Appendix H

Noise Impact Study

RK engineering group, inc.

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LETTER OF TRANSMITTAL

TO:	THE LONG BEACH PROJECT OWNER, LLC.	DATE:	October 15, 2013
	3 San Joaquin Plaza, Suite 100	JOB NO.:	2373-2013-01
	Newport Beach, CA 92660	SUBJECT:	Riverwalk Residential Development
			Noise Impact Study, City of Long Beach
ATTN:	Mr. Spencer Oliver		

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REMARKS:
Attached is the Riverwalk Residential Development Noise Impact Study, City of Long Beach.

Please call me at (949) 474-0809 extension 208, if you have any questions.

BY: Mike Dickerson

Mike Dickerson, INCE
Acoustical Engineer

COPIES TO:

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RIVERWALK RESIDENTIAL DEVELOPMENT
NOISE IMPACT STUDY
City of Long Beach, California

RK engineering group, inc.

RK engineering group, inc.

October 15, 2013

transportation planning • traffic engineering
acoustical engineering • parking studies

Mr. Spencer Oliver
THE LONG BEACH PROJECT OWNER, LLC.
3 San Joaquin Plaza, Suite 100
Newport Beach, CA 92660

Subject: Riverwalk Residential Development Noise Impact Study, Long Beach

Dear Mr. Oliver:

RK ENGINEERING GROUP, INC. (RK) has completed an acoustical analysis of the proposed Riverwalk Residential Development project. The project site is located at 4747 Daisy Avenue in the City of Long Beach, as indicated in Exhibit A. The proposed project's site plan is shown in Exhibit B. The acoustical parameters, including the City of Long Beach Noise Standards, are included in Appendix A.

The proposed project was assessed with respect to off-site noise impacts to and from the project site. The primary source of off-site generated noise would be traffic noise from the roadway network and railroad noise from the tracks directly south of the project site. The noise standards, defined by the City are indicated in Section 3.0 of the report. The project is expected to meet the required noise standards, as specified by the City of Long Beach with the recommendations of this report. The project will require a "windows closed" condition. A final noise study should be prepared prior to obtaining building permits for the project. The final noise study will review the architectural design from a noise perspective to ensure compliance to the noise isolation performance of party walls and ceiling/floor assemblies. In addition, it will confirm the precise interior noise levels.

RK ENGINEERING GROUP, INC. is pleased to provide THE LONG BEACH PROJECT OWNER with this acoustical analysis. If you have any questions regarding this study or need further review, please call us at (949) 474-0809.

Sincerely,
RK ENGINEERING GROUP, INC.

REGISTERED PROFESSIONAL ENGINEER
ROBERT KAHN
No. 20285
Exp. 09/30/13
CIVIL
STATE OF CALIFORNIA

Mike Dickerson, INCE	Robert Kahn, P.E.	Tiffany Giordano
Noise/Air Specialist	Principal	Engineer I

Attachments

MD:TG:mn/RK10128.doc
JN:2373-2013-01

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RIVERWALK RESIDENTIAL DEVELOPMENT
NOISE IMPACT STUDY
City of Long Beach, California

Prepared for:

THE LONG BEACH PROJECT OWNER, LLC.
3 San Joaquin Plaza, Suite 100
Newport Beach, CA 92660

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October 15, 2013

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Table of Contents

List of Attachments

Exhibits

Tables

Appendices

1.0 Introduction

1.1 Purpose of Analysis and Study Objectives

The purpose of this acoustical assessment is to evaluate the potential noise impacts for the project study area and to recommend noise mitigation measures, if necessary, to minimize the potential noise impacts. This assessment was conducted and compared to the noise standards set forth by the Federal, State, and Local agencies. Consistent with the City's Municipal Code, a significant impact related to noise would occur if a proposed project is determined to result in:

- Exposure of persons to or generation of noise levels in excess of standards established in the local Municipal Code or noise ordinance, or applicable agencies.

The following is provided in this report:

- A description of the study area and proposed project.
- Information regarding the fundamentals of noise.
- A description of the local noise guidelines and standards.
- An exterior/interior analysis of traffic and railroad noise impacts to the project study area.
- An analysis of railroad vibration impacts to the project study area.

1.2 Site Location and Study Area

The project site is located at 4747 Daisy Avenue in the City of Long Beach. The project is bounded by railroad tracks to the south, Dominquez Gap Wetlands to the west, existing residential units to the north, and Daisy Avenue to the east. Land uses surrounding the project include existing residential to the north and east, as demonstrated in Exhibit A. Approximately 1,500 feet to the west is the existing State Route 710 freeway. The existing railroad line to the south is assumed to be the Union Pacific Rail Line. The southern border of the site has an uphill grade, with an approximate 10 foot wall at the top of the slope. The uphill grading and wall are continuous throughout the residential area bordering the railroad line. The remainder of the site is relatively flat and approximately 45 feet above sea level. The site is currently vacant.

1.3 Proposed Project Description

The project proposes to develop 120 single family residential dwelling units on approximately 10.58 acres (a maximum of 11.34 DU/AC). The site plan used for this analysis, provided by Integral Communities and Urban Arena, is illustrated in Exhibit B.

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2.0 Fundamentals of Noise

This section of the report provides basic information about noise and presents some of the terms used within the report.

2.1 Sound, Noise and Acoustics

Sound is a disturbance created by a moving or vibrating source and is capable of being detected by the hearing organs. Sound may be thought of as mechanical energy of a moving object transmitted by pressure waves through a medium to a human ear. For traffic, or stationary noise, the medium of concern is air. *Noise* is defined as sound that is loud, unpleasant, unexpected, or unwanted.

2.2 Frequency and Hertz

A continuous sound is described by its *frequency* (pitch) and its *amplitude* (loudness). Frequency relates to the number of pressure oscillations per second. Low-frequency sounds are low in pitch (bass sounding) and high-frequency sounds are high in pitch (squeak). These oscillations per second (cycles) are commonly referred to as Hertz (Hz). The human ear can hear from the bass pitch starting out at 20 Hz all the way to the high pitch of 20,000 Hz.

2.3 Sound Pressure Levels and Decibels

The *amplitude* of a sound determines it loudness. The loudness of sound increases or decreases, as the amplitude increases or decreases. Sound pressure amplitude is measured in units of micro-Newton per square inch meter (N/m2), also called micro-Pascal (μPa). One μPa is approximately one hundred billionths (0.00000000001) of normal atmospheric pressure. Sound pressure level (SPL or L_p) is used to describe in logarithmic units the ratio of actual sound pressures to a reference pressure squared. These units are called decibels and abbreviated dB.

2.4 Addition of Decibels

Because decibels are on a logarithmic scale, sound pressure levels cannot be added or subtracted by simple plus or minus addition. When two (2) sounds or equal SPL are combined, they will produce an SPL 3 dB greater than the original single SPL. In other words, sound energy must be doubled to produce a 3 dB increase. If two (2) sounds differ by approximately 10 dB the higher sound level is the predominant sound.

2.5 Human Response to Changes in Noise Levels

In general, the healthy human ear is most sensitive to sounds between 1,000 Hz and 5,000 Hz, (A-weighted scale) and it perceives a sound within that range as being more intense than a sound with a higher or lower frequency with the same magnitude. For purposes of this report as well as with most environmental documents, the A-scale weighting is typically reported in terms of A-weighted decibel (dBA). Typically, the human ear can barely perceive the change in noise level of 3 dB. A change in 5 dB is readily perceptible, and a change in 10 dB is perceived as being twice or half as loud. As previously discussed, a doubling of sound energy results in a 3 dB increase in sound, which means that a doubling of sound energy (e.g. doubling the volume of traffic on a highway), would result in a barely perceptible change in sound level.

2.6 Noise Descriptors

Noise in our daily environment fluctuates over time. Some noise levels occur in regular patterns, others are random. Some noise levels are constant, while others are sporadic. Noise descriptors were created to describe the different time-varying noise levels. Following are the most commonly used noise descriptors along with brief definitions.

A-Weighted Sound Level

The sound pressure level in decibels as measured on a sound level meter using the A-weighted filter network. The A-weighting filter de-emphasizes the very low and very high frequency components of the sound in a manner similar to the response of the human ear. A numerical method of rating human judgment of loudness.

Ambient Noise Level

The composite of noise from all sources, near and far. In this context, the ambient noise level constitutes the normal or existing level of environmental noise at a given location.

Community Noise Equivalent Level (CNEL)

The average equivalent A-weighted sound level during a 24-hour day, obtained after addition of five (5) decibels to sound levels in the evening from 7:00 to 10:00 PM and after addition of ten (10) decibels to sound levels in the night before 7:00 AM and after 10:00 PM.

Decibel (dB)

A unit for measuring the amplitude of a sound, equal to 20 times the logarithm to the base 10 of the ratio of the pressure of the sound measured to the reference pressure, which is 20 micro-pascals.

dB(A)

A-weighted sound level (see definition above).

Equivalent Sound Level (LEQ)

The sound level corresponding to a steady noise level over a given sample period with the same amount of acoustic energy as the actual time varying noise level. The energy average noise level during the sample period.

Habitable Room

Any room meeting the requirements of the Uniform Building Code or other applicable regulations which is intended to be used for sleeping, living, cooking or dining purposes, excluding such enclosed spaces as closets, pantries, bath or toilet rooms, service rooms, connecting corridors, laundries, unfinished attics, foyers, storage spaces, cellars, utility rooms, and similar spaces.

L(n)

The A-weighted sound level exceeded during a certain percentage of the sample time. For example, L10 in the sound level exceeded 10 percent of the sample time. Similarly L50, L90 and L99, etc.

Noise

Any unwanted sound or sound which is undesirable because it interferes with speech and hearing, or is intense enough to damage hearing, or is otherwise annoying. The State Noise Control Act defines noise as "...excessive undesirable sound...".

Outdoor Living Area

Outdoor spaces that are associated with residential land uses typically used for passive recreational activities or other noise-sensitive uses. Such spaces include patio areas, barbecue areas, jacuzzi areas, etc. associated with residential uses; outdoor patient recovery or resting areas associated with hospitals, convalescent hospitals, or rest homes; outdoor areas associated with places of worship which have a significant role in services or other noise-sensitive activities; and outdoor school facilities routinely used for educational purposes which may be adversely impacted by noise. Outdoor areas usually not included in this definition are: front yard areas, driveways, greenbelts, maintenance areas and storage areas associated with residential land uses; exterior areas at hospitals that are not used for patient activities; outdoor areas associated with places of worship and principally used for short-term social gatherings; and, outdoor areas associated with school facilities that are not typically associated with educational uses prone to adverse noise impacts (for example, school play yard areas).

Percent Noise Levels

See L(n).

Sound Level (Noise Level)

The weighted sound pressure level obtained by use of a sound level meter having a standard frequency-filter for attenuating part of the sound spectrum.

Sound Level Meter

An instrument, including a microphone, an amplifier, an output meter, and frequency weighting networks for the measurement and determination of noise and sound levels.

Single Event Noise Exposure Level (SENEL)

The dBA level which, if it lasted for one (1) second, would produce the same A-weighted sound energy as the actual event.

2.7 Traffic Noise Prediction

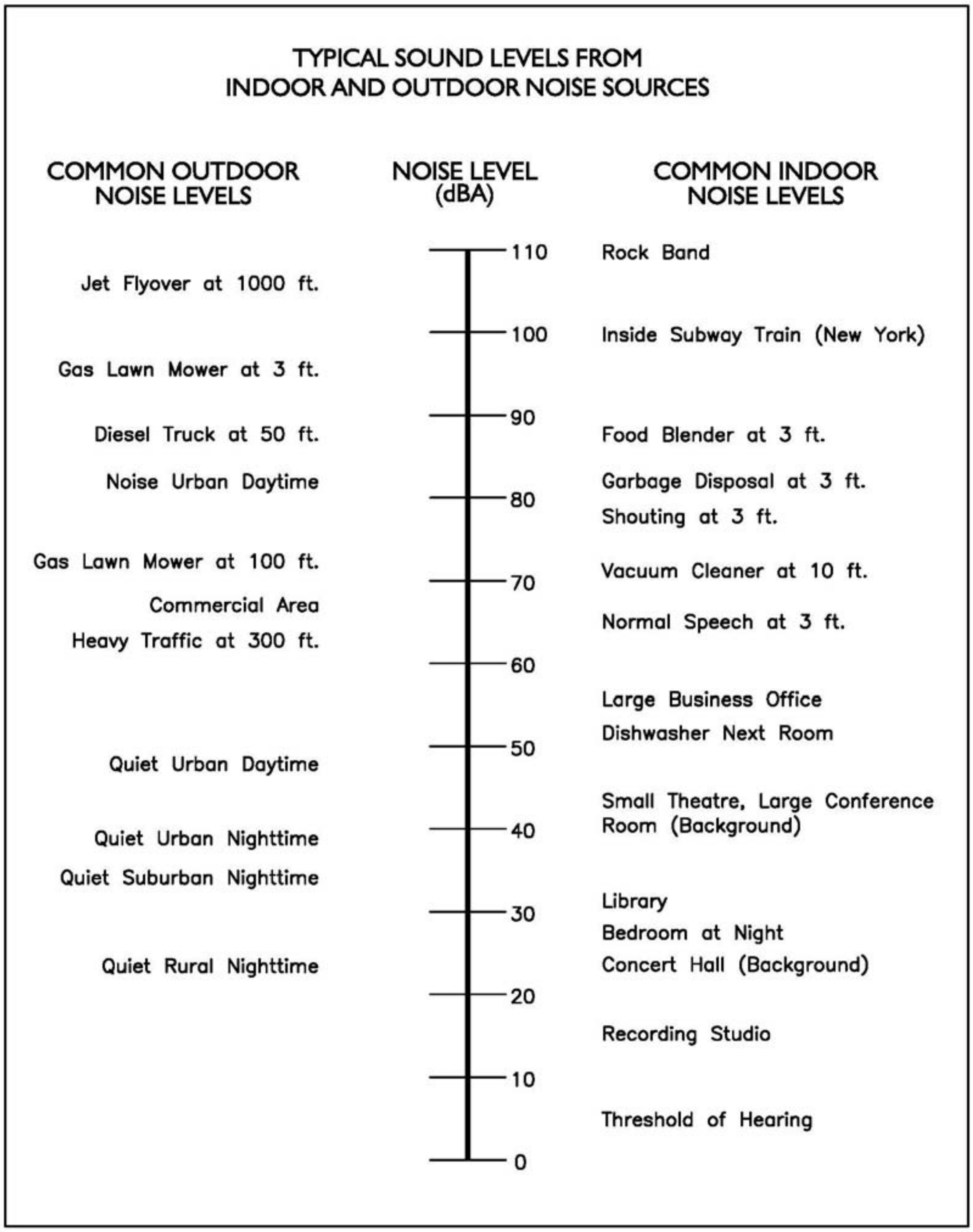
Noise levels associated with traffic depend on a variety of factors: (1) volume of traffic, (2) speed of traffic, (3) auto, medium truck (2 – 6 wheels) and heavy truck percentage (3 axle and greater), and sound propagation. The greater the volume of traffic, higher speeds and truck percentages equate to a louder volume in noise. A doubling of the Average Daily Traffic (ADT) along a roadway will increase noise levels by approximately 3 dB; reasons for this are discussed in the sections above.

