are well below the FTA impact threshold.

E.5 Lantana Campus

The Lantana Campus consists of five buildings roughly bounded by Olympic Boulevard to the north, Exposition Boulevard to the south, Stewart Street to the west, and Centinela Avenue to the east. The Campus is part of the City of Santa Monica Light Manufacturing Studio (LMSD) district. According to the staff report prepared for the August 28, 2007 Santa City Council Meeting, the zoning is intended to "encourage low-impact, high-employment entertainment industry facilities along with creative arts and supportive uses."

The tenants at the Lantana Campus are primarily from the entertainment media industry. Although the majority of the space appears to be used for offices, there are several screening rooms, recording studios, and spaces that are used for other activities such as audio/visual editing that require relatively low levels of background noise. The analysis has included detailed testing of how groundborne vibration will be transmitted into sensitive spaces of the buildings, measurements of the existing ambient vibration, and testing of sound insulation characteristics of representative spaces.

Figure 92 (Location of Lantana Campus) is an aerial view of the Lantana Campus with the buildings labeled. The five buildings are:

- **Lantana West** (2900 Olympic Blvd.): Located at the southeast corner of Olympic Boulevard and Stewart Street. Dick Clark Productions is a key tenant of this space. Much of the space is used for offices; noise and vibration sensitive uses include the Dick Clark Productions screening room on the first floor and suites that are used for editing. There is underground parking that extends south of the building underneath the surface parking area. The near track centerline will be approximately 80 ft from the south façade of Lantana West.
- **Lantana Center** (3000 Olympic Blvd): Lantana Center is an approximately 800 ft long low-rise building that fronts on Olympic Boulevard. Tenants include Todd-AO Studios and Gray Martin Studios that are located at the west end of the building. Many of the other spaces in Lantana Center are suites that are used as office space. The near track centerline of the Expo Corridor will be approximately 50 ft from the south façade of Lantana Center.
- **Lantana East**: Lantana East is a recently constructed three story office building that fronts on Olympic Boulevard. The building was under construction when the aerial photograph in Figure 92 (Location of Lantana Campus) was taken. There is underground parking that extends south of the building under the surface parking. The distances from the south façade of the building to the near track centerline will be approximately 150 ft.
- **IMAX**: The IMAX building fronts on Exposition Boulevard and is located south of the Expo Phase 2 alignment. It is a three story building and the ground floor is slab-on-grade. Most of the space is used for offices. In addition, there are three screening rooms near the center of the building. The inbound track for the Expo Phase 2 project will pass approximately 90 ft from the north façade of the building.
- **Lantana South**: Lantana South is located east of the IMAX building and also fronts on Exposition Boulevard. It is a new three story office building that had not been completely built out when the testing was performed in November 2009. The inbound Expo Phase 2

tracks will be approximately 150 ft from the back of the building (the north façade). There is underground parking that extends north under the surface parking.

Noise and/or vibration tests were performed at six locations on the Lantana Campus and one location in the Verizon parking lot adjacent to the Lantana Campus. The general locations of the tests are shown in Figure 92 (Location of Lantana Campus). Photographs taken during the testing are shown in Figures 93 (Outside of Lantana West [2900 Olympic]) through Figure 118 (Noise Monitoring Position inside IMAX Screening Room). The tests performed at the seven locations were as follows:

Site 1: Lantana West (2900 Olympic Blvd.). Vibration propagation tests were performed from south of the surface parking into the first and second floor of Lantana West. Indoor measurements were performed inside south facing offices on the first and second floor, an interior space on the second floor, and outside the screening room on the first floor. In addition, two accelerometers were located in the surface parking area south of the building. The indoor measurement positions were all within the offices of Dick Clark Productions and consisted of ambient vibration and vibration propagation. Lantana West is referred to in the main body of the report as Lan1.

Site 2: Lantana Center. The Lantana Center measurements were performed in two first floor offices (rooms 1369B and 1370) and two second floor offices (rooms 2370 and 2371). The offices were vacant at the time of the measurements. Offices 1369B and 2371 faced south overlooking the parking lot and offices 1370 and 2370 faced north overlooking an interior courtyard. The measurements included vibration propagation into the four offices and at two exterior positions, ambient noise and vibration, and noise reduction into the four offices. Lantana Center is referred to in the main body of the report as Lan4.

Site 3: Lantana South. Lantana South is a new building that is located south of the Expo ROW. The tests were performed into two office spaces on the first floor and two positions on the second floor. The second floor accelerometer positions are shown in Figure 104 (Accelerometer Positions, Second Floor, Lantana South). The second floor space was not built-out at the time of the measurements. In addition, two accelerometers were located north of the building (see Figure 102 [Outdoor Accelerometers, Lantana South]) above the underground parking structure. The measurements included vibration propagation and ambient noise and vibration.

Site 4: Todd-AO. Todd-AO is located at the west end of Lantana Center on the ground floor and basement. There are a number of audio recording stages and screening rooms within the Todd-AO facility. The measurement positions included the ADR Stage (Figure 105 [Accelerometer Position, ADR Stage, Todd-AO]), Foley Studio (Figure 106 Accelerometer Position in Foley Stage, Todd-AO]), a large stage (Figure 107 [Accelerometer Position, Large Stage, Todd-AO]), and a small stage (Figure 108 [Accelerometer Position, Small Stage, Todd-AO]). There is an equipment corridor that runs along the south wall of the building where an additional accelerometer was located (Figure 109 [Accelerometer Position in Equipment Corridor, Todd-AO]). The measurements included vibration propagation, ambient noise and vibration, and noise reduction. Figure 110 (Speaker Setup for Noise Reduction Tests, Todd-AO and Gray Martin Studios) shows the speakers set up for the noise reduction test. The impact line for the propagation test was just north of the dirt strip between the north and south sections of the parking lot. Todd-AO is referred to in the main body of the report as Lan2.

Site 5: Gray Martin Studios. Gray Martin Studios is located on the second floor above Todd-AO. The Gray Martin facility includes four recording studios plus two recording booths. Measurements were made inside Studio A, the Studio A booth, Studio B, Studio D, and the booth between Studios C and D. Studios C and D are on the south wall of the building overlooking the parking lot, Studio B is north of Studio D, and Studio A is on the north side of the space and is Gray Martin studio located the farthest from the Expo ROW. The measurements consisted of vibration propagation into three studios and two booths, ambient noise and vibration, and noise reduction. In addition, an outdoor measurement was performed at 25 ft from the impact line. The impact line was at the same location as for the Todd-AO tests but shifted 15 ft to the west. Gray Martin Studios are referred to in the main body of the report as Lan3.

Site 6: IMAX. Due to a scheduling conflict, it was not possible to perform a vibration propagation test at the IMAX facility. However, noise reduction tests from outdoors to the corridor just north of the screening rooms and into one of the screening rooms were performed. IMAX is referred to in the main body of the report as Lan5.

Site 7: Verizon Parking Lot. A vibration propagation test was performed in northeast corner of the Verizon parking lot. Although this site is not on the Lantana Campus, it is applicable because it is adjacent to the IMAX building and near Lantana East and Lantana Center. The impact line was parallel to the Expo ROW and the accelerometer line was perpendicular to the Expo ROW in the southerly direction. Accelerometers were located at distances of 25, 50, 75, 100, 125 and 150 feet from the impact line.

Figure 92 Location of Lantana Campus

Figure 93 Outside of Lantana West (2900 Olympic)

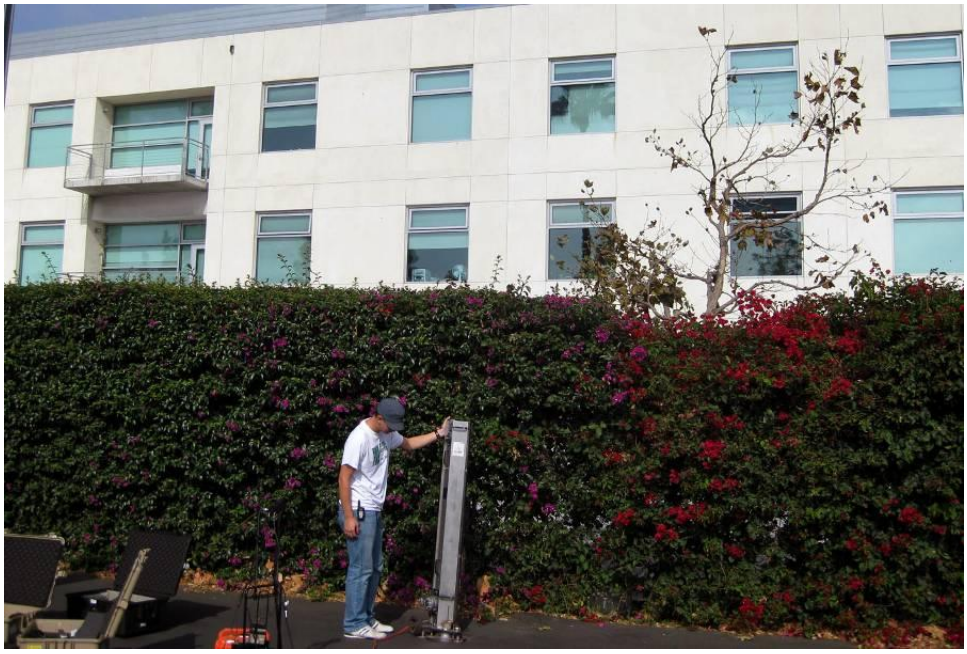


Figure 94 Location of Impact Line for Lantana West (2900 Olympic)

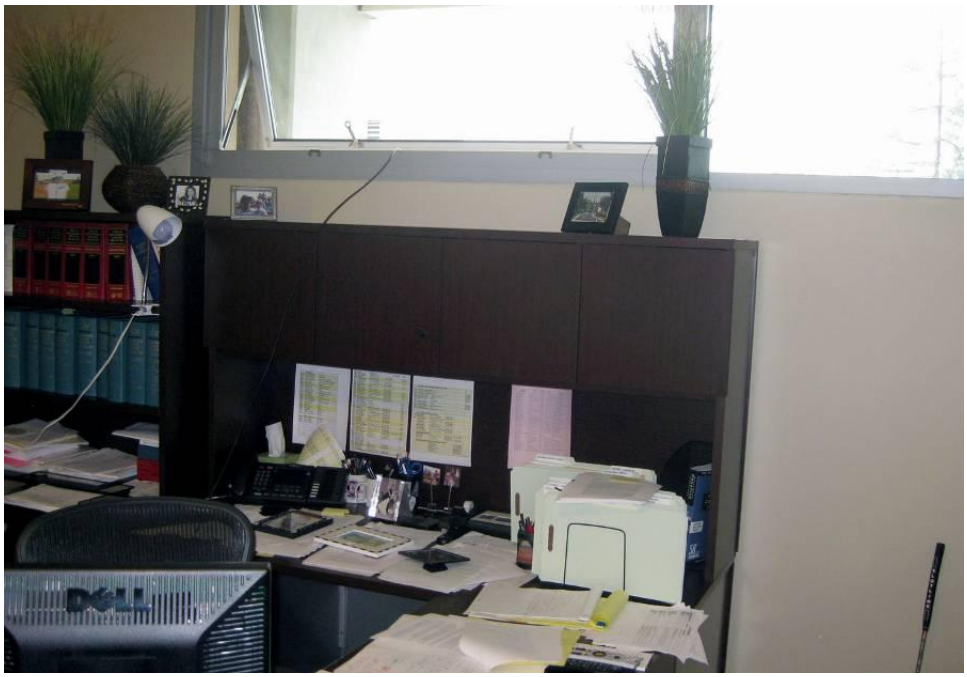


Figure 95 Inside First Floor Office, Lantana West (2900 Olympic)
(Accelerometer was located under the desk)

Figure 96 Inside Second Floor Office, Lantana West (2900 Olympic)

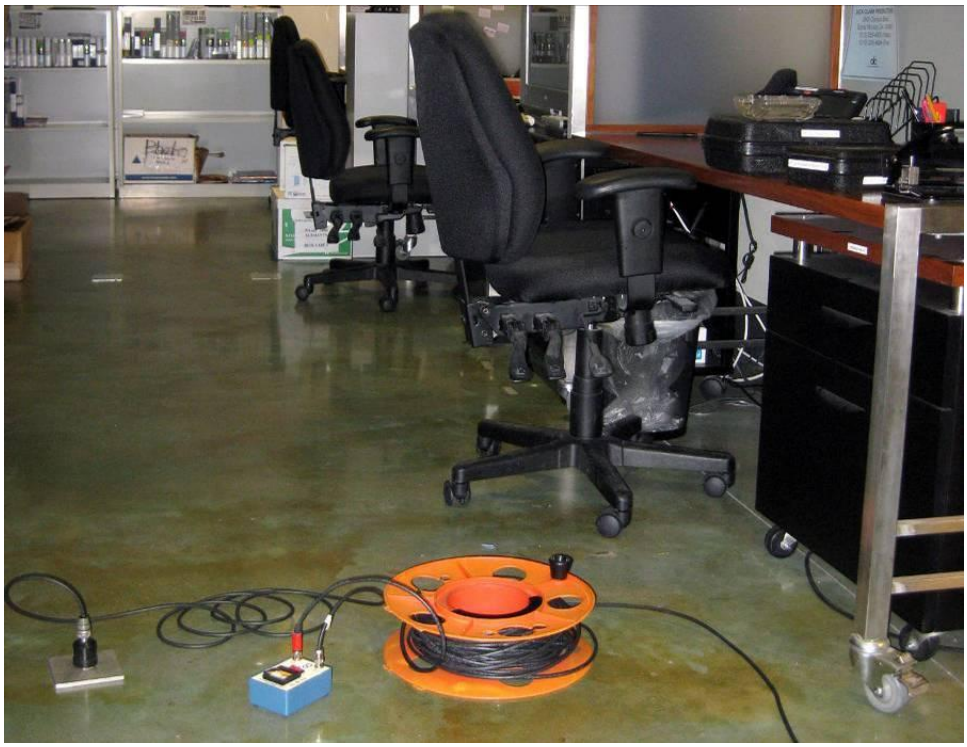


Figure 97 Measurement Position at Interior Space on Second Floor, Lantana West (2900 Olympic)

Figure 98 Measurement Position Outside Screening Room, First Floor, Lantana West (2900 Olympic)

Figure 99 Impact Line for Lantana Center Measurement (3000 Olympic)

Figure 100 Outdoor Accelerometer Positions, Lantana Center Measurement (3000 Olympic)

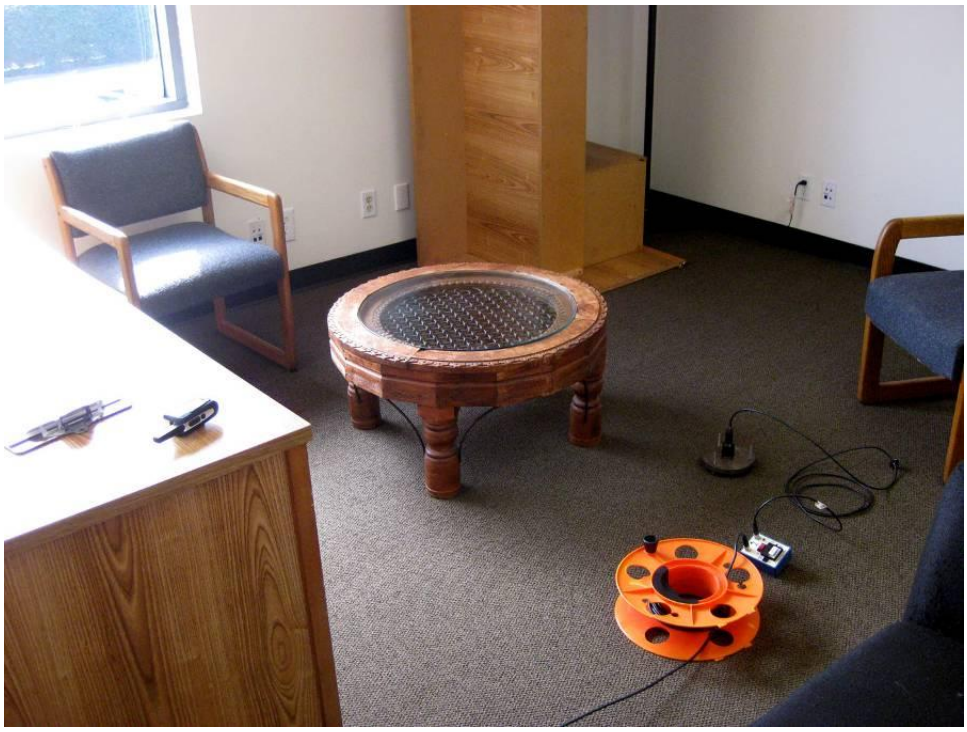


Figure 101 Accelerometer Position Inside Room 1370, Lantana Center Measurement (3000 Olympic)

Figure 102 Outdoor Accelerometers, Lantana South

Figure 103 Accelerometer Position, First Floor Office, Lantana South

Figure 104 Accelerometer Positions, Second Floor, Lantana South

Figure 105 Accelerometer Position, ADR Stage, Todd-AO

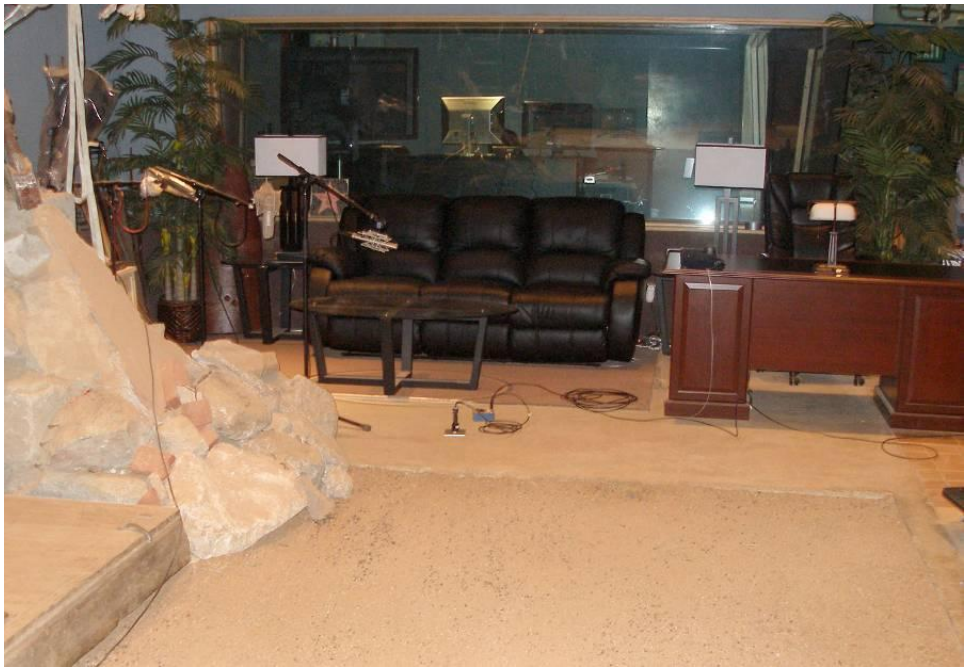


Figure 106 Accelerometer Position in Foley Stage, Todd-AO

Figure 107 Accelerometer Position, Large Stage, Todd-AO

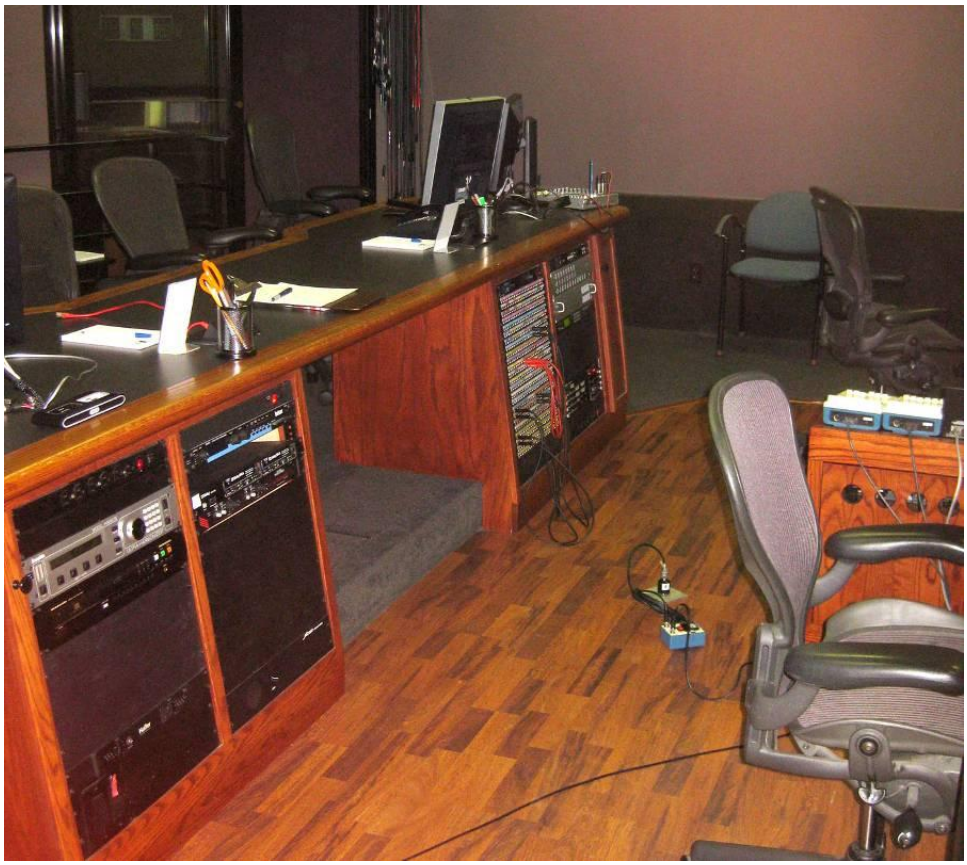


Figure 108 Accelerometer Position, Small Stage, Todd-AO

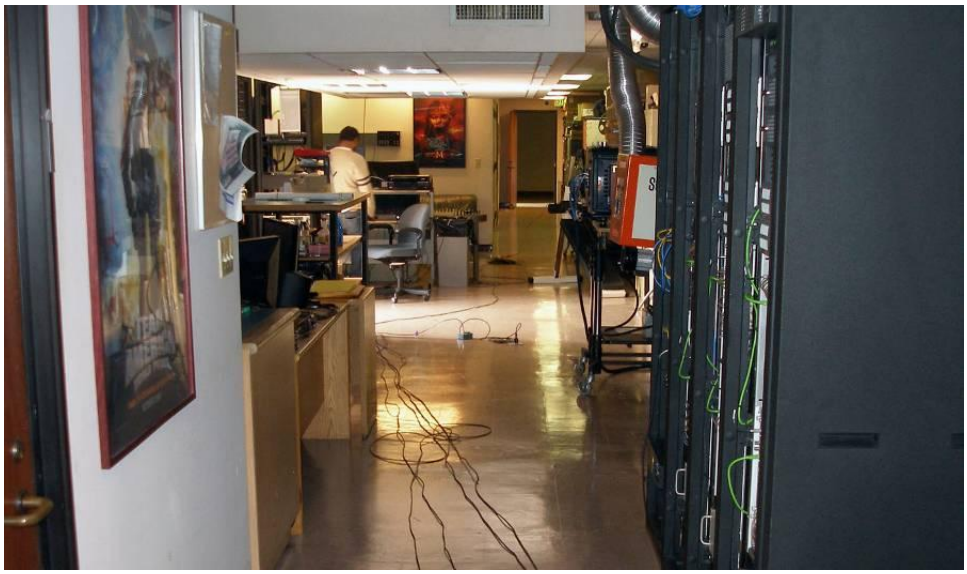


Figure 109 Accelerometer Position in Equipment Corridor, Todd-AO

Figure 110 Speaker Setup for Noise Reduction Tests, Todd-AO and Gray Martin Studios

Figure 111 Accelerometer Position in Studio A, Gray Martin Studios

Figure 112 Accelerometer Position in Studio A Booth, Gray Martin Studios

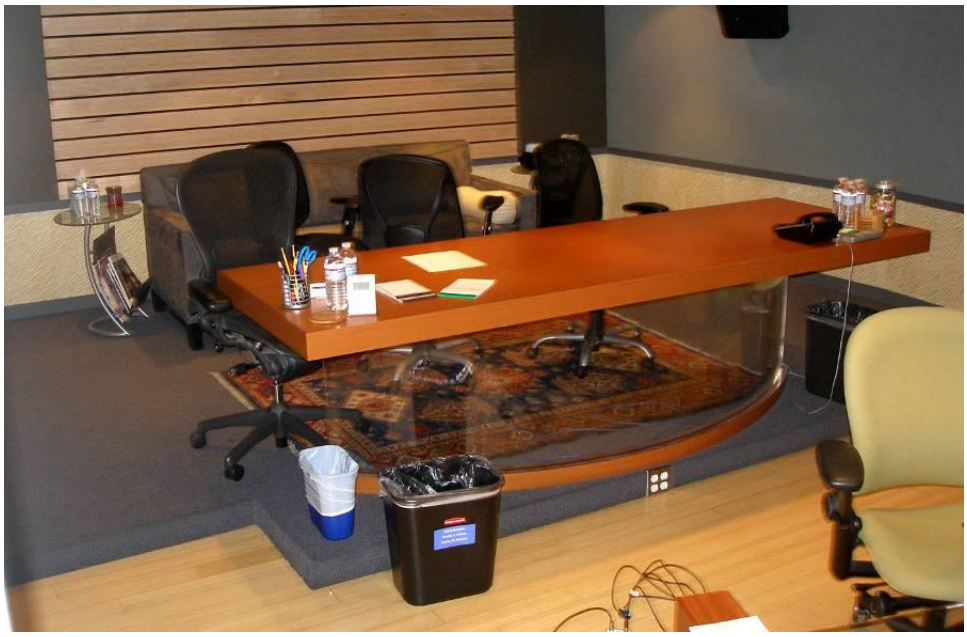


Figure 113 Accelerometer Position in Studio B, Gray Martin Studios

Figure 114 Accelerometer Position in Studio D, Gray Martin Studios

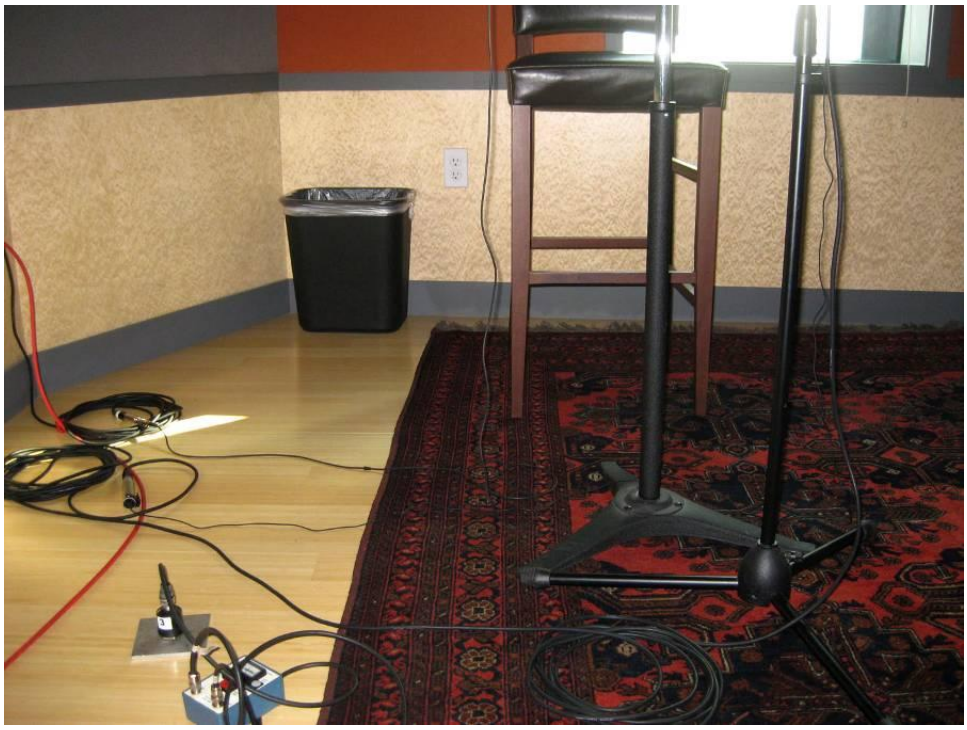


Figure 115 Accelerometer Position in Vocal Booth for Studios C and D, Gray Martin Studios