2.8 Sound Propagation

As sound propagates from a source it spreads geometrically. Sound from a small, localized source (i.e., a point source) radiates uniformly outward as it travels away from the source in a spherical pattern. The sound level attenuates at a rate of 6 dB per doubling of distance. The movement of vehicles down a roadway makes the source of the sound appear to propagate from a line (i.e., line source) rather than a point source. This line source results in the noise propagating from a roadway in a cylindrical spreading versus a spherical spreading that results from a point source. The sound level attenuates for a line source at a rate of 3 dB per doubling of distance.

As noise propagates from the source, it is affected by the ground and atmosphere. Noise models use hard site (reflective surfaces) and soft site (absorptive surfaces) to help calculate predicted noise levels. Hard site conditions assume no excessive ground absorption between the noise source and the receiver. Soft site conditions such as grass, soft dirt or landscaping attenuate noise at an additional rate of 1.5 dB per doubling of distance. When added to the geometric spreading, the excess ground attenuation results in an overall noise attenuation of 4.5 dB per doubling of distance for a line source and 6.0 dB per doubling of distance for a point source.

Research has demonstrated that atmospheric conditions can have a significant effect on noise levels when noise receivers are located 200 feet from a noise source. Wind, temperature, air humidity and turbulence can further impact how far sound can travel.



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3.0 Regulatory Setting

The proposed project is located in the City of Long Beach and noise regulations are addressed through the various federal, state, and local government agencies. The agencies responsible for regulating noise are discussed below.

3.1 Federal Regulations

The adverse impact of noise was officially recognized by the federal government in the Noise Control Act of 1972, which serves three (3) purposes:

- Publicize noise emission standards for interstate commerce
- Assist state and local abatement efforts
- Promote noise education and research

The Federal Office of Noise Abatement and Control (ONAC) was originally tasked with implementing the Noise Control Act. However, it was eventually eliminated leaving other federal agencies and committees to develop noise policies and programs. Some examples of these agencies are as follows: The Department of Transportation (DOT) assumed a significant role in noise control through its various agencies; The Federal Aviation Agency (FAA) is responsible to regulate noise from aircraft and airports; The Federal Highway Administration (FHWA) is responsible to regulate noise from the interstate highway system; The Occupational Safety and Health Administration (OSHA) is responsible for the prohibition of excessive noise exposure to workers.

The Federal government and the State advocate that local jurisdiction use their land use regulatory authority to arrange new development in such a way that “noise sensitive” uses are either prohibited from being constructed adjacent to a highway or, or alternatively that the developments are planned and constructed in such a manner that potential noise impacts are minimized.

Since the Federal government and the State have preempted the setting of standards for noise levels that can be emitted by the transportation source, the County is restricted to regulating the noise generated by the transportation system through nuisance abatement ordinances and land use planning.

3.2 State Regulations

Established in 1973, the California Department of Health Services Office of Noise Control (ONC) was instrumental in developing regularity tools to control and abate noise for use by local agencies. One significant model is the “Land Use Compatibility for Community Noise Environments Matrix.” The matrix allows the local jurisdiction to clearly delineate compatibility of sensitive uses with various incremental levels of noise.

The State of California has established noise insulation standards as outlined in Title 24 and the Uniform Building Code (UBC) which in some cases requires acoustical analyses to outline exterior noise levels and to ensure interior noise levels do not exceed the interior threshold. The State mandates that the legislative body of each county and city adopt a noise element as part of its comprehensive general plan. The local noise element must recognize the land use compatibility guidelines published by the State Department of Health Services. The guidelines rank noise land use compatibility in terms of normally acceptable, conditionally acceptable, normally unacceptable, and clearly unacceptable.

3.3 City of Long Beach Noise Regulations

The City of Long Beach outlines their noise regulations and standards within the City's Municipal Code (Section 8.80.130, Appendix A). For purposes of this analysis, the City of Long Beach's Acoustical Standards are used to evaluate the roadway noise impacts to the proposed project from the local roadway network.

Traffic Noise Regulation

The City of Long Beach's noise standards for residential development require that noise sensitive uses proposed to be located in areas with noise levels of 65 dBA LDN/CNEL or greater include the recommended mitigation measures or demonstrate the interior levels will not exceed an LDN/CNEL of 45 dBA.

Construction Noise Regulation

The City of Long Beach's Municipal Noise Code (Section 8.80.202) indicates that the project construction noise levels should be kept to a minimum by using acceptable practices where sensitive land uses are adjacent to construction zone. If construction activities fall outside the acceptable hours as outlined in the Code, the project must not exceed the maximum permitted noise levels for the underlying land use category.

The City's Code states that no person shall operate any tools or equipment used for construction, alteration, repair, remodeling, drilling, demolition or any other related building activity which produce loud or unusual noise which annoys or disturbs a reasonable person of normal sensitivity between the following hours:

- Weekdays and Federal Holidays: Between 7:00 PM and 7:00 AM.
- Saturdays: Between 7:00 PM on Friday and 9:00 AM on Saturday, and after 6:00 PM on Saturday
- Sundays: Anytime, except when person has received a work permit from the Noise Control Officer. In that case, the person may work between 9:00 AM and 6:00 PM during the dates specified in the work permit.

Railroad Noise Regulation

The City's noise standards for residential development require that noise levels from railroad tracks do not exceed 65 dBA LDN/CNEL.

4.0 Study Method and Procedures

The following describes the noise modeling procedures and assumptions.

4.1 Traffic Noise Modeling

Traffic noise from vehicular traffic was projected using a version of the FHWA Traffic Noise Prediction Model (FHWA-RD-77-108). The FHWA model arrives at the predicted noise level through a series of adjustments to the key input parameters. Long Beach Freeway (SR-710) traffic data, traffic volumes, and percentages were obtained through the 2011 Annual Average Daily Truck Traffic on the California State Highway System compiled by Traffic and Vehicle Data Systems. The referenced traffic data was applied to the model and is provided in Appendix B. Table 1 contains the roadway parameters and vehicle distribution.

The following outlines the key adjustments made to the computer model for the roadway inputs:

- Roadway classification – (e.g. freeway, major arterial, arterial, secondary, collector, etc),
- Roadway Active Width – (distance between the center of the outer most travel lanes on each side of the roadway).
- Average Daily Traffic (ADT) Volumes, Travel Speeds, and Percentages of automobiles, medium trucks, and heavy trucks.
- Roadway grade and angle of view.
- Site Conditions (e.g. soft vs. hard).
- Percentage of total ADT which flows each hour throughout a 24-hour period

The following outlines key adjustments to the computer model for the project site parameter inputs:

- Vertical and horizontal distances (Sensitive receptor distance from noise source).
- Noise barrier vertical and horizontal distances (Noise barrier distance from sound source and receptor).
- Traffic noise source spectra.
- Topography.

RK projected the traffic noise levels to the nearest building facades of the project site (first row lots nearest SR-710). The noise model takes into account the 5-foot berm near the Dominquez Gap Wetlands. Traffic noise levels were projected to the first and second floor for all residential units. The building facade is approximately 1,500 feet from the centerline of Long Beach Freeway (SR-710). It is important to note that the existing berm along the western property line will serve as a berm barrier; therefore, lowering the noise levels. The project noise calculation worksheet outputs are provided in Appendix C.

4.2 Interior Noise Modeling

The interior noise level is the difference between the projected exterior noise level at the structure's façade and the noise reduction provided by the structure itself. Typical building construction will provide a conservative 12 dBA noise level reduction with a "windows open" condition and a very conservative 20 dBA noise level reduction with "windows closed". RK estimated the interior noise level by subtracting the building shell design from the estimated exterior noise level.

4.3 Railroad Noise Modeling

The railroad source noise analysis uses a version of Wyle Labs WCR73_5, together with several key site parameters, to project the expected impacts of Railroad operations to the proposed project site. Key inputs include train category identification, percent grade, length of train, speed of train, and distance to receiver. Similar performance equations, including relative source-barrier-receiver horizontal separations, relative source-barrier-receiver vertical separations, typical noise source spectra, and barrier transmission loss from the railroad noise model, were utilized to complete the stationary source model. It is important to note that there is an existing uphill grade on the site leading to the track, as well as an approximate 10 foot high wall. It is estimated that the wall is about 25 feet from the railroad tracks. Railroad noise calculations are included in Appendix F.

The railroad tracks are assumed to be Union Pacific Rail Line. Since the exact rail line is unknown, information about the railroad activity and frequency must be assumed for modeling purposes. Appendix D shows the City of Carson's General Plan, which lists the various rail lines near the project area. Per the City's Plan, the Dominguez Channel line runs parallel to the project site, and can have operations up to approximately 16 times per day. This line is assumed to be the same line which runs south of the project. RK utilized the Federal Railroad Administration (FRA) website to obtain the track operations based on the railroad crossing. The aerial in Appendix D is from the FRA and depicts the railroads closest to the project site. According to the FRA online railroad portal, the railroad crossing nearest the project site is 811215N and is listed in Appendix D. The combination of reports in Appendix D was used to scientifically estimate the railroad modeling.

4.4 Railroad Vibration Modeling

The City's Municipal Code does not discuss vibration standards. Therefore, the Federal Transit Administration's (FTA) *Transit Noise and Vibration Impact Assessment*, (Washington D.C., 2006) was utilized to assess potential vibration impact from the adjacent rail line. The FTA Manual provides recommended vibration thresholds, and reference data for assessing probable ground-borne vibration near railroad or other fixed guide-way transportation systems. Typical levels of ground-borne vibrations are shown in Exhibit C. A summary of the ground-borne vibration criteria is included in Exhibit D from the FTA report.

The FTA Manual recommends a residential vibration velocity standard in decibels (VdB) of 80 VdB (re. 0.000001 inches per second) where there are fewer than 70 vibration events per day. The projected future track utilization would be approximately 16 freight events. The manual suggests that a vibration impact zone of 200 feet may be present for train movements at 60-70 miles per hour (mph). For slower speed movement, the impact distance is much smaller.

Figure 10-1 of the FTA Manual (Appendix E) shows a reference vibration level of 90 VdB at 25 feet from the track centerline for a heavy locomotive traveling at 50 mph, as indicated below.