Figure 116 North Façade of IMAX Showing Speaker Positions for Noise Reduction Test

Figure 117 Noise Monitoring Position in Corridor North of IMAX Screening Rooms

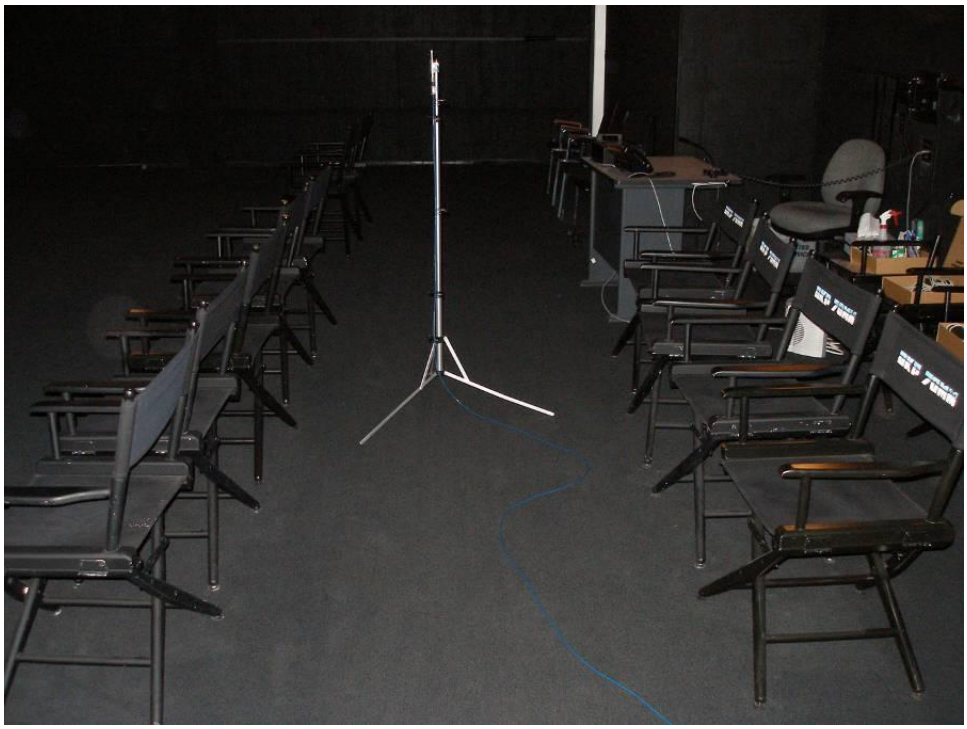


Figure 118 Noise Monitoring Position inside IMAX Screening Room

E.5.1 Noise Assessment, Lantana Campus

This section presents the results of the noise impact assessment for the five buildings on the Lantana Campus.

Noise Impact Thresholds

As discussed in Section 3 (Regulatory Framework), the noise impact assessment is based on criteria provided by FTA. The three land use categories defined by FTA for noise impact are: Category 1, tracts of land where quiet is an essential element of their intended purpose; Category 2, residential; and Category 3, institutional. Recording studios and concert halls are included in Category 1 and theaters are included in Category 3. FTA states that:

> … the criteria do not apply to most commercial or industrial uses because, in general, the activities within these buildings are compatible with higher noise levels. They do apply to business uses which depend on quiet as an important part of operations, such as sound and motion picture recording studios.

It is clear that the recording studios and screening rooms within the Lantana Campus are considered noise sensitive by the FTA noise impact criteria and that spaces used for offices are not considered noise sensitive. Based on discussions with the property manager and field observations, it appears that some of the suites in Lantana West and Lantana Center are used for audio/visual editing, which may require critical listening. For this analysis, the spaces that may be used for audio/visual editing are considered noise sensitive land uses under Category 3 because their sensitivity is approximately equivalent to that of theaters.

The three FTA noise sensitive land use categories and their applicability to the different Lantana spaces are summarized in Table 48 (Airborne Noise Criteria Applied to Buildings on Lantana Campus). Also shown is the assumed level of existing noise and the corresponding noise impact thresholds. The reasoning used to determine the Lantana spaces that are noise sensitive and to select the appropriate land use category is summarized below:

- Suites where audio/visual editing may be performed are considered to fall into land use Category 3 because their noise sensitivity is approximately equivalent to theaters. This includes suites within Lantana West (2900 Olympic) and Lantana Center (3000 Olympic).
- Screening rooms fall into Category 3 because they are equivalent to theaters that are specifically included in Category 3.
- The recording studios at Todd-AO and Gray Martin are in Category 1.
- Spaces used strictly for offices are not considered noise sensitive. This includes the offices in the IMAX building that face the alignment.
- Lantana East and Lantana South are not considered noise sensitive because it appears that they will be used primarily for offices.

As shown in Table 48 (Airborne Noise Criteria Applied to Buildings on Lantana Campus), the threshold for moderate impact is 56 dBA for Category 1 spaces and 61 dBA for Category 3 spaces. These thresholds apply to the highest hourly L_{eq} created by light rail operations. The thresholds for severe noise impact are 5 decibels greater than those for moderate impact.

Because the exterior space is not considered noise sensitive by the FTA criteria, there is no impact unless the train noise would adversely affect interior spaces such as recording studios. The assessment of noise impact at Lantana consisted of two steps:

1. Determine whether the predicted levels of light rail noise exceed the moderate or severe FTA noise impact threshold at the building façade. There is no significant impact unless the predicted levels of light rail noise exceed the moderate impact threshold

2. If the moderate impact threshold is exceeded, use the noise reduction measurements to determine whether the predicted train noise would change the ambient noise levels inside the sensitive spaces of the building. There is no significant impact unless the predicted light rail noise exceeds the measured ambient noise.

Outdoor ambient noise measurements were taken at Lantana Center, Lantana South, and Todd-AO/Gray Martin Studios. These measurements were taken on a weekend when ambient noise levels could be lower than normal because of less traffic on nearby roads and limited activity in the Lantana parking lots. The measured L_{eq} values were 56 dBA at Lantana Center, 57 dBA at Lantana South, and 58 dBA at Todd-AO/Gray Martin. These measurements are consistent with a 24-hour measurement taken at a residence on Exposition Boulevard just south of the Lantana Campus (Site LT-15). The daytime L_{eq} at Site LT-15 was 57 dBA, which is equal to the average of the daytime L_{eq}s measured at Lantana. The existing daytime L_{eq} has been assumed to be 57 dBA even though the typical weekday noise levels may be slightly higher. Note that the buildings along Olympic Boulevard provide acoustic shielding from traffic on Olympic Boulevard and the I-10 Freeway is in a cut which provides acoustic shielding. As a result the noise levels at the Lantana Campus are lower than would be expected given the proximity of Lantana to a freeway and a major arterial.

Table 48 Airborne Noise Criteria Applied to Buildings on Lantana Campus

Land Use Category[a]	Noise Metric (dBA)	Existing Noise Levels $L_{eq}(h)$	Impact Thresholds Mod/Sev $L_{eq}(h)$	Applicable Spaces
Category 1. Tracts of land where quiet is an essential element of their intended purpose. Also included are recording studios and concert halls.	Outdoor $L_{eq}(h)$[b]	57 dBA	56/62 dBA	Recording Studios: Todd-AO and, Gray Martin
Category 2. Residences and buildings where people normally sleep.	Outdoor L_{dn}	--	--	None
Category 3. Institutional land uses with primarily daytime and evening use. This category includes schools, libraries, theaters, and churches where it is important to avoid interference with such activities as speech, meditation, and concentration on reading material.	Outdoor $L_{eq}(h)$[b]	57 dBA	61/67 dBA	Screening rooms and edit suites at IMAX, Lantana Center, and Dick Clark Productions

Source: FTA 2006.

Notes:

a. See Section 3 (Regulatory Framework) for the full land use definitions.

b. L_{eq} for the noisiest hour of transit related activity during hours of noise sensitivity.

Noise Predictions

The procedures described in Section 4.2.1 (Prediction Model, Noise from Light-Rail Vehicle Operations) were used to predict the noise levels that will be generated by the future light rail operations. The key assumptions were:

- The existing daytime L_{eq} is 57 dBA. As discussed above, this is based on the daytime L_{eq} measured at Site LT-15.
- The train speed was assumed to be 55 mph, which will be the maximum operational speed for the Expo light rail.
- The maximum sound level (L_{max}) for a two-car train operating at 40 mph on ballast and tie track at a distance of 50 ft is 77 dBA. Using standard prediction formulas provided in the FTA manual, this scales up to an L_{max} of 81 dBA at a speed of 55 mph.

Table 39 (Summary of Noise Predictions at Lantana Building Facades) shows the results of the noise predictions indicating potential impact at each location within the Lantana Campus. The predictions in Table 39 (Summary of Noise Predictions at Lantana Building Facades) show that there is potential for noise impact at all of the Lantana Campus buildings that have recording studios or other facilities considered to be noise sensitive. As discussed above, noise mitigation is not warranted unless the predicted levels of train noise inside the facilities exceed the existing ambient noise.

Table 49 Summary of Noise Predictions at Lantana Building Facades

Site	Near Track Dist (ft)	Speed (mph)	L_{eq}, (dBA)				Potential Impact[b]
			Existing	Project[a]	Impact Threshold		
					Moderate	Severe	
Lantana West	80	55	57	65	61	67	Moderate
Lantana Center	50	55	57	67	61	67	Severe
Lantana East[c]	150	55	57	63	—	—	—
Site 3: Lantana South[c, d]	150	55	57	69	—	—	—
Site 4: Todd-AO	50	55	57	67	56	62	Severe
Site 5: Gray Martin Studios	50	55	57	67	56	62	Severe
Site 6: IMAX Screening Rooms[d,e]	90	55	57	71	61	67	Severe

Source: ATS Consulting, 2009.

a. Project L_{eq} is the additional noise that would be created by the LRT operations.
b. Impact is considered "potential" because predicted train noise must exceed the measured ambient inside the noise sensitive spaces for there to be an impact.
c. Lantana East and Lantana South are new buildings that appear to be intended for use as office buildings. According to the FTA criteria, office buildings are not considered to be noise sensitive.
d. Noise predictions for Lantana South and IMAX include the added noise from the special trackwork for the lead track into the Maintenance Facility.
e. FTA noise impact criteria do not consider office spaces to be noise sensitive. Therefore, the screening rooms within the IMAX building are the only spaces considered to be noise sensitive.
Moderate = moderate impact, Severe = severe 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. The test consists of using loud speakers to broadcast random noise at the façade of the building, measuring the noise levels inside and outside of the building, and determining the difference between the outdoor and indoor sound levels on a 1/3 octave band basis. The noise reduction measurements were performed with stationary microphones with no spatial averages of the indoor sound levels.

Figure 119 (Indoor and Outdoor Sound Levels, Gray Martin Studio D Noise Reduction Test) shows the A-weighted sound levels during one of the tests at Gray Martin Studios. The upper line is the outdoor noise levels that were around 58 dBA at the start of the recording, increased to 95 dBA for approximately 90 seconds, and then decreased to the background noise level of 58 dBA when the sound source was turned off. The sound levels inside the studio spaces was around 20 dBA before the sound source was turned on, increased to 30 dBA when the sound source was activated, and then dropped back to 20 dBA when the sound source was turned off. The difference between the outdoor and indoor noise during the test shows that the exterior wall/window system is providing over 60 dBA of attenuation.

The 1/3 octave band spectra for the measurements are shown in Figure 120 (Noise Reduction Test Results, Gray Martin Studios). The upper two graphs in Figure 120 (Noise Reduction Test Results, Gray Martin Studios) show the indoor sound levels with the sound source on and off. One factor that is evident in Figure 120 (Noise Reduction Test Results, Gray Martin Studios) is that the sound source did not affect indoor sound levels at frequencies greater than 500 Hz. The measured sound levels at these frequencies are near noise floor of the noise measurement equipment that was used, which means that the sound insulation data at these frequencies is greater than indicated by the measurements. However, referring to the graph in the lower left of Figure 120 (Noise Reduction Test Results, Gray Martin Studios), it is seen that the difference between the indoor and outdoor sound levels approaches or exceeds 70 dB in most of the 1/3 octave bands above 500 Hz.

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 would not be audible and that there would 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

Predicted levels of light rail noise are provided for the remainder of the tested spaces in Table 50 (Summary of Predicted Noise Levels Inside Sensitive Spaces at the Lantana Campus). The predictions in Table 50 (Summary of Predicted Noise Levels Inside Sensitive Spaces at the Lantana Campus) are for the maximum noise level (L_{max}) as a light rail train passes through the Lantana Campus at 55 mph. As seen in Table 50 (Summary of Predicted Noise Levels Inside Sensitive Spaces at the Lantana Campus), the predicted levels of light rail noise exceed the background noise inside the suites at Lantana Center and in the corridor outside the IMAX screening rooms. The predicted noise levels inside Gray Martin Studio D and the studio C/D booth are below the measured ambient noise. However, as discussed above the ambient noise

in these spaces at frequencies greater than 500 Hz is lower than can be measured with the equipment that was used for the noise reduction testing. A noise reduction test was not performed at the Lantana West building. Because Lantana West will be approximately the same distance from the near track and appears to be of similar construction as Lantana Center, the noise predictions for Lantana Center have been assumed to apply to Lantana West as well.