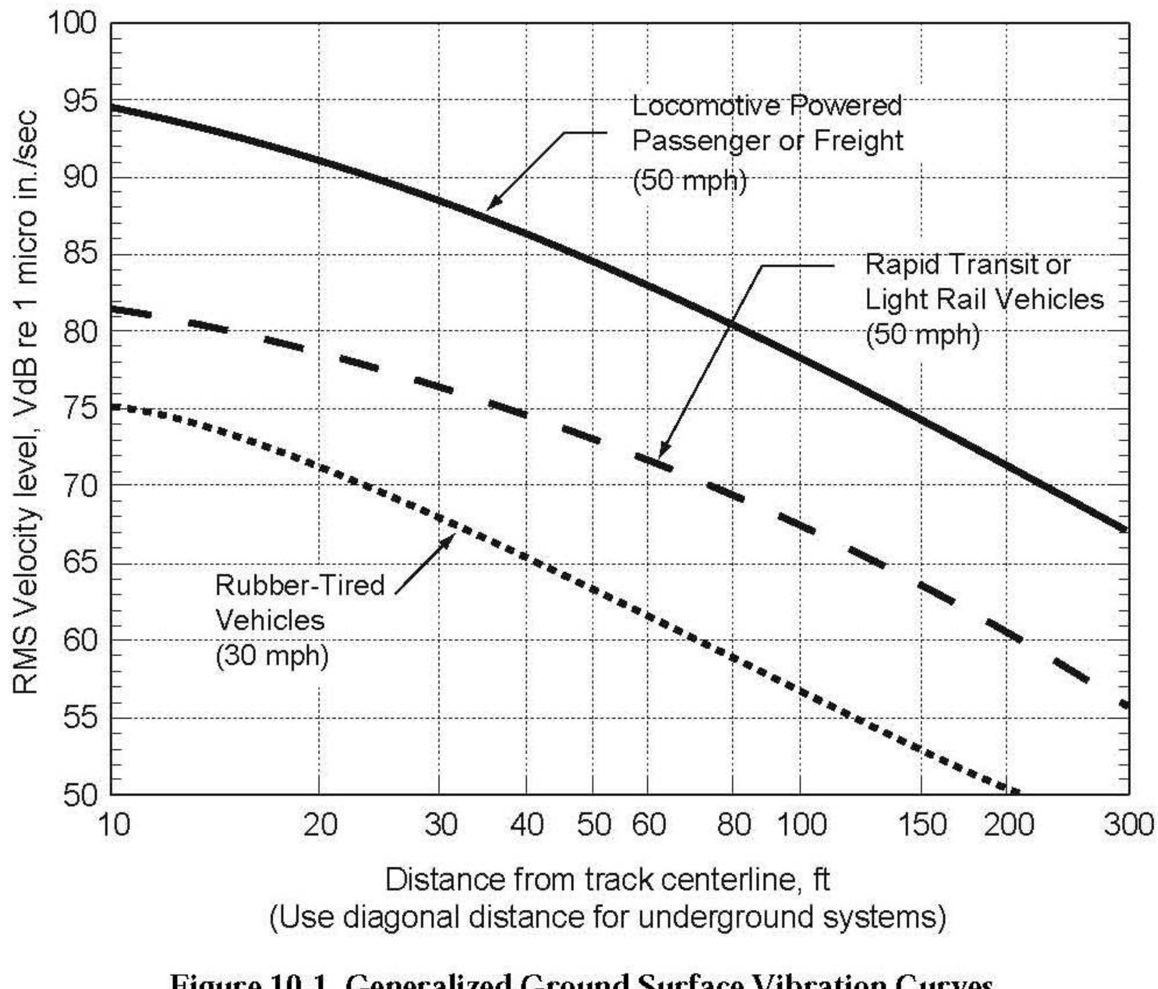

Figure 10-1. Generalized Ground Surface Vibration Curves

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5.0 Future Noise Environment Impacts and Mitigation

5.1 Future Exterior Noise

This assessment analyzes the traffic noise impacts from Long Beach Freeway (SR-710) and the rail line noise impacts from the adjacent railroad tracks to the proposed project site and compares the results to the City's Noise Standards. The analysis details the estimated vibration levels, exterior and interior noise levels, and mitigation measures.

5.1.1 Traffic Source Noise

Traffic noise along the Long Beach Freeway (SR-710) will be one of the main sources of noise impacting the project site and the surrounding area. Table 2 indicates the estimated future exterior noise levels for the first row of units facing the subject freeway at the project site. It is anticipated that the first row residential units facing the subject roadways will experience an exterior noise level of 48.9 dBA CNEL. This impact is considered less than significant.

5.1.2 Rail Line Source Noise

Railroad noise from the tracks south of the project site will be the other main source of noise impacting the southern portion of the project site and the surrounding area. Table 3 indicates the estimated future exterior noise levels for the units facing the railroad tracks at the project site. As previously discussed in Section 1.2 of the report, the southern border of the site has an uphill grade, with an approximate 10-foot wall at the top of the slope. It is anticipated that the first row residential units facing the subject rail line will experience an exterior noise level of 57.6 dBA CNEL at 100 feet from the railroad tracks. This impact is considered less than significant.

5.1.3 Train Vibration Analysis

The projected vibration impact for heavy locomotive operations is outlined in Table 4. The vibration impact will vary depending on the speed of the train and the respective distance to the sensitive receiver location. As demonstrated by the shaded area in Table 4 the vibration impact will range from 70-74 VdB. Exhibit D shows that the vibration standard set by the FTA is 80 VdB. It is estimated that at freight operations traveling at 20-30 mph (at 2 operations per day) will have a vibration impact of approximately 70 VdB at 100 feet. According to the FTA Manual, up to 30 events could occur per day without exceeding the vibration threshold. Therefore, the impact is considered less than significant.

5.2 Future Interior Noise

The future interior noise level was calculated for the sensitive receptor locations using a typical "windows open" and "windows closed" condition. A "windows open" condition assumes 12 dBA of noise attenuation from the exterior noise level. A "windows closed" condition" assumes 20 dBA of noise attenuation from the exterior noise level. Tables 5 and 6 indicate the interior noise levels for the project site. The interior noise level will range from 36.9 to 52.3 dBA CNEL with the windows open and 28.9 to 44.3 with the windows closed.

To meet the City's interior 45 dBA CNEL standard, a "windows closed" condition is required for all lots facing the subject roadway and the rail line. Exhibit E indicates the required mitigation measures and which units require a "windows closed" condition.

5.3 Summary of Mitigation Measures

The recommended mitigation measures for the project are indicated in Exhibit E. In order to comply with the City of Long Beach's Noise Criteria the project must incorporate the following recommendations into the project design:

First Floor and Second Floor – First Row Residential Units Facing SR-710 Freeway

- All first floor and second floor windows and sliding glass doors facing the SR-710 Freeway should utilize a minimum STC rating of 28.

First Floor and Second Floor – First Row Residential Units Facing Union Pacific Railroad

- All first floor and second floor windows and sliding glass doors facing the adjacent rail line should utilize a minimum STC rating of 30.

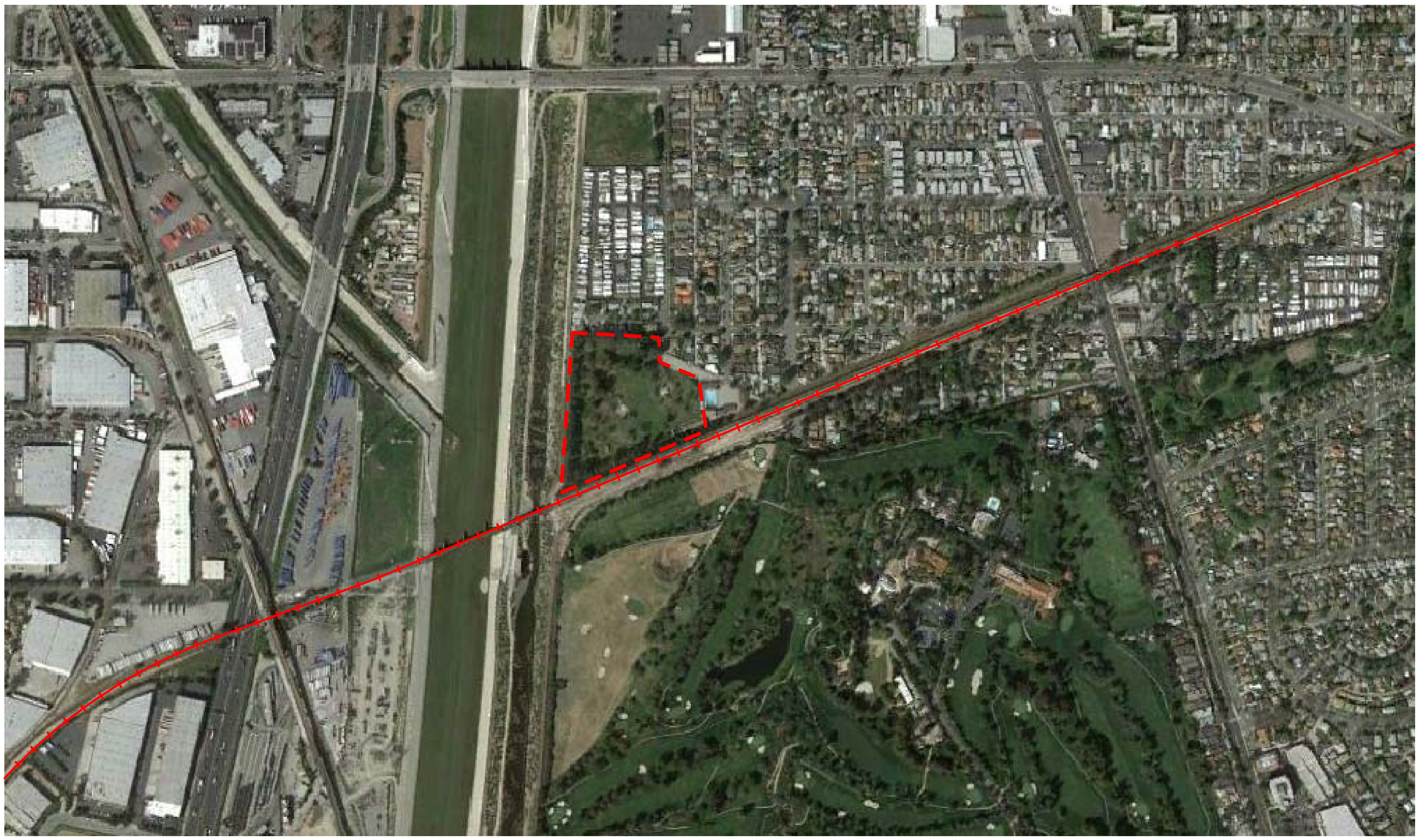
Remaining Residential Units – Second Row

- All other windows and sliding glass doors on project site should utilize a minimum STC rating of 25.

Exhibits

Exhibit A

Location Map



Legend:

- - = Site Boundary

-+-+- = Union Pacific Rail Line

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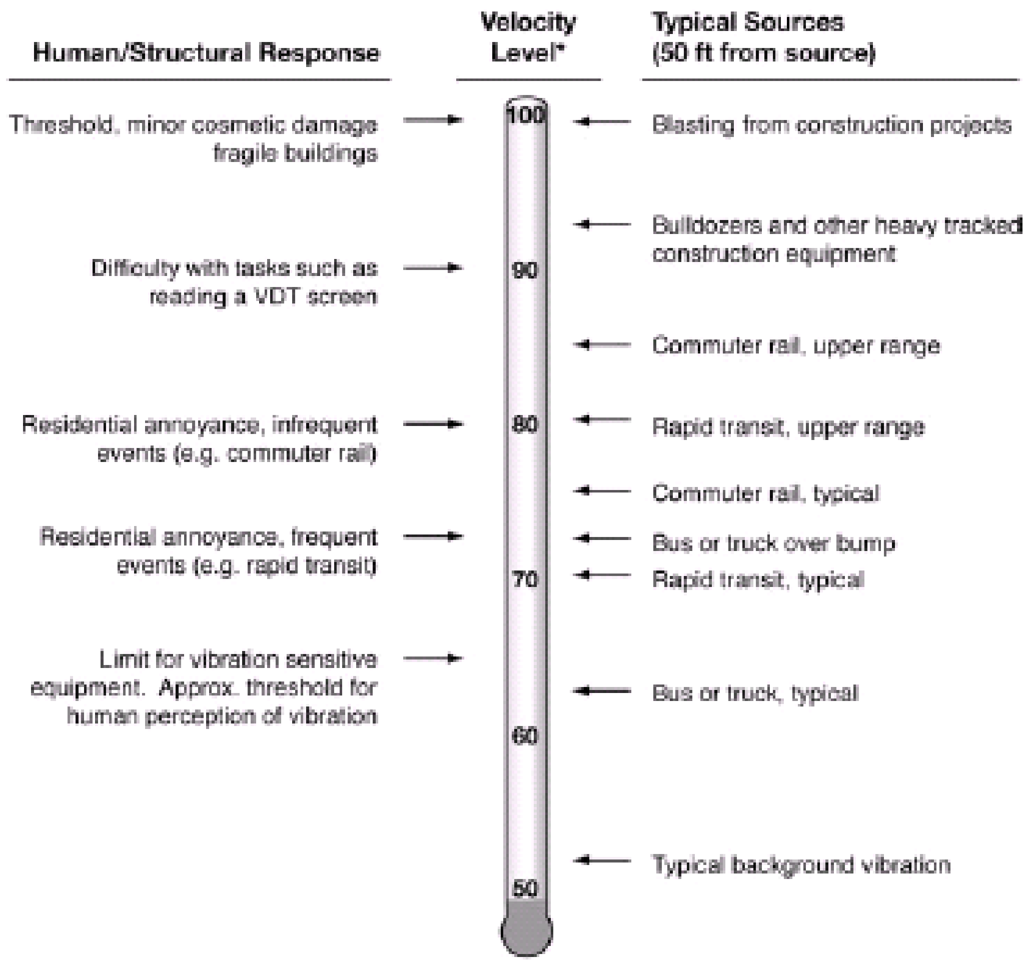
RK engineering group, inc.

Exhibit B

Site Plan

Exhibit C

Typical Levels of Ground-Borne Vibration



* *RMS Vibration Velocity Level in VdB relative to 10^{-6} inches/second*

Figure 7-3. Typical Levels of Ground-Borne Vibration

FTA Ground-Borne Vibration and Noise Criteria

Table 8-1. Ground-Borne Vibration (GBV) and Ground-Borne Noise (GBN) Impact Criteria for General Assessment

Land Use Category	GBV Impact Levels (VdB re 1 micro-inch /sec)			GBN Impact Levels (dB re 20 micro Pascals)		
	Frequent Events[1]	Occasional Events[2]	Infrequent Events[3]	Frequent Events[1]	Occasional Events[2]	Infrequent Events[3]
Category 1: Buildings where vibration would interfere with interior operations.	65 VdB[4]	65 VdB[4]	65 VdB[4]	N/A[4]	N/A[4]	N/A[4]
Category 2: Residences and buildings where people normally sleep.	72 VdB	75 VdB	80 VdB	35 dBA	38 dBA	43 dBA
Category 3: Institutional land uses with primarily daytime use.	75 VdB	78 VdB	83 VdB	40 dBA	43 dBA	48 dBA

Notes:

1. "Frequent Events" is defined as more than 70 vibration events of the same source per day. Most rapid transit projects fall into this category.
2. "Occasional Events" is defined as between 30 and 70 vibration events of the same source per day. Most commuter trunk lines have this many operations.
3. "Infrequent Events" is defined as fewer than 30 vibration events of the same kind per day. This category includes most commuter rail branch lines.
4. This criterion limit is based on levels that are acceptable for most moderately sensitive equipment such as optical microscopes. Vibration-sensitive manufacturing or research will require detailed evaluation to define the acceptable vibration levels. Ensuring lower vibration levels in a building often requires special design of the HVAC systems and stiffened floors.
5. Vibration-sensitive equipment is generally not sensitive to ground-borne noise.

N

Recommendations

First and Second Floor -
First Row Residential Units Facing SR-710 Freeway:

All first floor and second floor windows and sliding glass doors facing the SR-710 freeway should utilize a minimum STC rating of 28. To meet the City's interior 45 dBA CNEL standard, a "windows closed" condition is required.

First and Second Floor -
First Row Residential Units Facing Union Pacific Railroad:

All first floor and second floor windows and sliding glass doors facing the adjacent rail line should utilize a minimum STC rating of 30. To meet the City's interior 45 dBA CNEL standard, a "windows closed" condition is required.

Remaining Residential Units - Second Row:

All other windows and slide glass doors on project site should utilize a minimum STC rating of 25.

N

Tables

TABLE 1

Roadway Parameters and Vehicle Distribution

Interstate 710 Roadway Parameters

Roadway	Classification	Lanes	Buildout (ADT)[1]	Speed (MPH)	Site Conditions
State Route 710 Freeway	Freeway	8	179,000	65	Soft

Interstate 710 Vehicle Distribution (Truck Mix)[2]

Motor-Vehicle Type	Daytime % (7 AM to 7 PM)	Evening % (7 PM to 10 PM)	Night % (10 PM to 7 AM)	Total % of Traffic Flow
Automobiles	70.5	19.3	10.2	85.74
Medium Trucks	75.0	6.3	18.7	4.96
Heavy Trucks	75.0	6.5	18.5	9.30

[1] Source: Caltrans 2011 AADT Volumes obtained from Caltrans Website (see Appendix B).

[2] SR-710 vehicle mix is based on Caltrans 2011 Annual Average Daily Traffic Volumes (Appendix B).

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JN:2373-2013-01

TABLE 2

Future Exterior Noise Levels (dBA CNEL)[1]

Exterior (Ground Level) Study Locations	Unmitigated Exterior Noise Impacts From State Route 710 Freeway	Noise Barrier Height (in feet)[2]	Final Projected Exterior Noise Level
First Row Units Facing 710 Freeway	48.9	- -	48.9

[1] Exterior noise levels calculated to backyard.

[2] "- -" indicates noise levels from adjacent roadways are below City standard and therefore no mitigation is required

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TABLE 3

Projected Exterior Noise Levels Along Rail Line (dBA CNEL)[1]

Rail Line	Operations per Day	CNEL at Observer Location (dBA)[2]	Noise Level at Specified Distance (dBA CNEL)[3]			
	Freight		100 (ft)	200 (ft)	400 (ft)	800 (ft)
Union Pacific Rail Line	16	62.3	57.6	54.1	50.1	45.6

[1] Scenario assumes existing wall is to remain to shield residential units from rail line noise. Existing wall is located approximately 25 feet from the rail line, and is approximately 10 feet high.

[2] Noise levels calculated at 5 feet above ground level.

[3] Noise level is projected approximately 100 feet from centerline of track. Refer to Appendix F for projected noise level calculations.

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JN:2373-2013-01

TABLE 4

Projected Vibration for Heavy Locomotive Operation[1]

Speed[2]	Vibration @ 25 ft (FTA Manual)	Speed Correction Factor	Vibration Level (VdB) Distance from Centerline of Track (ft)[3]					
			12.5	25	37.5	50	75	100
10	76	-14	82	76	73	70	67	64
20	82	-8	88	82	79	76	73	70
30	86	-4	92	86	83	80	77	74
40	88	-2	94	88	85	82	79	76
50	90	0	96	90	87	84	81	78
60	92	2	98	92	89	86	83	80

[1] Table is based on reference vibration level of 90 VdB at 25 feet from track centerline as indicated in FTA Manual (Appendix E).

[2] Referenced vibration level: Speed 50 mph, 90 VdB at a distance of 25 feet from track centerline.

[3] Shaded area corresponds to the vibration impact range based on speed and distance.

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JN:2373-2013-01

TABLE 5

Future First Floor Interior Noise Levels (dBA CNEL)

Receiver Location	Noise Impacts at First Floor Building Façade	Interior Noise Reduction Required to Meet Interior Noise Standard of 45 dBA CNEL	First Floor Interior Noise Level w/ Standard Windows (STC > 25)	
			Windows Open[1]	Windows Closed[2]
First Row Units Facing 710 Freeway	48.9	3.9	36.9	28.9

[1] A minimum of 12 dBA noise reduction is assumed with a "windows open" condition.

[2] A minimum of 20 dBA noise reduction is assumed with a "windows closed" condition.

j:/rktables/RK10128TB.xls
JN:2373-2013-01

TABLE 6

Future Second Floor Interior Noise Levels (dBA CNEL)

Receiver Location	Noise Impacts at Second Floor Building Façade	Interior Noise Reduction Required to Meet Interior Noise Standard of 45 dBA CNEL	Second Floor Interior Noise Level w/ Standard Windows (STC ≥ 25)	
			Windows Open[1]	Windows Closed[2]
First Row Units Facing 710 Freeway	64.3	19.3	52.3	44.3

[1] A minimum of 12 dBA noise reduction is assumed with a "windows open" condition.

[2] A minimum of 20 dBA noise reduction is assumed with a "windows closed" condition.

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JN:2373-2013-01

Appendices

Appendix A

City of Long Beach
Municipal Code Noise Section

8.80.130 Disturbing noises prohibited.

A. Notwithstanding any other provision of this Chapter, and in addition thereto, it is unlawful for any person to willfully make or continue, or cause to be made or continued, a loud, unnecessary or unusual noise which disturbs the peace and quiet of any neighborhood or which causes any discomfort or annoyance to any reasonable person of normal sensitiveness residing in the area.

B. The standards which shall be considered in determining whether a violation of the provisions of this Section exist shall include, but not be limited to the following:

1. The sound level of the objectionable noise;
2. The sound level of the ambient noise;
3. The proximity of the noise to residential sleeping facilities;
4. The nature and zoning of the area within which the noise emanates;
5. The density of the inhabitation of the area within which the noise emanates;
6. The time of day or night the noise occurs;
7. The duration of the noise and its tonal, informational or musical content;
8. Whether the noise is continuous, recurrent, or intermittent;
9. Whether the noise is produced by a commercial or noncommercial activity.

(Ord. C-5371 § 1 (part), 1977: prior code § 4430.4)

8.80.140 Noise measurement procedure.

The measurement procedure presented in this Section assumes that personnel performing the noise measurements have been trained in the use of the instruments and in interpretation of measured data. Upon receipt of a complaint from a citizen, the Noise Control Officer, or his agent, equipped with sound level measurement equipment satisfying the requirements specified in Section 8.80.020, shall investigate the complaint. The investigation shall consist of a measurement and the gathering of data to adequately define the noise problem as specified in the California Office of Noise Control Model Enforcement Manual, and shall include the following:

A. Nonacoustic Data.

1. Type of noise source;
2. Location of noise source relative to complainant's property;
3. Time period during which noise source is considered by complainant to be intrusive;
4. Total duration of noise produced by noise source;
5. Date and time of noise measurement survey.

B. Procedure. Utilizing the A weighting scale of the sound level meter and the slow meter response, the noise level shall be measured at a position or positions along the complainant's property line closest to the noise source or at the location along the boundary line where the noise level is at a maximum. In general, the microphone shall be located five feet (5') above the ground; ten feet (10') or more from the nearest reflective surface, where possible. However, in those cases where another elevation is deemed appropriate, the latter shall be utilized. If the noise complaint is related to interior noise levels, interior noise measurements shall be made at a point at least four feet (4') from the wall, ceiling or floor nearest the noise source with windows in the normal seasonal configuration. Calibration of the instrument being used shall be performed immediately prior to and following the recording of any noise data utilizing the acoustic calibrator.

(Ord. C-5371 § 1 (part), 1977: prior code § 4430.5)

8.80.150 Exterior noise limits—Sound levels by receiving land use district.

A. The noise standards for the various land use districts identified by the noise control office as presented in Table A in Section 8.80.160 shall, unless otherwise specifically indicated, apply to all such property within a designated district.

B. No person shall operate or cause to be operated any source of sound at any location within the incorporated limits of the City or allow the creation of any noise on property owned, leased, occupied, or otherwise controlled by such person, which causes the noise level when measured from any other property, either incorporated or unincorporated, to exceed:

1. The noise standard for that land use district as specified in Table A in Section 8.80.160 for a cumulative period of more than thirty (30) minutes in any hour; or
2. The noise standard plus five (5) decibels for a cumulative period of more than fifteen (15) minutes in any hour; or
3. The noise standard plus ten (10) decibels for a cumulative period of more than five (5) minutes in any hour; or
4. The noise standard plus fifteen (15) decibels for a cumulative period of more than one (1) minute in any hour; or
5. The noise standard plus twenty (20) decibels or the maximum measured ambient, for any period of time.

C. If the measured ambient level exceeds that permissible within any of the first four (4) noise limit categories in Subsection B of this Section, the allowable noise exposure standard shall be increased in five (5) decibels increments in each category as appropriate to encompass or reflect the ambient noise level. In the event the ambient noise level exceeds the fifth noise limit category in Subsection B of this Section, the maximum allowable noise level under said category shall be increased to reflect the maximum ambient noise level.

D. If the measurement location is on a boundary between two (2) different districts, the noise level limit applicable shall be the arithmetic mean of the two (2) districts.

E. If possible, the ambient noise shall be measured at the same location along the property line utilized in Subsection B of this Section, with the alleged offending noise source inoperative. If for any reason the alleged offending noise source cannot be shut down, then the ambient noise must be estimated by performing a measurement in the same general area of the source but at a sufficient distance such that the offending noise from the source is inaudible. If the difference between the noise levels with noise source operating and not operating is six (6) decibels or greater, then the noise measurement of the alleged source can be considered valid with a small correction applied to account for the contribution of the ambient noise. The correction is to be applied in accordance with data shown in Table B in Section 8.80.160

(Ord. C-5371 § 1 (part), 1977: prior code § 4430.6 (a))

8.80.160 Exterior noise limits—Correction for character of sound.

In the event that alleged offensive noise contains a steady audible tone such as a whine, screech, or hum, or is a repetitive noise such as hammering or riveting or contains music or speech conveying informational content, the standard limits set forth in Table A shall be reduced by five (5) decibels.