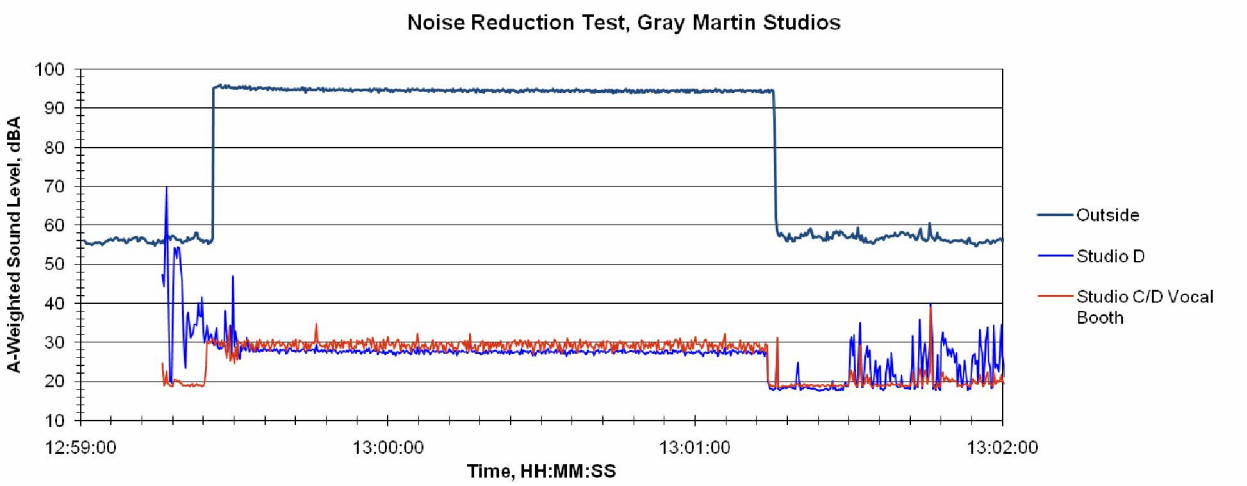
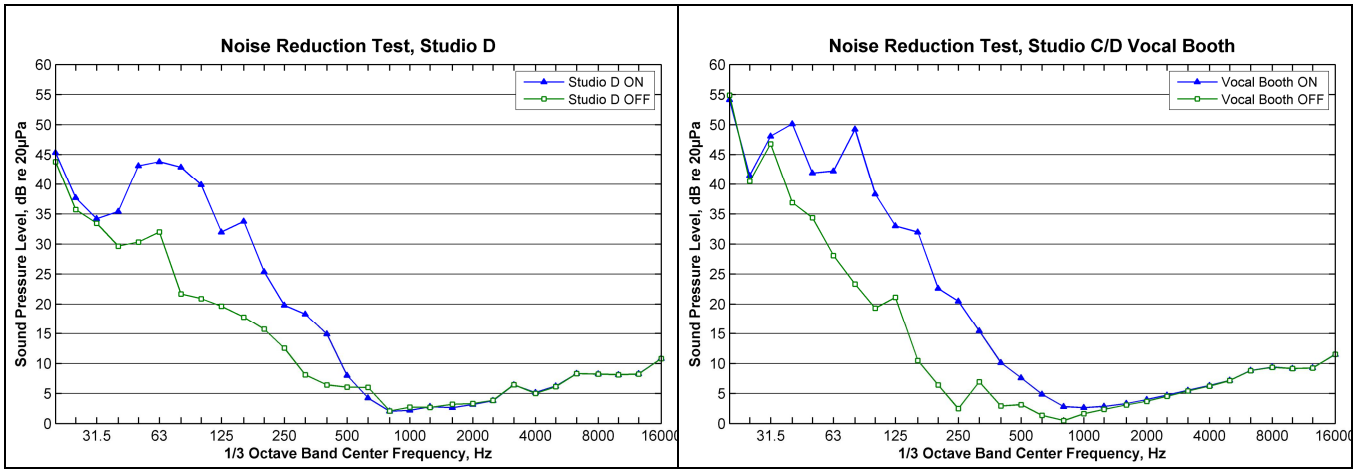


Figure 119 Indoor and Outdoor Sound Levels, Gray Martin Studio D Noise Reduction Test



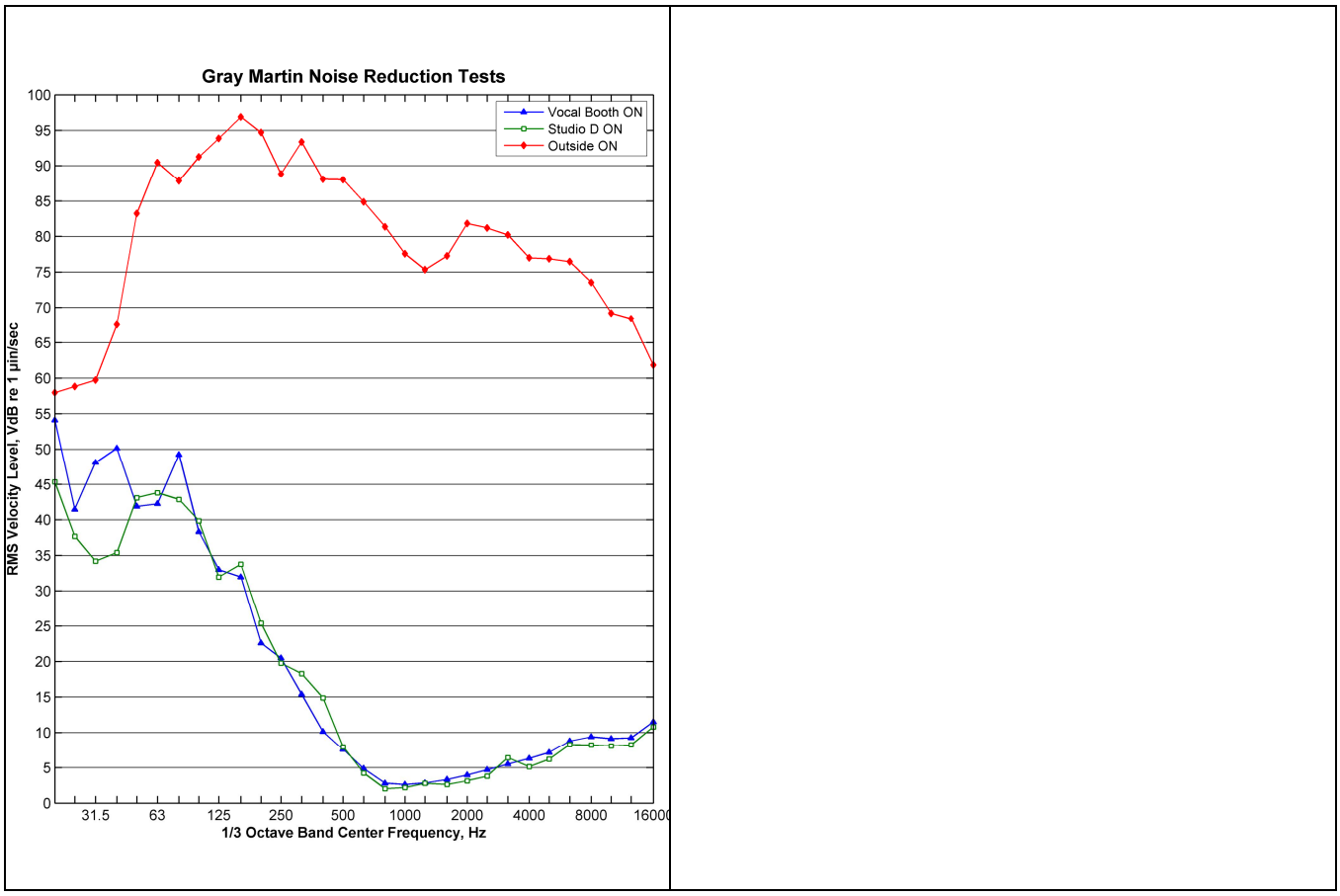


Figure 120 Noise Reduction Test Results, Gray Martin Studios

In Figure 120 (Noise Reduction Test Results, Gray Martin Studios),the top two graphs show the sound level spectra in Studio D and the Vocal Booth between studios C and D with the outdoor sound source on and off. Above approximately 500 Hz, the indoor sound levels are at the noise floor of the sound recording system so the data are not valid. The graph to the left compares the outdoor sound levels and the indoor sound levels. The curves indicate that the outdoor-to-indoor noise reduction provided by the current exterior wall and window system is providing approximately 70 decibels of noise reduction at frequencies above 250 Hz. At frequencies greater than 500 Hz where the measured sound levels were not valid, the sound levels with and without the outdoor sound source turned on were at acceptable levels for a recording studio indicating that noise mitigation is not required at these frequencies.

Table 50 Summary of Predicted Noise Levels Inside Sensitive Spaces at the Lantana Campus

Location[a]	Ambient (dBA)	Train Noise at Façade (dBA)	Predicted Indoor Train Noise (dBA)	Exterior minus Interior[b] (dB)	Train Noise minus Ambient[c] (dB)
Lantana Center 1st Floor	38	81	43	38	+5
Lantana Center 2nd Floor	38	81	44	37	+6
Gray Martin Studio D[d]	19	81	11	70	-8
Gray Martin Booth for Studios C and D[d]	19	81	16	66	-3
IMAX Corridor	47	84[e]	51[e]	33	+4

Source: ATS Consulting, 2009.

a. Predictions for Todd-AO stages and Gray Martin studios A, B and the booth for Studio A are not shown because the exterior noise source was inaudible during the noise reduction tests. Because the light rail noise will be lower than the noise source used for the testing, it is assumed that the noise light rail operations will be inaudible inside these spaces.

b. Predicted train noise at building façade (A-weighted) minus the predicted noise from train operations inside the space.

c. A negative number indicates that the sound level as a light rail train passes would be lower than the measured ambient noise inside the space.

d. The ambient noise inside the Gray Martin spaces was near or below the instrumentation noise floor at frequencies greater than 500 Hz. Therefore, it is not clear whether the predicted levels of train noise will exceed the ambient noise.

e. The predictions for the IMAX spaces include the added noise from the turnout special trackwork that will be located near the northeast corner of the IMAX building.

Noise Mitigation

The conclusion from the noise assessment is that the exterior noise impact thresholds will be exceeded at all of the Lantana buildings that have noise sensitive uses, which is assumed to consist of Lantana West, Lantana Center (including Todd-AO and Gray Martin), and the IMAX building. However, the noise reduction tests show that light rail noise will be lower than the ambient inside sensitive spaces at Todd-AO, IMAX, and the Gray Martin studios A and B. The predicted light rail noise levels inside Gray Martin studios C and D and the vocal booth between studios C and D, and Lantana Center are not below the ambient. Therefore, noise impact is predicted at the Gray Martin Studios spaces that are along the south side of the building, and Lantana Center. All predicted noise impacts at these locations can be eliminated with a sound wall or berm that extends to heights of 6 to 8 ft above the top of rail. Figure 121 (Location of Noise Mitigation) shows the location of the proposed mitigation on the north side of the mainline between Stewart Street and the western edge of Lantana East.

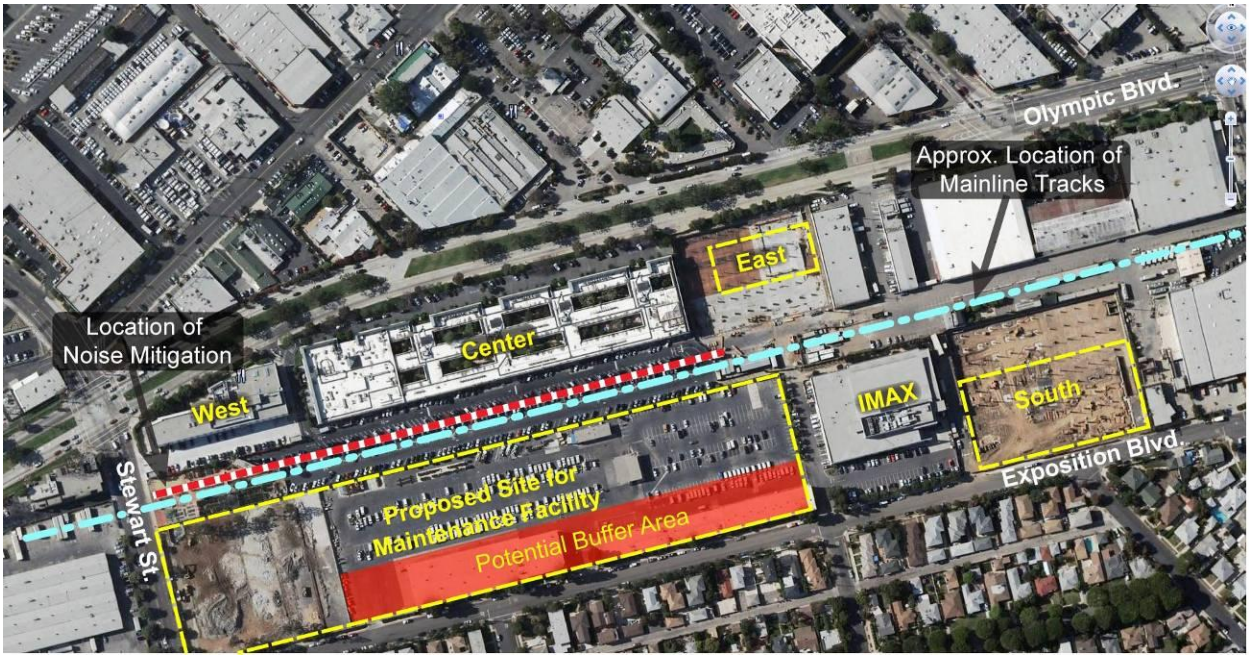


Figure 121 Location of Noise Mitigation

Maintenance Facility

The Maintenance Facility would include a 6.9-acre area directly south of the Lantana West and Lantana Center locations. The site is located on parcels currently owned by Verizon and Metro, and portions of two adjacent parcels east and west of the Verizon property. A Maintenance Facility Buffer Design Option was added to the FEIR, which would occupy only a portion of the Verizon site and extend into the existing Santa Monica College parking lot to the west. Utilization of the adjacent parking lot on the west side of the Verizon site would create an approximate 100- to 110-foot buffer between the Maintenance Facility and the residential area on the south side of Exposition Boulevard. Between 43 and 45 vehicles would be stored at the Maintenance Facility overnight. The facility would be used for vehicle cleaning and maintenance. Noise predictions for the Lantana Campus using the more conservative Category 1 Land Use Criteria were made for both maintenance facility layouts. A minimum 8- to 12-foot security wall and combination fence would surround the facility at its perimeter, and this would mitigate noise at the buildings on the Lantana Campus to below the Category 1 impact thresholds for both Maintenance Facility layouts.