Table A

EXTERIOR NOISE LIMITS

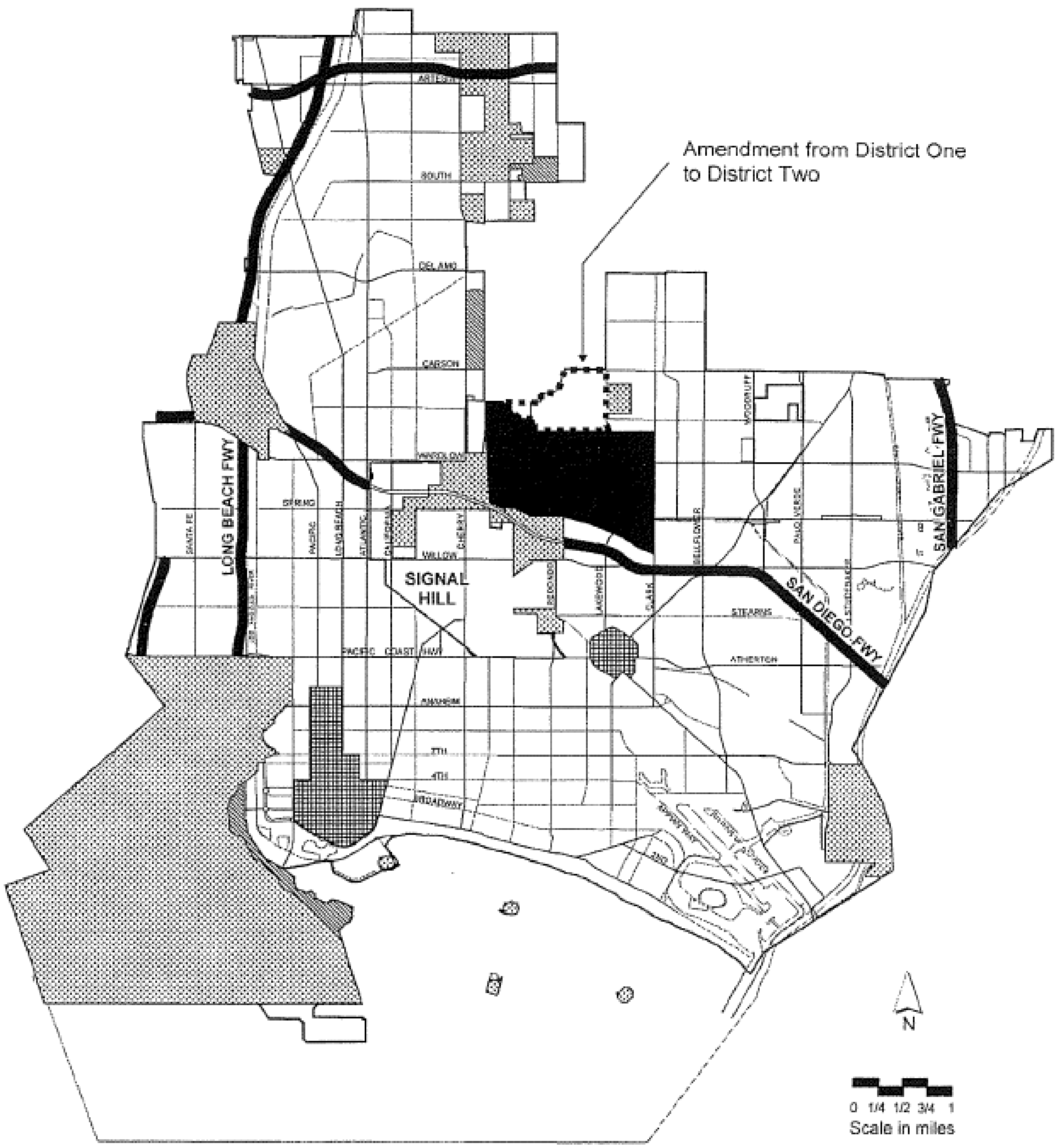
Receiving Land Use District*	Time Period	Noise Level** (dBA)
District One	Night:	
	10:00 p.m.—7:00 a.m.	45
	Day:	
	7:00 a.m.—10:00 p.m.	50
District Two	Night:	
	10:00 p.m.—7:00 a.m.	55
	Day:	
	7:00 a.m.—10:00 p.m.	60
District Three	Any time	65
District Four	Any time	70
District Five	Regulated by other agencies and laws	
*District One:	Predominantly residential with other land use types also present	
District Two:	Predominantly commercial with other land use types also present	
Districts Three and Four:	Predominantly industrial with other land types use also present	
District Five:	Airport, freeways and waterways regulated by other agencies	

** Districts Three and Four limits are intended primarily for use at their boundaries rather than for noise control within those districts.

Table B
BACKGROUND NOISE CORRECTION

Difference between total noise and background noise alone (decibels)	Amount to be subtracted from
6—8	1
9—10	.5

NOISE DISTRICT MAP



* Noise at Long Beach Airport is regulated by State & Federal Laws. It is the responsibility of the Noise Control Officer to address complaints filed against aircraft noise, report all violations to proper enforcing agencies and the Long Beach City Council.

District 1 - Remainder of the City

District 2

District 3

District 4

District 5 - Preempted by other Agencies*

(ORD-09-0030, § 1(exh. A), 2009; Ord. C-7959 § 1 (exh. A), 2004; Ord. C-5371 § 1 (part), 1977: prior code § 4430.6(b))

8.80.170 Interior noise limits—Maximum sound levels.

A. The interior noise standards for various land use districts as presented in Table C shall apply, unless otherwise specifically indicated, within structures located in designated zones with windows in their normal seasonal configuration.

TABLE C

Receiving Land Use District	Type of Land Use	Time Interval	Allowable Interior Noise Level (dBA)
All	Residential	10:00 p.m.—7:00 a.m. 7:00 a.m.—10:00 p.m.	35 45
All	School	7:00 a.m.—10:00 p.m. (While school is in session)	45
Hospital, designated quiet zones and noise sensitive zones		Any time	40

B. No person shall operate, or cause to be operated, any source of sound indoors at any location within the incorporated limits of the City or allow the creation of any indoor noise which causes the noise level when measured inside the receiving dwelling unit to exceed:

1. The noise standard for that land use district as specified in Table C for a cumulative period of more than five (5) minutes in any hour; or
2. The noise standard plus five decibels (5 dB) for a cumulative period of more than one (1) minute in any hour; or
3. The noise standard plus ten decibels (10 dB) or the maximum measured ambient, for any period of time.

C. If the measured indoor ambient level exceeds that permissible within any of the first two (2) noise limit categories in this Section, the allowable noise exposure standard shall be increased in five decibel (5 dB) increments in each category as appropriate to reflect the indoor ambient noise level. In the event the indoor ambient noise level exceeds the third noise limit category, the maximum allowable indoor noise level under said category shall be increased to reflect the maximum indoor ambient noise level.

(Ord. C-5371 § 1 (part), 1977: prior code § 4430.7(a))

8.80.180 Interior noise limits—Correction for character of sound.

In the event the alleged offensive noise contains a steady audible tone such as a whine, screech or hum, or is a repetitive noise such as hammering or riveting, or contains music or speech conveying information content, the standard limits set forth in Table C in Section 8.80.170 shall be reduced by five decibels (5 dB).

(Ord. C-5371 § 1 (part), 1977: prior code § 4430.7(b))

8.80.190 Noise disturbances—Prohibited.

No person shall unnecessarily make, continue or cause to be made or continued, any noise disturbance.

(Ord. C-5371 § 1 (part), 1977: prior code § 4430.8(a))

8.80.200 Noise disturbances—Acts specified.

The following acts, and the causing or permitting thereof, are declared to be in violation of this Chapter:

A. Radios, television sets, musical instruments and similar devices. Operating, playing or permitting the operation or playing of any radio, television set, phonograph, drum, musical instrument, or similar device which produces or reproduces sound:

1. Between the hours of ten p.m. and seven a.m. the following day in such a manner as to create a noise disturbance across a residential or commercial real property line or at any time to violate the provisions of Sections 8.80.150 or 8.80.170 except for activities for which a variance has been issued by the noise control office,

2. In such a manner as to exceed the levels set forth in Table A in Section 8.80.160, measured at a distance of at least fifty feet (50') (fifteen (15) meters) from such device operating on a public right-of-way or public space;

B. Loudspeakers (amplified sound). Using or operating for any purpose any loudspeaker, loudspeaker system, or similar device between the hours of ten p.m. and seven a.m. the following day, such that the sound therefrom creates a noise disturbance across a residential real property line, or at any time violates the provisions of Sections 8.80.150 or 8.80.170, except for any noncommercial public speaking, public assembly or other activity for which a variance has been issued by the noise control office;

C. Street sales. Offering for sale, selling anything or advertising by shouting or outcry within any residential or commercial area or noise sensitive zone of the City except by variance issued by the noise control office. The provisions of this subsection shall not be construed to prohibit the selling by outcry of merchandise, food and beverages at licensed sporting events, parades, fairs, circuses or other similar licensed public entertainment events;

D. Animals and birds. Owning, possessing or harboring any animal or bird which frequently or for continued duration howls, barks, meows, squawks, or makes other sounds which create a noise disturbance across a residential or commercial real property line or within a noise sensitive zone. This provision shall not apply to public zoos;

E. Loading and unloading. Loading, unloading, opening, closing or other handling of boxes, crates, containers, building materials, garbage cans, or similar objects between the hours of ten p.m. and seven a.m. the following day in such a manner as to cause a noise disturbance across a residential real property line or at any time to violate the provisions of Sections 8.80.150 and 8.80.170

F. Repealed;

G. Vibration. Operating or permitting the operation of any device that creates vibration which is above the vibration perception threshold of an individual at or beyond the property boundary of the source if on private property or at one hundred fifty feet (150') (forty-six (46) meters) from the source if on a public space or public right-of-way. For the purposes of this subsection, "vibration perception threshold" means the minimum ground or structure-borne vibrational motion necessary to cause a normal person to be aware of the vibration by such directed means as, but not limited to, sensation by touch or visual observation of moving objects. The perception threshold shall be presumed to be .001 g's in the frequency range 0—30 hertz and .003 g's in the frequency range between thirty and one hundred hertz;

H. Explosives, firearms and similar devices. Using or firing explosives, firearms, firecrackers or similar devices such that the sound therefrom creates a noise disturbance across a real property line, or within a noise sensitive zone, public space or public right-of-way, without first obtaining a variance issued by the noise control office or other appropriate regulatory agency;

I. Powered model vehicles. Operating or permitting the operation of powered model vehicles:

1. Between the hours of seven p.m. and seven a.m. the following day so as to create a noise disturbance across a residential or commercial real property line or at any time to violate the provisions of Sections 8.80.150 or 8.80.170
2. In such a manner as to exceed the levels set forth in Table A in Section 8.80.160 measured at a distance not less than one hundred feet (100') (thirty (30) meters) from any point on the path of a vehicle operating on public space or public right-of-way;

J. Stationary nonemergency signaling devices.

1. Sounding or permitting the sounding of any electronically amplified signal from any stationary bell, chime, siren, whistle, or similar device, intended primarily for nonemergency purposes, from any place, for more than ten (10) seconds in any hourly period,
2. Houses of religious worship and chimes in the civic center shall be exempt from the operation of this provision,
3. Sound sources covered by this provision and not exempted under Subsection 8.80.200.J.2 of this Section may be exempted by a variance issued by the noise control office;

K. Emergency signaling devices.

1. The intentional sounding or permitting the sounding outdoors of any fire, burglar or civil defense alarm, siren, whistle or similar stationary emergency signaling device, except for emergency purposes or for testing, as provided in Subsection 8.80.200.K.2 of this Section,
2. a. Testing of a stationary emergency signaling device shall not occur before seven a.m. or after seven p.m. Any such testing shall only use the minimum cycle test time. In no case shall such test time exceed ten (10) seconds,
   b. Testing of the complete emergency signaling system, including the functioning of the signaling device and the personnel response to the signaling device shall not occur more than once in each calendar month. Such testing shall not occur before seven a.m. or after ten p.m. The time limit specified in Subsection 8.80.200.K.2.a of this Section shall not apply to such complete system testing,
3. Sounding or permitting the sounding of any exterior burglar or fire alarm unless such alarm is automatically terminated within fifteen (15) minutes of activation;

L. Noise sensitive zones.

1. Creating or causing the creation of any sound within any noise sensitive zone, so as to exceed the specified land use noise standards set forth in Sections 8.80.150 and 8.80.170, or
2. Creating or causing the creation of any sound within or adjacent to any noise sensitive zone containing a hospital, nursing home, school, court or other designated use so as to interfere with the functions of such activity or annoy the patients or participants of such activity;

M.

Domestic power tools.

1. Operating or permitting the operation of any mechanically powered saw, sander, drill, grinder, lawn or garden tool, or similar tool between ten p.m. and seven a.m. the following day so as to create a noise disturbance across a residential or commercial real property line,
2. Any motor, machinery, pump, etc., shall be sufficiently enclosed or muffled and maintained so as not to create a noise disturbance,
3. Operating leaf blowers, consisting of portable power equipment used in any landscape maintenance, construction, property repair or property maintenance for the purpose of blowing, dispersing or redistributing dust, dirt, leaves, grass clippings, cuttings, or trimmings from plants, trees or other debris is unlawful if operated within any residential area or in any nonresidential area within four hundred feet (400') of any residential area in the City between the hours after eight p.m. and before eight a.m. Monday through Friday, after five p.m. and before nine a.m. on Saturdays, and after five p.m. and before eleven a.m. on Sundays and legal holidays. Notwithstanding the provisions of Section 8.80.380, violations of this Subsection 8.80.200.M.3 shall be infractions except as specifically provided in this Section. The first violation in any one (1) year period shall be subject to a fine of fifty dollars ($50.00); a second violation in any one (1) year period shall be subject to a fine of seventy-five dollars ($75.00); a third violation in any one (1) year period shall be subject to a fine of one hundred dollars ($100.00). A fourth or subsequent violation of this Subsection in any one (1) year period may be filed as a misdemeanor. Notwithstanding the provisions of any other Section in this Chapter, the provisions of this subsection may be enforced by a Police Officer;

N. Air-conditioning or air refrigerating equipment. Operating or permitting the operation of any air-conditioning or air refrigerating equipment in such a manner as to exceed any of the following sound levels measured as specified in the American Society of Heating, Refrigeration and Air Conditioning Engineers Code of Recommended Practices:

Measurement Location	Units Installed Before 1-1-80 dB (A)	Units Installed On Or After 1-1-80 dB (A)
Any point on neighboring property line, five feet above grade level, no closer than three feet from any wall	60	55
Center of neighboring patio five feet above grade level, no closer than three feet from any wall	55	50
Outside the neighboring living area window nearest the equipment location, not more than three feet from the window opening, but at least three feet from any other surface	55	50

In case of conflict, the interior noise standards as specified in Section 8.80.170 shall nonetheless apply;

O. Places of public entertainment. Operating or permitting to be operated any loudspeaker or other source of sound in any place of public entertainment that exceeds the levels shown in Table D at any point normally occupied by a customer, without a conspicuous and legible sign stating

"WARNING, SOUND LEVELS WITHIN MAY CAUSE PERMANENT HEARING

IMPAIRMENT."

Table D
MAXIMUM LEVELS ALLOWED IN PLACES
OF PUBLIC ENTERTAINMENT

Duration Per Day Continuous Hours	Noise Level dB (A)
8	85
6	86
4	88
3	89
2	91
1 ½	92
1	94
½	97
¼ or less	100

P. Tampering. The following acts or the causing thereof are prohibited:

1. The removal or rendering inoperative by any person other than for purposes of maintenance, repair, or replacement, of any noise control device or element of design or noise label of any product identified under Subsection 8.80.040.G and Subsection 8.80.050.C. The Noise Control Officer may, by regulation, list those acts which constitute violation of this provision,
2. The use of a product, identified under Subsection 8.80.040.G and Subsection 8.80.050.C, which has had a noise control device or element of design or noise label removed or rendered inoperative with knowledge that such action has occurred.

(Ord. C-7745 § 1, 2001; Ord. C-7175 § 1, 1994; Ord. C-6474 § 2, 1988; Ord. C-6036 § 1, 1984; Ord. C-5371 § 1 (part), 1977: prior code § 4430.8(b))

8.80.202 Construction activity—Noise regulations.

The following regulations shall apply only to construction activities where a building or other related permit is required or was issued by the Building Official and shall not apply to any construction activities within the Long Beach harbor district as established pursuant to Section 201 of the City Charter.

A. Weekdays and federal holidays. No person shall operate or permit the operation of any tools or equipment used for construction, alteration, repair, remodeling, drilling, demolition or any other related building activity which produce loud or unusual noise which annoys or disturbs a reasonable person of normal sensitivity between the hours of seven p.m. and seven am. the following day on weekdays, except for emergency work authorized by the Building Official. For purposes of this Section, a federal holiday shall be considered a weekday.

B. Saturdays. No person shall operate or permit the operation of any tools or equipment used for construction, alteration, repair, remodeling, drilling, demolition or any other related building activity which produce loud or unusual noise which annoys or disturbs a reasonable person of normal sensitivity between the hours of seven p.m. on Friday and nine a.m. on Saturday and after six p.m. on Saturday, except for emergency work authorized by the Building Official.

C. Sundays. No person shall operate or permit the operation of any tools or equipment used for construction, alteration, repair, remodeling, drilling, demolition or any other related building activity at any time on Sunday, except for emergency work authorized by the Building Official or except for work authorized by permit issued by the Noise Control Officer.

D. Owner's/employer's responsibility. It is unlawful for the landowner, construction company owner, contractor, subcontractor or employer of persons working, laboring, building, or assisting in construction to permit construction activities in violation of provisions in this Section.

E. Sunday work permits. Any person who wants to do construction work on a Sunday must apply for a work permit from the Noise Control Officer. The Noise Control Officer may issue a Sunday work permit if there is good cause shown; and in issuing such a permit, consideration will be given to the nature of the work and its proximity to residential areas. The permit may allow work on Sundays, only between nine a.m. and six p.m., and it shall designate the specific dates when it is allowed.

F. Enforcement. Notwithstanding the provisions of Sections 8.80.370 and 8.80.380, this Section may be enforced by a Police Officer.

Any person who violates any provision of this Section is guilty of a misdemeanor and shall be fined in an amount not to exceed five hundred dollars ($500.00), or be imprisoned for a period not to exceed one hundred eighty (180) days, or by both such fine and imprisonment. Each day that a violation occurs shall constitute a separate offense and shall be punishable as such.

Whenever an employee is prosecuted for a violation of this noise control ordinance, the court shall, at the request of the employee, take appropriate action to make the landowner, construction company owner, contractor, subcontractor or employer a codefendant.

(Ord. C-6488 § 1, 1988; Ord. C-6474 § 1, 1988)

8.80.290 Exemption—From exterior noise standards.

The provisions of Section 8.80.150 shall not apply to activities covered by the following Sections:

A. Section 8.80.200 C, street sales;
B. Section 8.80.200 D, animals and birds;
C. Section 8.80.200 J, stationary nonemergency signaling devices;
D. Section 8.80.200 K, emergency signaling devices;
E. Section 8.80.200 M, domestic power tools;
F. Section 8.80.200 N, air conditioning or air refrigerating equipment; and
G. Section 8.80.210, refuse collection vehicles.

(Ord. C-5371 § 1 (part), 1977: prior code § 4430.10 (e))

Appendix B

2011 Annual Average Daily Truck Traffic on
California State Highway System

2011 ADT

RTE	DIST	CNTY	POST MILE	LEG	DESCRIPTION	VEHICLE AADT TOTAL	TRUCK AADT TOTAL	TRUCK % TOT VEH	-------- 2	TRUCK By 3	AADT Axle 4	TOTAL ------------ 5+	% ---------- 2	TRUCK By 3	AADT Axle 4	----------- 5+	EAL 2-WAY -1000	YEAR VER/ EST
680	4	CC	21.191	B	JCT. RTE. 4	126000	3402	2.7	1764	507	120	1011	51.84	14.91	3.53	29.72	475	00V
680	4	CC	21.191	A	JCT. RTE. 4	117000	7968	6.81	4132	920	241	2675	51.86	11.54	3.03	33.57	1188	00V
680	4	SOL	R2.819	B	LAKE HERMAN ROAD	58000	3091	5.33	1032	223	127	1710	33.38	7.22	4.1	55.3	665	00V
680	4	SOL	R2.819	A	LAKE HERMAN ROAD	59000	3162	5.36	1136	272	115	1639	35.93	8.6	3.64	51.83	647	00V
680	4	SOL	13.126	B	CORDELIA WYE, JCT. RTE. 80	63000	3282	5.21	1152	286	271	1573	35.1	8.72	8.25	47.93	649	00V
710	7	LA	4.96	A	LONG BEACH, BEGIN ROUTE 710, LONG BEACH FREEWAY	57000	15954	27.99	1039	2728	78	12109	6.51	17.1	0.49	75.9	4476	11E
710	7	LA	6.881	B	LONG BEACH, JCT. RTE. 1, PACIFIC COAST HIGHWAY INTERCHANGE	129000	18937	14.68	2488	3202	286	12960	13.14	16.91	1.51	68.44	4895	11E
710	7	LA	6.881	A	LONG BEACH, JCT. RTE. 1, PACIFIC COAST HIGHWAY INTERCHANGE	149000	21873	14.68	2874	3699	330	14970	13.14	16.91	1.51	68.44	5654	11V
710	7	LA	9.41	B	LONG BEACH, JCT. RTE. 405, SAN DIEGO FREEWAY INTERCHANGE	164000	22419	13.67	2946	3791	339	15344	13.14	16.91	1.51	68.44	5795	11E
710	7	LA	9.41	A	LONG BEACH, JCT. RTE. 405, SAN DIEGO FREEWAY INTERCHANGE	176000	25010	14.21	5085	3326	350	16249	20.33	13.3	1.4	64.97	6141	11E
710	7	LA	10.823	A	LONG BEACH, DEL AMO BOULEVARD INTERCHANGE	179000	25525	14.26	5189	3395	357	16584	20.33	13.3	1.4	64.97	6268	11V

AUTOS: 85.74%
MED TKS: 4.996%
HVY TKS: 9.264%

Appendix C

Long Beach Freeway (SR-710)
Roadway Calculations

FHWA-RD-77-108 HIGHWAY NOISE PREDICTION MODEL (CALVENO)

PROJECT: RIVERWALK
ROADWAY: STATE ROUTE 710 FREEWAY
LOCATION: 1ST ROW UNITS FACING 710 FREEWAY (1ST FLOOR)

JOB #: 2373-2013-01
DATE: 9-Oct-13
ENGINEER: M. Dickerson

NOISE INPUT DATA

ROADWAY CONDITIONS

ADT = 179,000
SPEED = 65
PK HR % = 10
NEAR LANE/FAR LANE DIST 105
ROAD ELEVATION = 50.0
GRADE = 0.5 %
PK HR VOL = 17,900

RECEIVER INPUT DATA

RECEIVER DISTANCE = 1,510
DIST C/L TO WALL = 1,500
RECEIVER HEIGHT = 5.0
WALL DISTANCE FROM RECEIVER = 10
PAD ELEVATION = 45.0
ROADWAY VIEW: LF ANGLE= -90
RT ANGLE= 90
DF ANGLE= 180

SITE CONDITIONS

AUTOMOBILES = 15
MEDIUM TRUCKS = 15
HEAVY TRUCKS = 15
(10 = HARD SITE, 15 = SOFT SITE)

WALL INFORMATION

HTH WALL= 5.0
AMBIENT= 0.0
BARRIER = 1 (0 = WALL, 1 = BERM)

VEHICLE MIX DATA

VEHICLE TYPE	DAY	EVENING	NIGHT	DAILY
AUTOMOBILES	0.705	0.193	0.102	0.8574
MEDIUM TRUCKS	0.750	0.063	0.187	0.0496
HEAVY TRUCKS	0.750	0.065	0.185	0.0930

MISC. VEHICLE INFO

VEHICLE TYPE	HEIGHT	SLE DISTANCE	GRADE ADJUSTMENT
AUTOMOBILES	52.0	1509.08	- -
MEDIUM TRUCKS	54.0	1509.09	- -
HEAVY TRUCKS	58.0	1509.10	0.00

NOISE OUTPUT DATA

NOISE IMPACTS (WITHOUT TOPO OR BARRIER SHIELDING)

VEHICLE TYPE	PK HR LEQ	DAY LEQ	EVEN LEQ	NIGHT LEQ	LDN	CNEL
AUTOMOBILES	60.5	58.2	58.6	51.0	59.5	60.3
MEDIUM TRUCKS	54.3	52.2	47.5	47.4	54.7	55.0
HEAVY TRUCKS	60.5	58.4	53.8	53.6	60.9	61.2
NOISE LEVELS (dBA)	64.0	61.8	60.1	56.1	63.9	64.3

NOISE IMPACTS (WITH TOPO AND BARRIER SHIELDING)

VEHICLE TYPE	PK HR LEQ	DAY LEQ	EVEN LEQ	NIGHT LEQ	LDN	CNEL
AUTOMOBILES	45.0	42.7	43.1	35.5	44.0	44.8
MEDIUM TRUCKS	38.9	36.8	32.1	32.0	39.3	39.6
HEAVY TRUCKS	45.1	43.0	38.4	38.2	45.5	45.8
NOISE LEVELS (dBA)	48.5	46.4	44.6	40.7	48.4	48.9

NOISE CONTOUR (FT)				
NOISE LEVELS	70 dBA	65 dBA	60 dBA	55 dBA
CNEL	632	1361	2931	6315
LDN	588	1267	2730	5881

FHWA-RD-77-108 HIGHWAY NOISE PREDICTION MODEL (CALVENO)

PROJECT:	RIVERWALK	JOB #:	2373-2013-01
ROADWAY:	STATE ROUTE 710 FREEWAY	DATE:	9-Oct-13
LOCATION:	1ST ROW UNITS FACING 710 FREEWAY (2ND FLOOR)	ENGINEER:	M. Dickerson

NOISE INPUT DATA

ROADWAY CONDITIONS

ADT =	179,000
SPEED =	65
PK HR % =	10
NEAR LANE/FAR LANE DIST	105
ROAD ELEVATION =	50.0
GRADE =	0.5 %
PK HR VOL =	17,900

RECEIVER INPUT DATA

RECEIVER DISTANCE =		1,510
DIST C/L TO WALL =		1,500
RECEIVER HEIGHT =		15.0
WALL DISTANCE FROM RECEIVER =		10
PAD ELEVATION =		45.0
ROADWAY VIEW:	LF ANGLE=	-90
	RT ANGLE=	90
	DF ANGLE=	180

SITE CONDITIONS

AUTOMOBILES =	15
MEDIUM TRUCKS =	15
HEAVY TRUCKS =	15

(10 = HARD SITE, 15 = SOFT SITE)

WALL INFORMATION

HTH WALL=	5.0
AMBIENT=	0.0
BARRIER =	1 (0 = WALL, 1 = BERM)

VEHICLE MIX DATA

VEHICLE TYPE	DAY	EVENING	NIGHT	DAILY
AUTOMOBILES	0.705	0.193	0.102	0.8574
MEDIUM TRUCKS	0.750	0.063	0.187	0.0496
HEAVY TRUCKS	0.750	0.065	0.185	0.0930

MISC. VEHICLE INFO

VEHICLE TYPE	HEIGHT	SLE DISTANCE	GRADE ADJUSTMENT
AUTOMOBILES	52.0	1509.11	- -
MEDIUM TRUCKS	54.0	1509.10	- -
HEAVY TRUCKS	58.0	1509.09	0.00

NOISE OUTPUT DATA

NOISE IMPACTS (WITHOUT TOPO OR BARRIER SHIELDING)

VEHICLE TYPE	PK HR LEQ	DAY LEQ	EVEN LEQ	NIGHT LEQ	LDN	CNEL
AUTOMOBILES	60.5	58.2	58.6	51.0	59.5	60.3
MEDIUM TRUCKS	54.3	52.2	47.5	47.4	54.7	55.0
HEAVY TRUCKS	60.5	58.4	53.8	53.6	60.9	61.2
NOISE LEVELS (dBA)	64.0	61.8	60.1	56.1	63.9	64.3

NOISE IMPACTS (WITH TOPO AND BARRIER SHIELDING)

VEHICLE TYPE	PK HR LEQ	DAY LEQ	EVEN LEQ	NIGHT LEQ	LDN	CNEL
AUTOMOBILES	60.5	58.2	58.6	51.0	59.5	60.3
MEDIUM TRUCKS	54.3	52.2	47.5	47.4	54.7	55.0
HEAVY TRUCKS	60.5	58.4	53.8	53.6	60.9	61.2
NOISE LEVELS (dBA)	64.0	61.8	60.1	56.1	63.9	64.3

NOISE CONTOUR (FT)				
NOISE LEVELS	70 dBA	65 dBA	60 dBA	55 dBA
CNEL	632	1361	2931	6315
LDN	588	1267	2730	5881

Appendix D

City of Carson General Plan and
Federal Railroad Administration (FRA) Report

sporting events and horns. These noise sources have the potential to temporarily disrupt the quietness of an area. Effective control of these noise sources cannot be accomplished through decibel standards, but instead may be accomplished through provisions in the Noise Ordinance.