E.5.2 Vibration Assessment, Lantana Campus

Vibration Impact Thresholds

The vibration assessment is based on the impact thresholds provided in the FTA Guidance Manual (see Section 3, Regulatory Framework). The FTA criteria for groundborne vibration include limits on both the building vibration that may be perceptible and hence annoying to building occupants as well as the goundborne noise (the noise generated by the vibrating room surfaces). The groundborne noise impact thresholds are not normally applied for surface transportation systems such as the Expo Corridor because the groundborne noise is usually

masked by the noise reaching the receivers via the normal airborne paths. However, for spaces such as some of the Lantana facilities where audio recordings are made and critical listening is important, the groundborne noise criteria are applicable. The FTA criteria for groundborne noise and vibration include limits for three land use categories and for specific uses, such as theaters and concert halls, which are uniquely sensitive to intrusive noise and vibration.

The specific vibration impact thresholds applicable to the different spaces of the Lantana Campus are given in Table 51(Groundborne Vibration Criteria Applied to Buildings on Lantana Campus). Included in Table 51 (Groundborne Vibration Criteria Applied to Buildings on Lantana Campus) are the three FTA landuse categories for vibration impact and the specific vibration sensitive uses that are applicable to the Lantana Campus. It is important to recognize that the FTA land use categories for noise impact differ slightly from the FTA land use categories for vibration impact. One important difference is that the FTA noise impact criteria do not consider offices spaces as a sensitive receptor. However, the FTA vibration criteria include office spaces under Category 3. Specifically, the FTA guidance manual states that "…it is generally appropriate to include office buildings in this category" and only excludes offices that are located in buildings primarily used for non-sensitive activities such as industrial buildings.

One question is what the appropriate vibration impact category is for Lantana suites that are used for activities such as audio/visual editing. For this analysis, audio/visual editing has been considered to have sensitivity equivalent to office space. This is in contrast to the airborne noise impact assessment where audio/visual editing has been considered equivalent to theaters. The reasons for this difference in the application of the noise and vibration impact criteria are:

- The FTA groundborne vibration criteria consider office spaces as sensitive receptors while the airborne noise criteria do not consider offices as sensitive.
- Of the available FTA land use categories for airborne noise, Category 3 (Institutional) is the best fit for audio/visual editing. This category includes "…schools, libraries, theaters, and churches." The noise sensitivity of theaters and audio/visual editing suites are approximately equivalent although theaters generally are more sensitive to noise than are audio/visual editing suites.
- The FTA vibration criteria for Category 3 includes "quiet offices." Theaters are covered by a separate category under "special buildings." Slightly higher groundborne noise and vibration are allowed for quiet offices than for theaters.

The conclusion is that it is appropriate to apply the criteria for quiet offices to the suites that are used for audio/visual editing or similar activities.

The key assumptions made in applying the FTA vibration criteria to the Lantana facilities are:

1. There are no spaces within the Lantana Campus that contain vibration sensitive equipment (FTA vibration Category 1) or that are used as residences.

2. The majority of the Lantana Campus spaces that could be affected by groundborne vibration from light rail operations are used as offices or audio/visual editing. The vibration impact thresholds applicable to quiet offices (FTA Category 3) have been applied to these spaces.

3. The impact thresholds applicable to theaters have been applied to spaces that contain screening rooms.

4. The impact thresholds applicable to "concert Halls, TV studios, and recording studios" have been applied to the stages and recording studios of Todd-AO and Gray Martin Studios.

Table 51 Groundborne Vibration Criteria Applied to Buildings on Lantana Campus

Land Use Category	General Vibration Assessment Impact Thresholds		Detailed Assessment Vibration Impact Thresholds (VdB)[a]	Applicable Lantana Spaces
	Groundborne Vibration (VdB)	Groundborne Noise (dBA)		
Category 1. Buildings where vibration would interfere with interior operations (primarily applicable to vibration sensitive equipment such as electron microscopes.)	65	—	N/A	None
Category 2. Residences and buildings where people normally sleep.	72	35	72	None
Category 3. Institutional land uses with primarily daytime use including office spaces.	75	40	75[b]	Suites used for office space, audio/video editing, and similar activities
Concert Halls, TV Studios, Recording Studios	65	25	N/A	Recording studios at Todd-AO, Gray Martin
Auditoriums	72	30	N/A	None
Theaters	72	35	N/A	Screening rooms at Todd-AO, IMAX, Dick Clark Productions

Source: FTA Criteria, as applied by ATS Consulting, 2009.

a. The FTA guidance manual provides criteria based on international standards that can be used when the predictions include the 1/3 octave band spectra of the vibration. The Detailed Vibration Analysis criteria define impact to occur when any 1/3 octave band level of the predicted vibration exceeds a curve defining the impact threshold (See Figure 10 [FTA Criteria for Detailed Vibration Analysis]).

b. The value for offices in Figure 10 (FTA Criteria for Detailed Vibration Analysis) is 84 VdB. This is inconsistent with the General Vibration Analysis impact threshold of 75 VdB for Category 3 land uses. A value of 75 VdB has been used as the Detailed Vibration Analysis threshold for Category 3 land uses.

Vibration Propagation Test Results

The vibration test procedure used to characterize how vibration will be transmitted from the light rail tracks into various spaces of the Lantana Campus is described in Section 2.2.1 (Vibration Propagation Test Procedure). The test results are in terms of the line source transfer mobility (LSTM) and the coherence. The LSTM characterizes the relationship between the exciting force and the resulting vibration velocity. The coherence provides a measure of the data quality. Coherence close to 1 indicates a strong relationship between the exciting force and the

vibration. Coherence less than 0.1 indicates a relatively weak relationship between the exciting force and the vibration. Coherence less than 0.1 to 0.2 indicates that the background vibration is greater than the vibration generated by the exciting force and that the measured LSTM is an upper bound for the true LSTM. Experience is that the predicted vibration levels will be 5 to 10 decibels greater than the true vibration levels when the coherence is less than 0.3.

Following are summaries of each vibration propagation test performed at the Lantana Campus.

Site 1: Lantana West (2900 Olympic). The test results for Lantana West are shown in Figure 122 (Measured LSTM and Coherence, Lantana West [2900 Olympic Blvd.]). The two outdoor measurements were in the surface parking lot south of the building that is above an underground parking structure. The impact line was just south of the surface parking structure at a distance of 60 ft from the south façade of Lantana West. The closest Expo Phase 2 track is expected to be approximately 75 ft from the building. Unfortunately, it was not feasible to locate the impact line at this distance. The vibration predictions for Lantana West are based on the measured LSTMs without any adjustment for the location of the impact line. As a result, the predictions are expected to be at least 1 to 4 decibels on the conservative (high) side. Some observations from inspection of the data in Figure 122 (Measured LSTM and Coherence, Lantana West [2900 Olympic Blvd.]) are:

- The coherence indicates that the valid data range extends from 16 Hz to 125 Hz.
- The measurement just outside the screening room indicates more efficient propagation in the 50 and 63 Hz 1/3 octave bands at this location.
- The LSTM at the second floor positions generally is substantially lower than at the first floor positions. A notable exception is at frequencies of 63 Hz and greater at the second floor office.

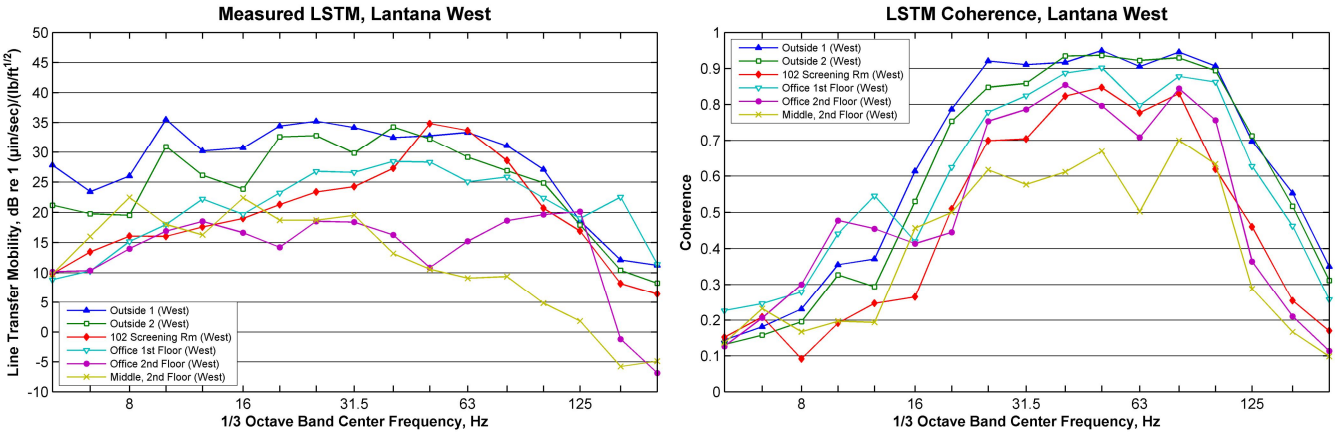


Figure 122 Measured LSTM and Coherence, Lantana West (2900 Olympic Blvd.)

Site 2: Lantana Center (3000 Olympic). The measurements for Lantana Center were performed at four suites located west of entrance door 4. The LSTM measurements were performed at two second floor suites and two first floor suites. Suites 1369B and 2371 were located on the south side of the corridor and suites 1370 and 2370 were located on the north side of the corridor. The two outdoor measurements were at distances of 25 and 50 ft from the impact line. The LSTM test results are presented in Figure 123 (Measured LSTM and Coherence, Lantana West [2900 Olympic Blvd.]). The results show that:

- The coherence indicates that the valid data range extends from 10 to 160 Hz for the outdoor and first floor measurements and from 10 to 125 Hz for the two second floor measurements.
- Room 1369B has more efficient vibration propagation than the other three rooms at frequencies greater than 50 Hz.
- The most efficient propagation into the building over the 16 to 40 Hz range is for room 2370, which is on the second floor on the north side of the corridor.
- The vibration propagation into the office spaces of Lantana Center tends to be more efficient than for most of the other Lantana Campus spaces where measurements were performed.

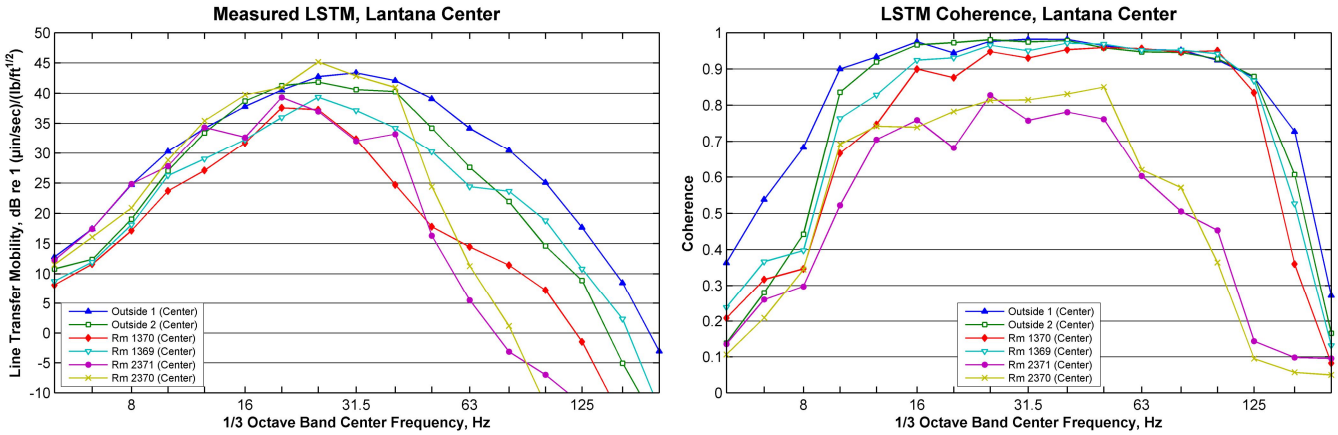


Figure 123 Measured LSTM and Coherence, Lantana West (2900 Olympic Blvd.)

Site 3: Lantana South. The LSTM measurements at Lantana South included two outdoor positions in the parking lot above the underground parking structure, two on the first floor and two on the second floor. The second floor was not built out at the time of the measurements. The results shown in Figure 124 (Measured LSTM and Coherence, Lantana South) indicate that:

- The results are valid over the 8 to 100 Hz frequency range.
- The propagation into the building drops off steadily at frequencies greater than 20 Hz.
- All four interior positions have similar LSTMs.
- The LSTMs on the first floor are slightly higher than the LSTMs on the second floor and the LSTMs for the positions closest to the impact line are slightly higher than the LSTMs for the positions farther back.