3.3.4 RAIL LINE NOISE

The City of Carson is served by three railroads: Union Pacific Railroad (UPRR), Burlington Northern Santa Fe (BNSF) Railroad and the Metro Blue line. The UPRR runs two lines (San Pedro and Wilmington) along the extreme western portion of the City, as it converges on the Los Angeles City container transfer facility, which borders the west side of Long Beach. Several UPRR spur lines extend westward from the San Pedro and Wilmington lines into the central portion of Carson providing rail service to many of the major petroleum production companies. A UPRR line also runs within the right-of-way of the Dominguez Channel. A BNSF rail line traverses the southern portion of the City from the Alameda Street Corridor to the Harbor Freeway (I-110). The Metro Blue line crosses the extreme eastern section of the City, running north to downtown Los Angeles and south through Long Beach; no Blue Line stations are in the City.

Three UPRR lines run within the City of Carson: San Pedro line, Wilmington line, and Dominguez Channel line. The San Pedro line carries five trains each day. The Wilmington line, which runs parallel to the Alameda Corridor line and is the preferred route out of the harbor, operates 15 trains each day. The train(s) run approximately every three hours on the Wilmington line. In approximately three years, the San Pedro line will be the only UPRR line in operation. However, the Wilmington line will remain in place and serve as an auxiliary line. The Dominguez Channel line carries five (5) trains per day in each direction. However, when the trains are used for shipping coal, the line is utilized 10 to 15 times per day each direction.[1]

According to the *Alameda Corridor Environmental Impact Report*, dated January 1993, residents located immediately adjacent to the Alameda and Wilmington lines between Dominguez Street and 223rd Street are experiencing noise levels of 68 dBA CNEL, which exceeds the City exterior noise standard of 65 dBA CNEL by 3 dBA. However, this noise level includes vehicular-generated noise associated with Alameda Street.

The BNSF line is located in the southern portion of Carson and runs from Alameda Street west through light industrial and residential areas to the Harbor Freeway.[2] There are approximately 38 trains that utilize the BNSF rail line within the City of Carson each day. No acoustical data or additional operational information was provided by BNSF, regarding operations within the City of Carson.

[1] Mr. Mike Irvine, General Superintendent of Transportation, Union Pacific Railroad, April 7, 1999.

[2] Train operation data associated with the BNSF Railroad line were provided by Mr. Don Cleveland, staff with BNSF, April 14, 1999.

U.S. DOT - CROSSING INVENTORY INFORMATION
AS OF 10/7/2013

Crossing No.: 811215N | Update Reason: Changed Crossing | Effective Begin-Date of Record: 01/01/11
Railroad: UP Union Pacific RR Co. [UP] | End-Date of Record:
Initiating Agency Railroad | Type and Positiion: Public At Grade

Part I Location and Classification of Crossing

Division:	WESTERN	State:	CA
Subdivision:	CALIFORNIA	County:	LOS ANGELES
Branch or Line Name:	SAN PEDRO	City:	In LONG BEACH
Railroad Milepost:	0018.05	Street or Road Name:	CARSON ST
RailRoad I.D. No.:	3A 18.05	Highway Type & No.:	NON FA
Nearest RR Timetable Stn:	CARSON	HSR Corridor ID:	
Parent Railroad:		County Map Ref. No.:	13V53
Crossing Owner:		Latitude:	33.8317586
ENS Sign Installed:		Longitude:	-118.2145250
Passenger Service:		Lat/Long Source:	Actual
Avg Passenger Train Count:	0	Quiet Zone:	No
Adjacent Crossing with Separate Number:			

Private Crossing Information:

Category: | Public Access: Unknown

Specify Signs: | Specify Signals:

	ST/RR A	ST/RR B	ST/RR C	ST/RR D
Railroad Use:				
State Use:				

Narrative:

Emergency Contact: (800)848-8715 | Railroad Contact: | State Contact: (415)703-3722

Part II Railroad Information

Number of Daily Train Movements: | Less Than One Movement Per Day: No

Total Trains: 6 | Total Switching: 2 | Day Thru: 4

Typical Speed Range Over Crossing: From 20 to 30 mph | Maximum Time Table Speed: 30

Type and Number of Tracks: Main: 1 Other 0 | Specify:

Does Another RR Operate a Separate Track at Crossing? No

Does Another RR Operate Over Your Track at Crossing? No

U.S. DOT - CROSSING INVENTORY INFORMATION
Continued

Crossing 811215N

Effective Begin-Date of Record: 01/01/11
End-Date of Record:

Part III: Traffic Control Device Information

Signs:

Crossbucks:	0	Highway Stop Signs:	0
Advanced Warning:	No	Hump Crossing Sign:	
Pavement Markings:	No Markings	Other Signs: 0 / 0	Specify:

Train Activated Devices:

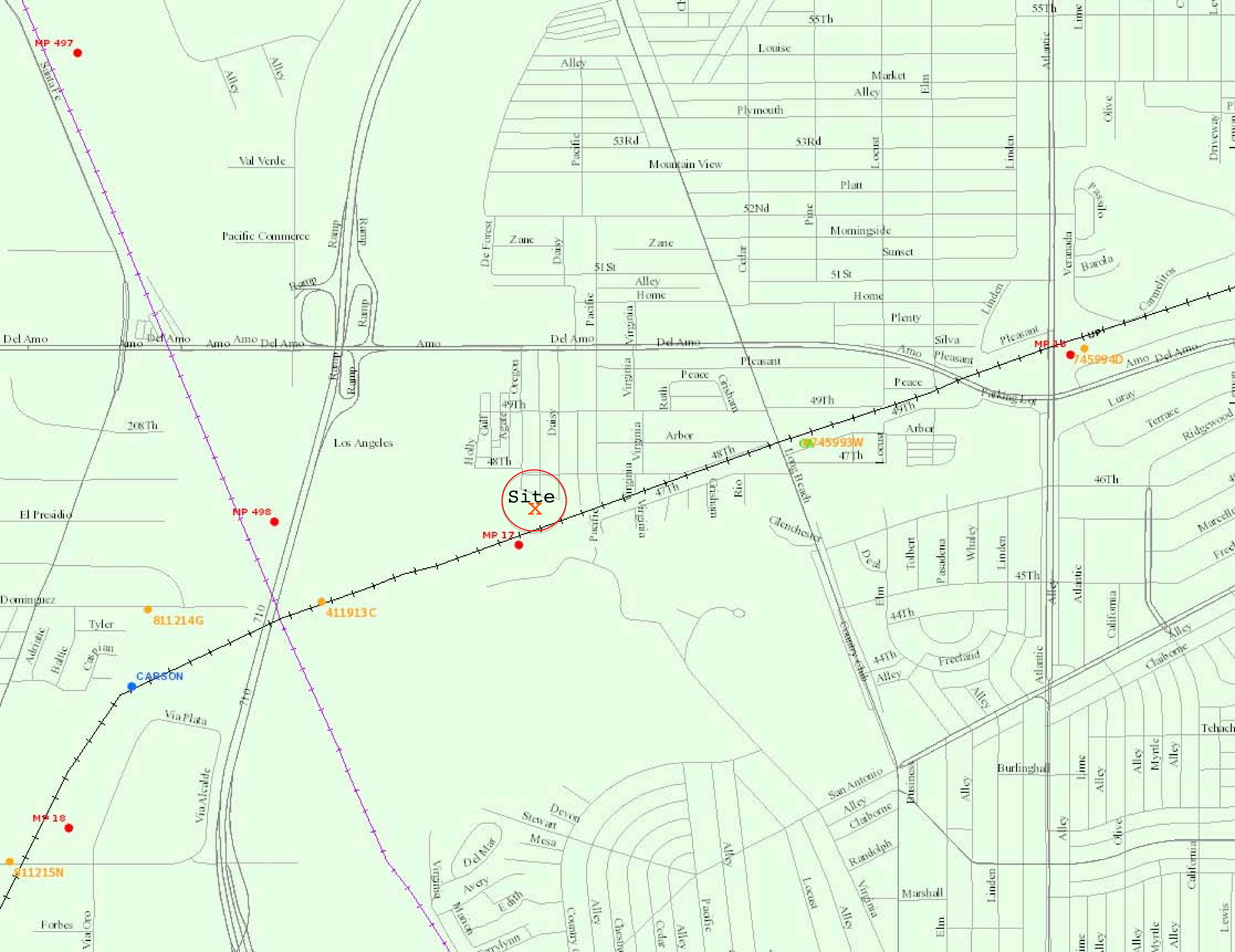
Gates:	4	4 Quad or Full Barrier:	
Mast Mounted FL:	0	Total Number FL Pairs:	0
Cantilevered FL (Over):	0	Cantilevered FL (Not over):	0
Other Flashing Lights:	0	Specify Other Flashing Lights:	
Highway Traffic Signals:	0	Wigwags: 0	Bells: 4
Other Train Activated Warning Devices:		Special Warning Devices Not Train Activated:	
Channelization:		Type of Train Detection:	Constant Warning Time
Track Equipped with Train Signals?	No	Traffic Light Interconnection/Preemption:	

Part IV: Physical Characteristics

Type of Development:	Open Space	Smallest Crossing Angle:	60 to 90 Degrees
Number of Traffic Lanes Crossing Railroad:	2	Are Truck Pullout Lanes Present?	No
Is Highway Paved?	Yes		
Crossing Surface:	Rubber	If Other:	
Nearby Intersecting Highway?	N/A	Is it Signalized?	
Does Track Run Down a Street?	No	Is Crossing Illuminated?	
Is Commercial Power Available?	Yes		

Part V: Highway Information

Highway System:	Non-Federal-aid	Functional Classification of Road at Crossing:	Urban Local
Is Crossing on State Highway System:	No		
Annual Average Daily Traffic (AADT):	025000	AADT Year:	1986
Estimated Percent Trucks:	18	Avg. No of School Buses per Day:	0
Posted Highway Speed:	0		


Site
X
MP 497
MP 498
MP 17
MP 16
MP 18
CARSON
UP
811214G
411913C
745994D
745993W
811215N
Los Angeles
Pacific Commerce
Val Verde
El Presidio
Dominguez
Del Amo
208Th
Tyler
Adriatic
Baltic
Caspian
Via Plata
Via Alcalde
Via Oro
Forbes
Santa Fe
710
Ramp
Alley
55Th
Louise
Market
Plymouth
53Rd
Mountain View
Platt
52Nd
Morningside
Sunset
51 St
Home
Plenty
Zane
Pleasant
Peace
49Th
48Th
47Th
46Th
45Th
44Th
Arbor
Silva
Veranada
Barcola
Carmelitos
Parking Lot
Luray
Terrace
Ridgewood
De Forest
Daisy
Pacific
Virginia
Oregon
Holly
Gulf
Agave
Ruth
Grisham
Cedar
Pine
Locust
Linden
Elm
Atlantic
Lime
Olive
Passeo
Long Beach
Rio
Glenchessa
Deal
Tolbert
Pasadena
Whitley
California
Country club
Freeland
Claiborne
Burlinghall
San Antonio
Business
Randolph
Marshall
Myrtle
Tehachapi
Devon
Stewart
Mesa
Del Mar
Avery
Marion
Edith
Lewis

Appendix E

Federal Transit Administration (FTA)
General Vibration Assessment

10. GENERAL VIBRATION ASSESSMENT

This chapter outlines procedures that can be used to develop generalized predictions of ground-borne vibration and noise. This manual includes three different levels of detail for projecting ground-borne vibration:

- **Screening:** The screening procedure is discussed in Chapter 9. A standard table of impact distances is used to determine if ground-borne vibration from the project may affect sensitive land uses. More detailed analysis is required if any sensitive land uses are within the screening distances. The screening procedure does not require any specific knowledge about the vibration characteristics of the system or the geology of the area. If different propagation conditions are known to be present, a simple adjustment is provided.

- **General Assessment:** The general level of assessment, as described in this chapter, is an extension of the screening procedure. It uses generalized data to develop a curve of vibration level as a function of distance from the track. The vibration levels at specific buildings are estimated by reading values from the curve and applying adjustments to account for factors such as track support system, vehicle speed, type of building, and track and wheel condition. The general level deals only with the overall vibration velocity level and the A-weighted sound level. It does not consider the frequency spectrum of the vibration or noise.