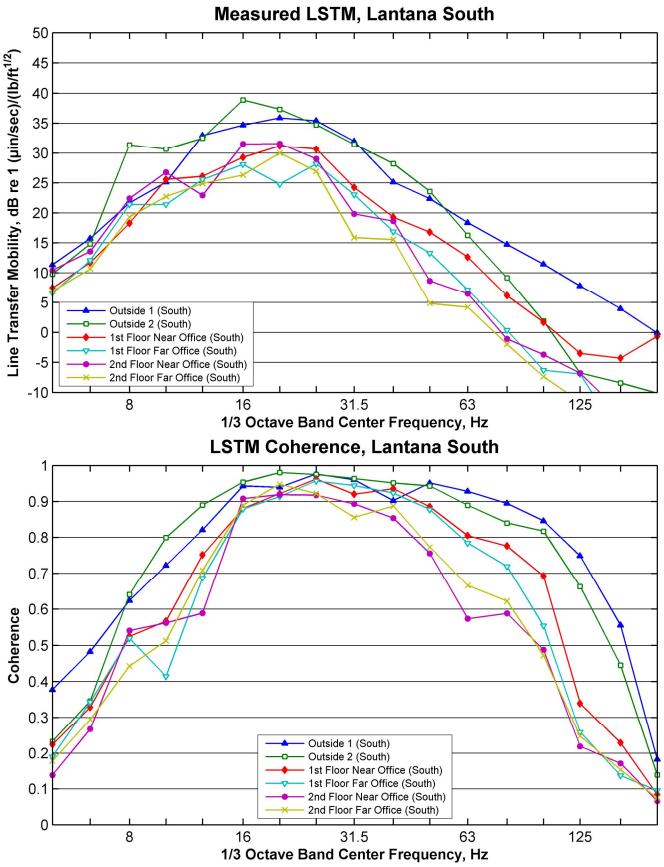


Figure 124 Measured LSTM and Coherence, Lantana South

Site 4: Todd-AO. The measurements at Todd-AO included the equipment corridor that is along the south wall of the building, two stages that are just north of the equipment corridor, and two stages farther north in the building (the ADR Stage and the Foley Studio). There was also one outdoor measurement position. The LSTM and coherence results shown in Figure 125 (Measured LSTM and Coherence, Todd-AO) indicate that:

- Comparing the LSTM measured at the outdoor position and the closest interior position (the hallway), it is clear that there is substantial outdoor-to-indoor attenuation at frequencies greater than 40 Hz.
- The coherence indicates accurate data over a relatively wide frequency range. For the hallway, small stage, and large stage the valid data extends up to 125 Hz. For the ADR and Foley, which are located substantially farther from the impact line, the valid range extends up to 80 Hz. As discussed above, the LSTM results when coherence is low represent an upper bound for the true LSTM and will lead to conservative predictions of train vibration.
- As expected, the LSTM at tends to be lower the farther the measurement position was from the impact line. The ADR measurement is a notable exception. Considering the distance that it is from the impact line, the propagation over the 20 to 63 Hz range is quite efficient. This result could be related to some feature of the ADR floor system that amplifies vibration in this frequency range.

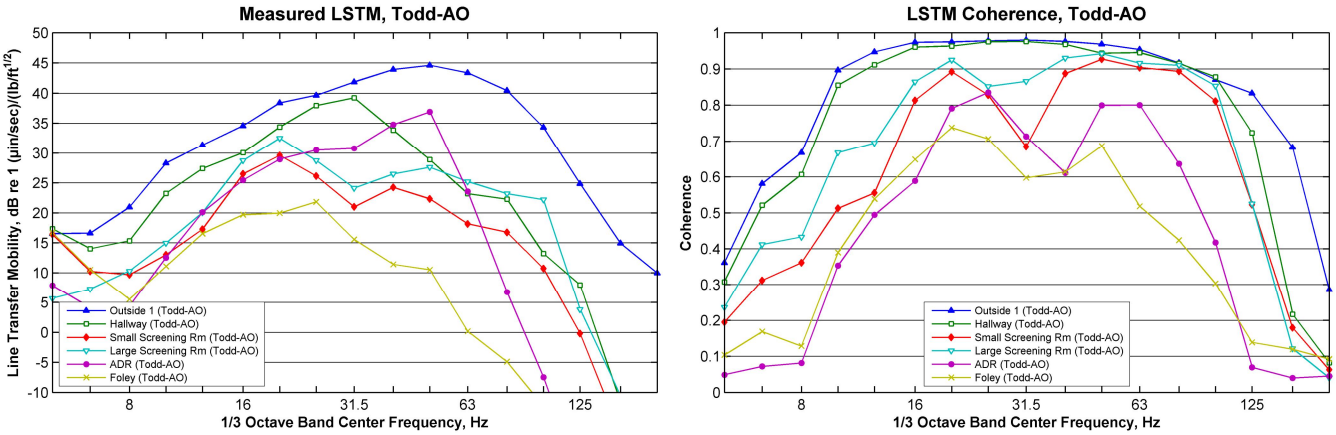


Figure 125 Measured LSTM and Coherence, Todd-AO

Site 5: Gray Martin Studios. Gray Martin Studios is located above Todd-AO at the west end of Lantana Center. The facility has four recording studios (A, B, C, and D) and booths for studio A and between studios C and D. Studios C and D and the booth for studios C and D are located on the south side of the building closest to the impact line. The LSTM and coherence results shown in Figure 126 (Measured LSTM and Coherence, Gray Martin Studios) indicate that:

- Similar to the Todd-AO measurements, there is substantial outdoor-to-indoor attenuation at frequencies greater than 40 Hz.
- The LSTM tends to drop with distance from the impact line. The one exception is the booth for studio A where the LSTM at some frequencies is greater than the LSTM measured in studio B that was closer to the impact line.

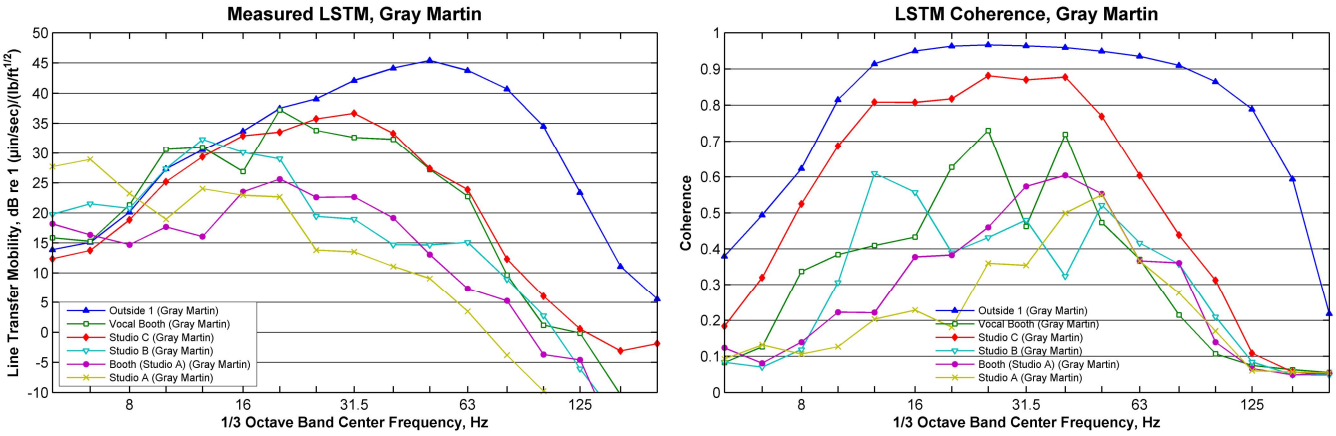


Figure 126 Measured LSTM and Coherence, Gray Martin Studios

Site 6: IMAX. Vibration propagation tests at the IMAX building. However, as discussed below, Site 7 was close enough to IMAX that it can be used for vibration predictions.

Site 7: Verizon Parking Lot. This measurement was performed in the northeast corner of the Verizon parking lot adjacent to the IMAX building. Measurements were made at distances of 25, 38, 50, 75, 100, and 150 ft. The results are shown in Figure 127 (Measured LSTM and

Coherence, Site 7, Verizon Parking Lot). The data show a consistent and relatively smooth attenuation with distance perhaps indicating relatively uniform soil conditions at this site. The coherence indicates that the LSTM results are valid up to 160 Hz for the tests out to 75 ft, and 100 Hz for the tests at 100 ft and 150 ft. Because the IMAX building is slab-on-grade construction, the measurements at this site are directly applicable to predicting groundborne vibration levels inside the IMAX building.

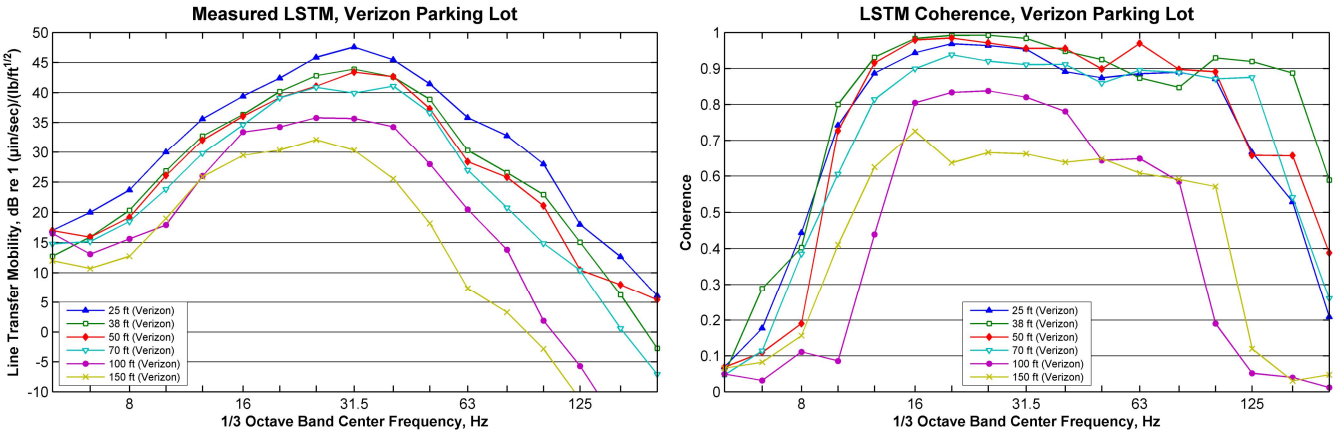


Figure 127 Measured LSTM and Coherence, Site 7, Verizon Parking Lot

Comparison of Outdoor Measurements. Figure 128 (Measured LSTM and Coherence, Lantana Outdoor Measurement Position) shows the LSTM results for all of the outdoor measurements at Lantana that were 50 ft or less from the impact line. Two factors are evident. First the results at most of the measurement positions are quite consistent both in terms of the amplitudes and the spectrum shape. Second is the higher LSTM results at frequencies of 50 Hz and greater for the Todd-AO and Gray Martin Studios tests. The consistency indicates that soil conditions are relatively uniform over the Lantana Campus with a notable exception of more efficient propagation at Todd-AO and Gray Martin. Referring back to Figure 125 (Measured LSTM and Coherence, Todd-AO) and Figure 126 (Measured LSTM and Coherence, Gray Martin Studios) it is seen that there is unusually high attenuation of vibration from the outdoor position into the closest positions at Todd-AO and Gray Martin. This indicates that the geologic condition that resulted in a relatively high outdoor LSTM factor will not result in relatively high indoor levels at Todd-AO and Gray Martin Studios.

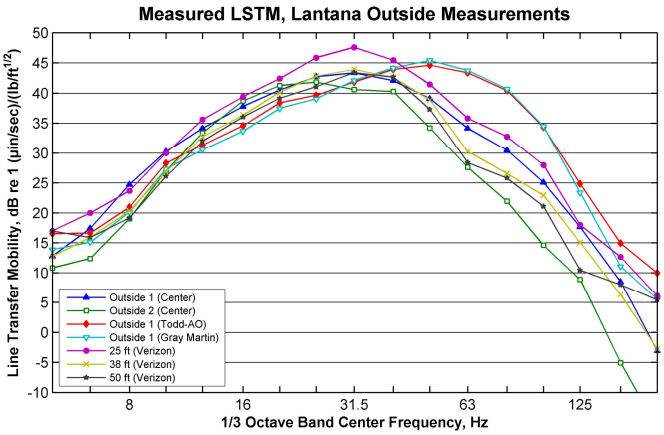


Figure 128 Measured LSTM and Coherence, Lantana Outdoor Measurement Position

Vibration Impact Assessment

The measured LSTM have been combined with the force density to predict the levels of groundborne vibration that will be generated inside the Lantana Campus spaces where vibration propagation tests were performed. This procedure is discussed in Section 4.3.1 (Operational Vibration). Key assumptions that were made in the prediction process are:

Train Speed	55 mph
Safety factor/contingency:	3 decibels
Adjustment from VdB to sound pressure:	-5 decibels

The predicted overall vibration and noise vibration levels for each of the indoor spaces where propagation tests were performed are presented in Table 52 (Predicted Groundborne Vibration and Groundborne Noise in Sensitive Lantana Spaces). Shown are the impact thresholds and the predicted vibration and noise levels with no mitigation, with ballast mats as mitigation, and with a floating slab as mitigation. A 12 Hz floating slab is assumed for all spaces except Gray Martin where the predicted levels with a 12 Hz floating slab still exceed the applicable impact threshold for vibration. A 3 to 5 Hz floating slab is assumed for Gray Martin. Floating slabs with resonance frequencies of 8 Hz and higher are usually constructed with natural rubber or other elastomer materials supporting the concrete track slab. To obtain a lower resonance frequency usually requires using coil springs to support the track.

The locations where the predicted levels exceed the impact thresholds are highlighted. Graphs of the predicted groundborne vibration levels for the spaces where impacts are predicted are shown in Figure 129 (Predicted Vibration Levels, Lantana West) through Figure 132 (Predicted Vibration Levels, Gray Martin Studios). The options for mitigating vibration impacts are discussed in Section 6.5 (Train Vibration). Each of these spaces and the mitigation options are discussed below:

Lantana West: The spaces where impact is predicted are the screening room on the first floor and the two the offices at the south façade of the building. The predicted levels in the offices are only marginally above the applicable impact threshold for groundborne noise while the predicted groundborne noise in the screening room exceeds the applicable impact threshold by 7 decibels. Not only does the screening room have a lower impact threshold than the other spaces in the building, but the measured LSTM have more energy in the higher frequencies

(see Figure 129 [Predicted Vibration Levels, Lantana West]). The analysis indicates that these impacts can be mitigated with the use of a ballast mat.

Lantana Center: The predicted vibration levels in the two upstairs suites tested in Lantana Center exceed the vibration impact threshold for a General Vibration Analysis. However, as shown in Figure 130 (Predicted Vibration Levels, Lantana Center, 2nd Floor Suites), the predicted vibration levels do not exceed the impact threshold for a Detailed Vibration Analysis. Therefore, no vibration mitigation is required for the Lantana Center suites that are east of Todd-AO and Gray Martin Studios.

Lantana South: No vibration impacts are predicted for Lantana South. Lantana East is predicted to have similar vibration levels as Lantana South, therefore no impact are predicted at Lantana East.

Todd-AO: The predicted levels of groundborne noise and groundborne vibration at three of the four sensitive spaces tested in the Todd-AO facility exceed the impact thresholds. Based on the predictions summarized in Table 52 (Predicted Groundborne Vibration and Groundborne Noise in Sensitive Lantana Spaces), vibration mitigation in the form of a 12 Hz floating slab will be sufficient to ensure that the impacts at Todd-AO are mitigated.

Gray Martin Studios: The predicted vibration levels in three of the five spaces tested exceed the impact threshold and the predicted groundborne noise levels exceed the impact threshold in two of the spaces. The predicted vibration levels have considerable energy at low frequencies, which may be an indication of a relatively flexible floor. Because of this low frequency vibration, a 12 Hz floating slab will not be an effective vibration mitigation measure. As indicated in Table 52 (Predicted Groundborne Vibration and Groundborne Noise in Sensitive Lantana Spaces), mitigation of this vibration will require a floating slab with a resonance frequency in the 3 to 5 Hz range. Factors that should be evaluated during the final design of the vibration mitigation for Todd-AO and Gray Martin include:

- the amount that the predicted vibration with a 12 Hz floating slab exceeds the ambient vibration inside the studios during a normal workday when the building is occupied,
- whether modifications to the building structure would be sufficient in combination with a 12 Hz floating slab to eliminate the vibration impact, and
- whether vibration that exceeds the FTA impact threshold at subaudible frequencies would interfere with the use of the studios.

IMAX: The predicted groundborne vibration and noise levels at the IMAX building exceed the impact thresholds because of the special trackwork that would be located near the northeast corner of the building for the lead track to the Maintenance Facility. The most effective means of eliminating this impact is to use a spring rail frog in the switch to eliminate the wheel impacts that occur with most standard frogs. It is possible that other low-impact frog designs would also provide sufficient vibration mitigation to eliminate the predicted impact. An example is a properly designed flange bearing frog that provides a smooth transition through the rail gap with a ramp that temporarily transfers the load to the wheel flange. Use of a low-impact frog is sufficient to reduce predicted vibration levels to below the impact threshold. No additional vibration mitigation, such as a ballast mat, is required.

The general locations and types of vibration mitigation measures are shown in Figure 133 (Locations for Vibration Mitigation).

Table 52 Predicted Groundborne Vibration and Groundborne Noise in Sensitive Lantana Spaces

Location	Predicted Groundborne Vibration, VdB				Predicted Groundborne Noise, dBA			
	Thres-holda	No Mitig.	Ballast Mat	Floating Slab	Thres-holda	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
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[e]	10

Source: ATS Consulting, 2009.

a. Impact threshold for the overall vibration level. Refer to Table 51 and 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.

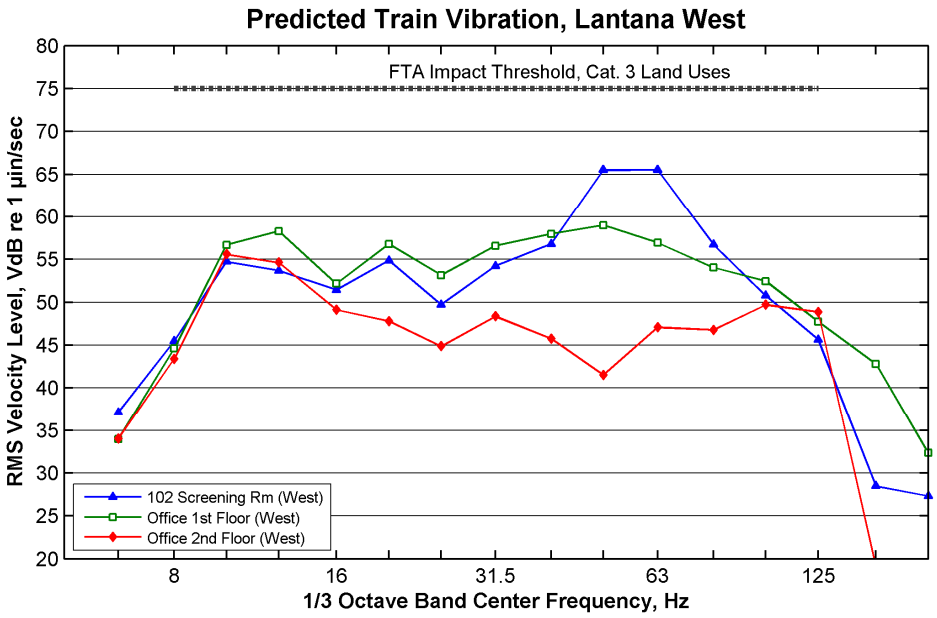


Figure 129 Predicted Vibration Levels, Lantana West

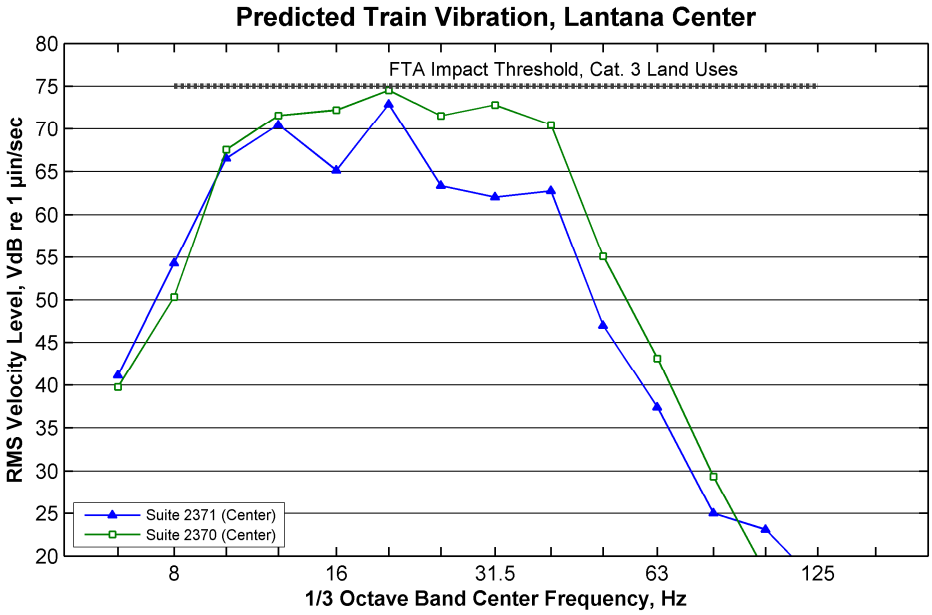


Figure 130 Predicted Vibration Levels, Lantana Center, 2nd Floor Suites

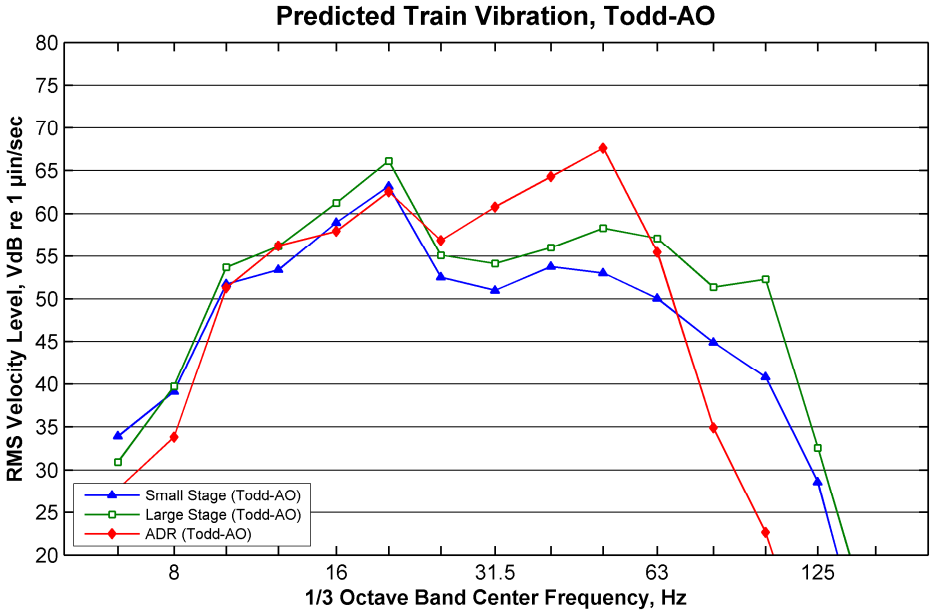


Figure 131 Predicted Vibration Levels, Todd-AO Stages

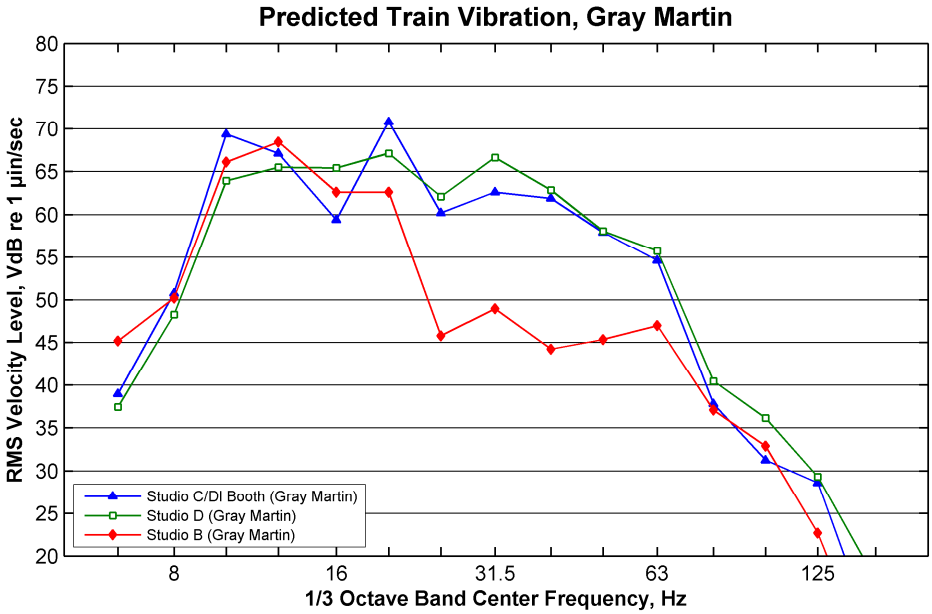


Figure 132 Predicted Vibration Levels, Gray Martin Studios

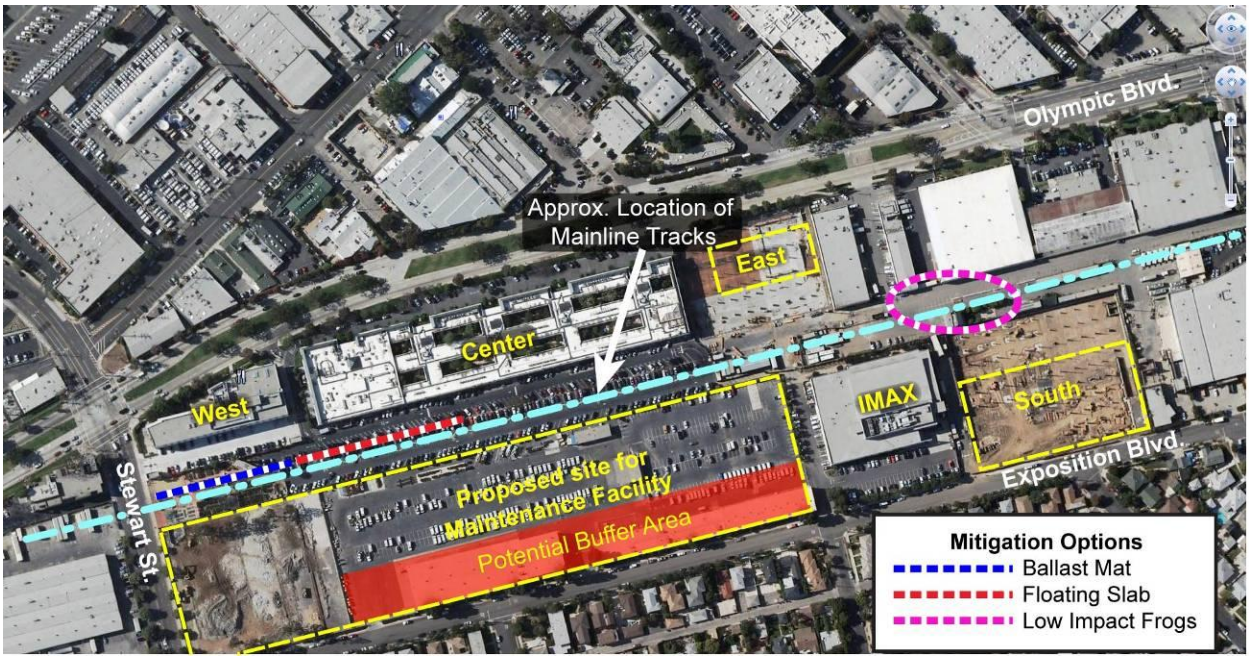


Figure 133 Locations for Vibration Mitigation

E.6 Maintenance Facility

The Maintenance Yard Facility would include a 6.9-acre area directly south of the ROW and east of Stewart Street. There are currently two options for the layout of the maintenance facility, the original DEIR layout with slight modifications and a Buffer Design Option. Between 43 and 45 vehicles would be stored at the Maintenance Facility overnight. The facility would be used for vehicle cleaning and maintenance. The shop would be used for light repairs 24 hours a day and would be equipped with wheel truing facilities. A minimum 8- to 12-foot security wall and combination fence would surround the facility at its perimeter. Because of the facility's close proximity to residences along Exposition Boulevard to the south and the community's concerns about noise in the area, a series of supplementary noise tests were carried out at a similar maintenance facility used by the Green Line. The Green Line Maintenance Yard is located at 33rd Street and Aviation Boulevard. Two long-term measurements and four short-term measurements were taken at this location in order to provide reference noise levels for analysis at the proposed Stewart Maintenance Yard Facility. The long-term measurements were used to determine overall noise levels in the yard and also for individual trains entering and exiting the yard. The short-term measurements were taken to use as a reference for noise predictions at the proposed Stewart Street Maintenance Yard Facility.

Short-term measurement locations were chosen throughout the Green Line Yard because of the close proximity to specific operations. Figure 134 (Location of Operations and Measurements in the Green Line Yard) shows the locations of operations and measurement locations at the Green Line Yard. Previous measurements taken at the Gold Line Yard were also considered when predicting future noise levels. Where measurements of similar facilities at the Gold and Green Line yards were available, the higher of the two measurements was used for the predictions to ensure that the predictions are on the conservative side. Each of the measurements is discussed below.

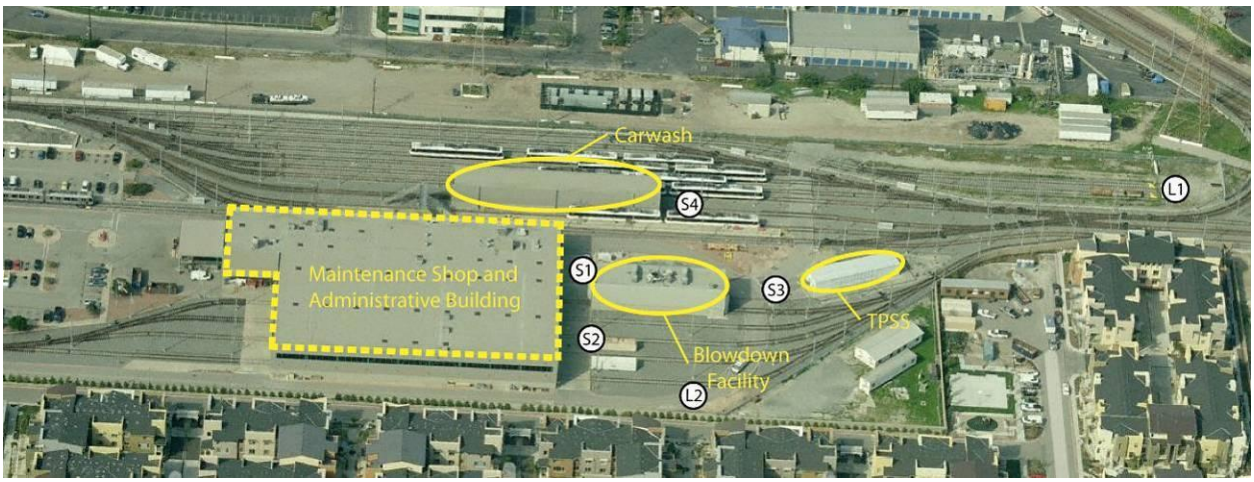


Figure 134 Location of Operations and Measurements in the Green Line Yard

Blowdown facility: A blowdown facility is used to clean the underside of transit vehicles. Noise sources associated with blowdown facilities include a vacuum system and an air compressor. The measured noise levels for the blowdown facilities are summarized in Table 48 (Blowdown Facility Sound Levels). The noise levels at the Gold Line blowdown facility were substantially higher than noise levels measured at the Green Line Yard. This was because the Gold Line

blowdown facility has a high-powered compressor near the entrance to the facility. The Gold Line measurements were used as a reference for our analysis.

Table 48 Blowdown Facility Sound Levels

Metric	Sound Levels at 20 ft from entrance, dBA	
	Gold Line	Green Line
L_{eq}	69.1	57
L_{max}	69.7	58
SEL	96.9	85.1
Duration	10 minutes	

Source: ATS Consulting, 2009.

Car Wash Noise Measurements: The noise from a car wash cycle was measured at a distance of 20 ft from the exit end of the car wash. Table 49 (Car wash Sound Levels) summarizes the measured sound levels at car washes in the Gold Line and Green Line. Note that the Gold Line car wash does not have blowers to strip the water off of the vehicle. When car washes are equipped with blowers, the blower fans tend to be the dominant noise source. In addition, measurements were performed at the car wash in the Blue Line Yard. When the noise from the Blue Line car wash was measured, the blowers generated a sound level of 80 dBA at a distance of 60 ft from the blowers. The car wash blowers at the Blue Line Yard are located outside, which would not be the case for the car wash at the Expo Maintenance Facility.

Table 49 Car wash Sound Levels

Metric	Sound Levels, dBA	
	Gold Line	Green Line
L_{max}	73 dBA	64 dBA
L_{eq}	64 dBA	61 dBA
SEL	88 dBA	85 dBA
Duration	5 minutes	

Source: ATS Consulting, 2009.

TPSS Measurements: Traction Power Substations (TPSS) are electrical substations that redistribute the electrical current needed to power the LRT. A TPSS is typically a prefabricated structure approximately 15 feet wide by 43 feet long by 16 feet high. The primary noise sources on TPSS units are transformer hum and noise from cooling systems. The cooling fans are the primary noise source on the TPSS units used on the Metro Gold Line. The noise level at a distance of 40 ft from the cooling fan of a Gold Line TPSS unit in South Pasadena was measured to be 51 dBA, which is equivalent to 49 dBA at a distance of 50 ft (the measurement was not done at 50 ft because of obstructions).

Maintenance Shop: Noise sources associated with the Maintenance Shop include compressors, fans, vehicle-lift alarms, and various hand tools. The measurement location is

shown as S2 in Figure 134 (Location of Operations and Measurements in the Green Line Yard) and was 30 feet from the entrance of the shop. The measured sound level was 62 dBA L_{eq} over a period of 30 minutes.

Longer measurements were taken at the entrance to the yard and at the perimeter wall closest to the maintenance shop entrance (L1 and L2 respectively, see Figure 134). Measurement Site L1 was at the yard entrance and L2 was at the perimeter south of the main shop building. The purpose of these measurements was to verify the assumptions made about noise from trains entering and exiting the yard and to measure the total noise from the yard operations at the perimeter of the yard. The time histories of both measurements are shown in Figure 135 (One-Minute L_{eq} Noise Levels near Green Line Yard Entrance [Site L1]) and Figure 136 (One-Minute L_{eq} Noise Levels at South Boundary of Green Line Yard [Site L2]). Sound levels from trains entering and exiting the yard averaged 61 dBA at 50 feet.

The 1-minute average sound levels at Site L1 (the entrance to the yard) were consistently between 53 to 60 dBA with small peaks from trains passing on the mainline and trains entering and exiting the yard. The sound levels at Site L2 were also generally between 55 and 60 dBA during the daytime hours with several brief periods when sound levels were higher.

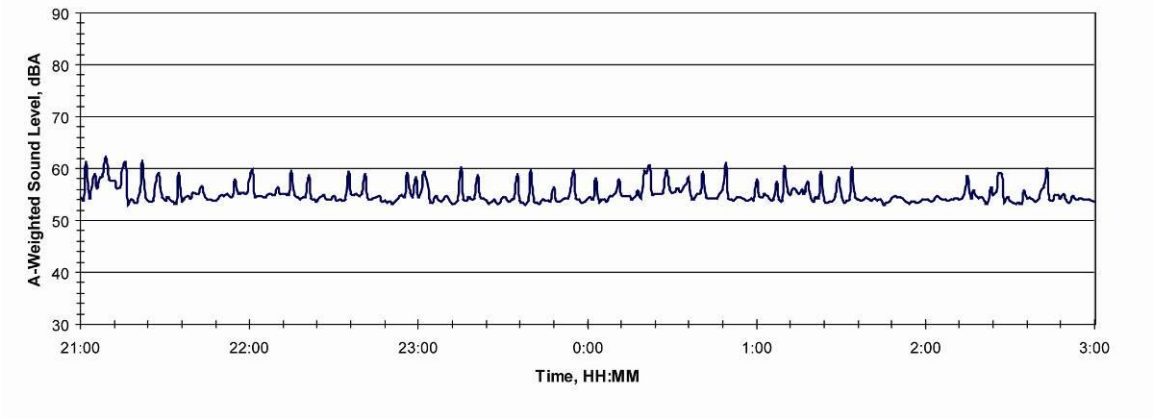


Figure 135 One-Minute L_{eq} Noise Levels near Green Line Yard Entrance (Site L1)

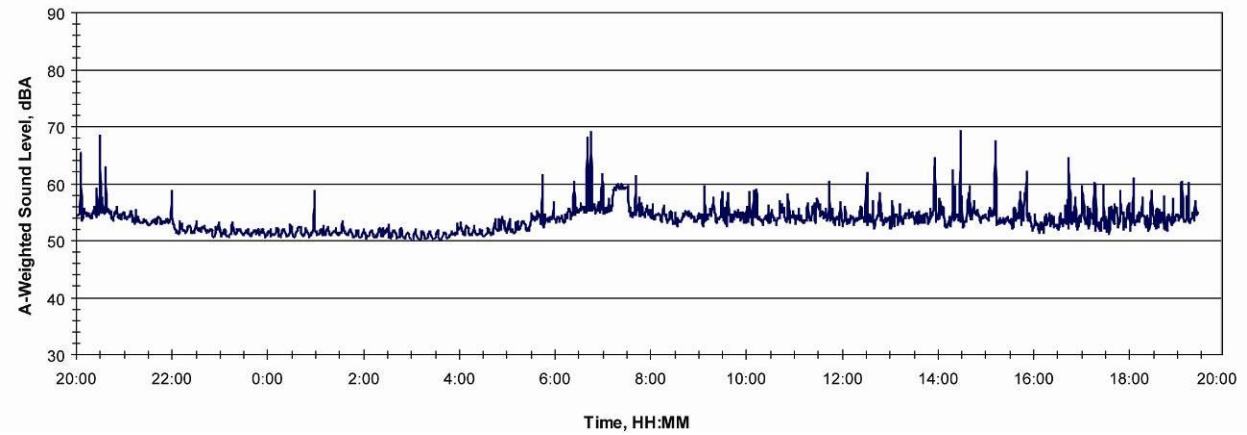


Figure 136 One-Minute L_{eq} Noise Levels at South Boundary of Green Line Yard (Site L2)

Table 50 (Noise Levels for Maintenance Facility Activities) shows the key assumptions used for predicting noise from the maintenance; these are based on the noise measurements at the Gold Line Yard, the Green Line Yard, and the TPSS unit in South Pasadena. Table 51 (Predicted Maintenance Facility Noise) and Table 52 (Predicted Maintenance Facility Buffer Design Option Noise) show the predicted noise levels from Maintenance Facility activities at the residences along Exposition Boulevard south of the proposed Stewart Street site for the Maintenance Facility. The dominant noise sources at all of the residences are the car wash and the blowdown facility. The predicted levels of noise from Maintenance Facility activities do not exceed the applicable FTA noise impact thresholds for the both the original DEIR layout or the Buffer Design Option layout.

Table 50 Noise Levels for Maintenance Facility Activities

Noise Source	Ref Dist., ft	Sound Level, dBA	Duration[a]	Partial L_{dn}[b] (dBA)	Comments
Trains entering yard	50	61[c]	785	58	Based on Measurements at the Green Line Yard.
Trains exiting yard	50	61[c]	560	57	
Car wash	50	61[c]	1100	60	Based on measurement of Blue Line car wash adjusted to account for blowers being located inside the car wash enclosure
Blowdown facility	50	61	1320	52	Based on Measurements at the Green Line Yard.
Shop activities	50	58	Continuous	65	Noise coming out of open shop doors continuously over a 24-hour period. Based on Measurements at the Green Line Yard.
TPSS	50	50	Continuous	56	Continuous noise from unit over 24-hour period.

Source: ATS Consulting, 2009.

a. The duration of the activity in minutes per day or the number of events per day. The values have been adjusted to account for nighttime events, which are counted as the equivalent of 10 daytime events in the calculation of L_{dn}.

b. The L_{dn} due to only the specific noise source at the reference distance.

c. The train noise is based on a speed of 25 mph plus noise from wheel impacts at the Maintenance Facility special trackwork.

Table 51 Predicted Maintenance Facility Noise

Clust.[a]	Desc.	Civil Station	Exist L_{dn} (dBA)	Maintenance Facility L_{dn}, (dBA)			Number of Impacts[b]	
				Impact Threshold		Maintenance Facility Noise		
				Mod	Severe		Mod	Severe
M1	SFR	746.50	58	57	63	52	—	—
M2	SFR	744.00	58	57	63	55	—	—
M3	SFR	742.00	58	57	63	50	—	—
M4	SFR	740.50	58	57	63	46	—	—
M5	SFR	737.00	58	57	63	52	—	—

Table 51 Predicted Maintenance Facility Noise

Clust.[a]	Desc.	Civil Station	Exist L_{dn} (dBA)	Maintenance Facility L_{dn}, (dBA)			Number of Impacts[b]	
				Impact Threshold		Maintenance Facility Noise		
				Mod	Severe		Mod	Severe
M6	SFR	735.00	58	57	63	56	—	—
M7	SFR	732.00	59	57	63	53	—	—
M8	Lantana.	740.00	57 [c]	56 [c]	62 [c]	54 [c]	—	—

Source: ATS Consulting, 2008; updated 2009.

SFR = single-family residence

Mod = moderate impact, Severe = severe impact.

a. The locations and buildings included in each cluster are shown in Appendix D (page 171).

b. Number of dwelling units. This is a count of the number of single-family residences in the cluster.

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

Table 52 Predicted Maintenance Facility Buffer Design Option Noise

Clust.[a]	Desc.	Civil Station	Exist L_{dn} (dBA)	Maintenance Facility L_{dn}, (dBA)			Number of Impacts[b]	
				Impact Threshold		Maintenance Facility Noise		
				Mod	Severe		Mod	Severe
M1	SFR	746.50	58	57	63	54	—	—
M2	SFR	744.00	58	57	63	57	—	—
M3	SFR	742.00	58	57	63	55	—	—
M4	SFR	740.50	58	57	63	53	—	—
M5	SFR	737.00	58	57	63	51	—	—
M6	SFR	735.00	58	57	63	50	—	—
M7	SFR	732.00	59	57	63	47	—	—
M8[c]	Lantana.	740.00	57 [c]	56 [c]	62 [c]	56 [c]	—	—

Source: ATS Consulting, 2009.

SFR = single-family residence

Mod = moderate impact, Severe = severe impact.

a. The locations and buildings included in each cluster are shown in Appendix D (page 171).

b. Number of dwelling units. This is a count of the number of single-family residences in the cluster.

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