- **Detailed Analysis:** Discussed in Chapter 11, the Detailed Analysis involves applying all of the available tools for accurately projecting the vibration impact at specific sites. The procedure outlined in this manual includes a test of the vehicle (or similar vehicle) to define the forces generated by the vibration source and tests at the site in question to define how the local geology affects vibration propagation. It is considerably more complex to develop detailed projections of ground-borne vibration than it is to develop detailed projections of airborne noise. Accurate projections of ground-borne vibration require professionals with experience in performing and interpreting vibration propagation tests. As such, detailed vibration predictions are usually performed during the final design phase of a project when there is sufficient reason to suspect adverse vibration impact from the project. The procedure for Detailed Vibration Analysis presented in Chapter 11 is based on measurements to characterize vibration propagation at specific sites.

There is not always a clear distinction between general and detailed predictions. For example, it is often appropriate to use several representative measurements of vibration propagation along the planned alignment in developing generalized propagation curves. Other times, generalized prediction curves may be sufficient for the majority of the alignment, but with Detailed Analysis applied to particularly sensitive buildings such as a concert hall. The methods for analyzing transit vibration in this manual are consistent with those described in recognized handbooks and international standards.(1, 2)

The purpose of the General Assessment is to provide a relatively simple method of developing estimates of the overall levels of ground-borne vibration and noise that can be compared to the acceptability criteria given in Chapter 8. For many projects, particularly when comparing alternatives, this level of detail will be sufficient for the environmental impact assessment. Where there are potential problems, the Detailed Analysis is then undertaken during final design of the selected alternative to accurately define the level of impact and design mitigation measures. A Detailed Analysis usually will be required when designing special track-support systems such as floating slabs or ballast mats. Detailed Analysis is not usually required if, as is often the case, the mitigation measure consists of relocating a crossover or turnout. Usually, the General Assessment is adequate to determine whether a crossover needs to be relocated.

The basic approach for the General Assessment is to define a curve, or set of curves, that predicts the overall ground-surface vibration as a function of distance from the source, then apply adjustments to these curves to account for factors such as vehicle speed, building type, and receiver location within the building. Section 10.1 includes curves of vibration level as a function of distance from the source for the common types of vibration sources such as rapid transit trains and buses. When the vehicle type is not covered by the curves included in this section, it will be necessary to define an appropriate curve either by extrapolating from existing information or performing measurements at an existing facility.

10.1 SELECTION OF BASE CURVE FOR GROUND SURFACE VIBRATION LEVEL

The base curves for three standard transportation systems are defined in Figure 10-1. This figure shows typical ground-surface vibration levels assuming equipment in good condition and speeds of 50 mph for the rail systems and 30 mph for buses. The levels must be adjusted to account for factors such as different speeds and different geologic conditions than assumed. The adjustment factors are discussed in Section 10.2.

The curves in Figure 10-1 are based on measurements of ground-borne vibration at representative North American transit systems. The top curve applies to trains that are powered by diesel or electric locomotives. It includes intercity passenger trains and commuter rail trains. The curve for rapid transit rail cars covers both heavy and light-rail vehicles on at-grade and subway track. It is somewhat surprising that subway and at-grade track can be represented by the same curve since ground-borne vibration created by a train operating in a subway has very different characteristics than vibration from at-grade track. However, in spite of these differences, the overall vibration velocity levels are comparable. Subways tend to have more vibration problems than at-grade track. This is probably due to two factors: (1) subways are usually located in more densely developed areas, and (2) the airborne noise is usually a more serious problem for at-grade systems than the ground-borne vibration. Another difference between subway and at-grade track is that the ground-borne vibration from subways tends to be higher frequency than the vibration from at-grade track, which makes the ground-borne noise more noticeable.

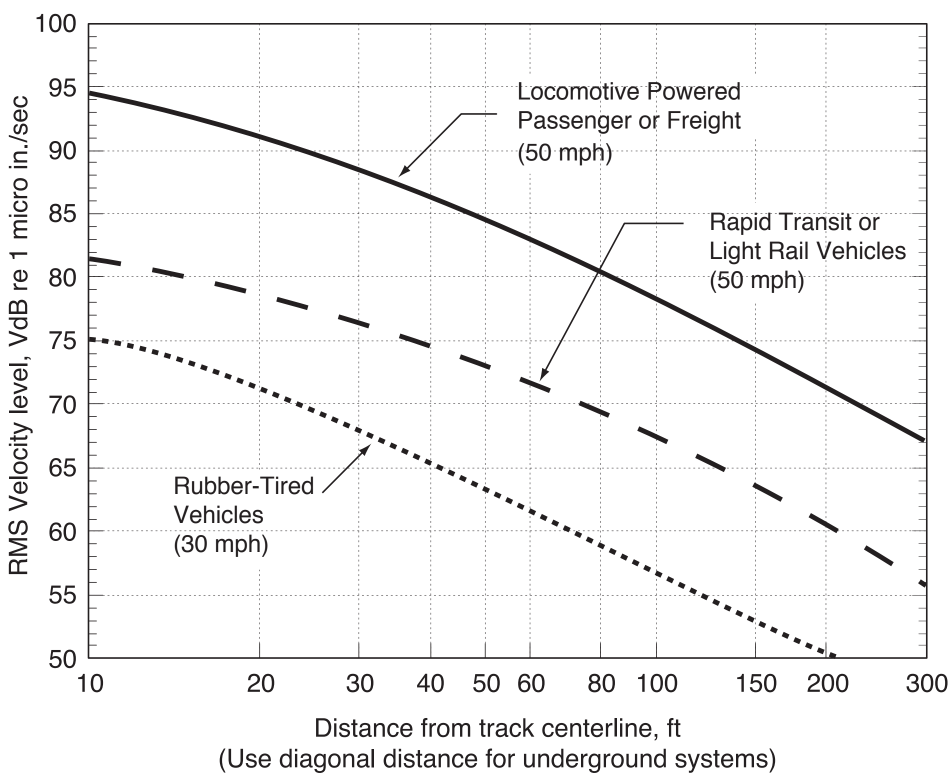


Figure 10-1. Generalized Ground Surface Vibration Curves

The curves in Figure 10-1 were developed from many measurements of ground-borne vibration. Experience with ground-borne vibration data is that, for any specific type of transit mode, a significant variation in vibration levels under apparently similar conditions is not uncommon. The curves in Figure

10-1 represent the upper range of the measurement data from well-maintained systems. Although actual levels fluctuate widely, it is rare that ground-borne vibration will exceed the curves in Figure 10-1 by more than one or two decibels unless there are extenuating circumstances, such as wheel- or running-surface defects.

One approach to dealing with the normal fluctuation is to show projections as a range. For example, the projected level from Figure 10-1 for an LRT system with train speeds of 50 mph is about 72 VdB at a distance of 60 feet from the track centerline, just at the threshold for acceptable ground-borne vibration for residential land uses. To help illustrate the normal fluctuation, the projected level of ground-borne vibration might be given as 67 to 72 VdB. This approach is not recommended since it tends to confuse the interpretation of whether or not the projected vibration levels exceed the impact threshold. However, because actual levels of ground-borne vibration will sometimes differ substantially from the projections, some care must be taken when interpreting projections. Some guidelines are given below:

1. Projected vibration is below the impact threshold. Vibration impact is unlikely in this case.
2. Projected ground-borne vibration is 0 to 5 decibels greater than the impact threshold. In this range there is still a significant chance that actual ground-borne vibration levels will be below the impact threshold. In this case, the impact would be reported in the environmental document as exceeding the applicable threshold and a commitment would be made to conduct more detailed studies to refine the vibration impact analysis during final design and determine appropriate mitigation, if necessary. A site-specific Detailed Analysis may show that vibration control measures are not needed.
3. Projected ground-borne vibration is 5 decibels or more greater than the impact threshold. Vibration impact is probable and Detailed Analysis will be needed during final design to help determine appropriate vibration control measures.

The two most important factors that must be accounted for in a General Assessment are the type of vibration source (the mode of transit) and the vibration propagation characteristics. It is well known that there are situations where ground-borne vibration propagates much more efficiently than normal. The result is unacceptable vibration levels at distances two to three times the normal distance. Unfortunately, the geologic conditions that promote efficient propagation have not been well documented and are not fully understood. Shallow bedrock or stiff clay soil often are involved. One possibility is that shallow bedrock acts to keep the vibration energy near the surface. Much of the energy that would normally radiate down is directed back towards the surface by the rock layer with the result that the ground surface vibration is higher than normal.

The selection of a base curve depends on the mode of rail transit under consideration. Appropriate correction factors are then added to account for any unusual propagation characteristics. For less common modes such as magnetically-levitated vehicles (maglev), monorail, or automated guideway transit (AGT), it is necessary to either make a judgment about which curve and adjustment factors best fit the mode or to develop new estimates of vibration level as a function of distance from the track. For example, the vibration from a rubber-tire monorail that will be operating on aerial guideway can be approximated using the bus/rubber tire systems with the appropriate adjustment for the aerial structure. Another example is a magnetic levitation system. Most of the data available on the noise and vibration characteristics of maglev vehicles comes from high-speed systems intended for inter-city service. Even though there is no direct contact between the vehicle and the guideway, the dynamic loads on the guideway can generate ground-borne vibration. Measurements on a German high-speed maglev resulted in ground-borne vibrations at 75 mph comparable to the base curve for rubber-tired vehicles at 30 mph.[(3)] Considerations for selecting a base curve are discussed below:

- **Intercity Passenger Trains:** Although intercity passenger trains can be an important source of environmental vibration, it is rare that they are significant for FTA-funded projects unless a new transit mode will use an existing rail alignment. When a new transit line will use an existing rail alignment, the changes in the intercity passenger traffic can result in either positive or negative impacts. Unless there are specific data available on the ground-borne vibration created by the train operations, the upper curve in Figure 10-1 should be used for intercity passenger trains.
- **Locomotive-Powered Commuter Rail:** The locomotive curve from Figure 10-1 should be used for any commuter rail system powered by either diesel or electric locomotives. The locomotives often create vibration levels that are 3 to 8 decibels higher than those created by the passenger cars. Self-powered electric commuter rail trains can be considered to be similar to rapid transit vehicles. Although they are relatively rare in the U.S., self-powered diesel multiple units (DMU's) create vibration levels somewhere between rapid transit vehicles and locomotive-powered passenger trains. When the axle loads and suspension parameters of a particular DMU are comparable to typical rapid transit vehicles, the rapid transit curve in Figure 10-1 can be used for that mode.
- **Subway Heavy Rail:** Complaints about ground-borne vibration are more common near subways than near at-grade track. This is not because subways create higher vibration levels than at-grade systems - rather it is because subways are usually located in high-density areas in close proximity to building foundations. When applied to subways, the rapid transit curve in Figure 10-1 assumes a relatively lightweight bored concrete tunnel in soil. The vibration levels will be lower for heavier subway structures such as cut-and-cover box structures and stations.
- **At-Grade Heavy Rail or LRT:** The available data show that heavy rail and light rail transit vehicles create similar levels of ground-borne vibration. This is not surprising since the vehicles have similar suspension systems and axle loads. Light-rail systems tend to have fewer problems with ground-borne vibration because of the lower operating speeds. Similar to the subway case, an adjustment factor must be used if the transit vehicle has a primary suspension that is stiff in the vertical direction.
- **Intermediate Capacity Transit:** The vibration levels created by an intermediate capacity transit system or an AGT system will depend on whether the vehicles have steel wheels or rubber wheels. If they have steel wheels, the transit car curve in Figure 10-1 should be used with appropriate adjustments for operating speed. The bus/rubber tire curve should be used for rubber-tired ICT systems.

- **Bus/Rubber Tire:** Rubber-tire vehicles rarely create ground-borne vibration problems unless there is a discontinuity or bump in the road that causes the vibration. The curve in Figure 10-1 shows the vibration level for a typical bus operating on smooth roadway.

10.2 ADJUSTMENTS

Once the base curve has been selected, the adjustments in Table 10-1 can be used to develop vibration projections for specific receiver positions inside buildings. All of the adjustments are given as single numbers to be added to, or subtracted from, the base level. The adjustment parameters are speed, wheel and rail type and condition, type of track support system, type of building foundation, and number of floors above the basement level. It should be recognized that many of these adjustments are strongly dependent on the frequency spectrum of the vibration source and the frequency dependence of the vibration propagation. The single number values are suitable for generalized evaluation of the vibration impact and vibration mitigation measures since they are based on typical vibration spectra. However, the single number adjustments are not adequate for detailed evaluations of impact of sensitive buildings or for detailed specification of mitigation measures. Detailed Analysis requires consideration of the relative importance of different frequency components.

Table 10-1. Adjustment Factors for Generalized Predictions of Ground-Borne Vibration and Noise

Factors Affecting Vibration Source				
Source Factor	**Adjustment to Propagation Curve**			**Comment**
		Reference Speed		
Speed	Vehicle Speed	50 mph	30 mph	Vibration level is approximately proportional to 20*log(speed/speed$_{ref}$). Sometimes the variation with speed has been observed to be as low as 10 to 15 log(speed/speed$_{ref}$).
	60 mph	+1.6 dB	+6.0 dB	
	50 mph	0.0 dB	+4.4 dB	
	40 mph	-1.9 dB	+2.5 dB	
	30 mph	-4.4 dB	0.0 dB	
	20 mph	-8.0 dB	-3.5 dB	
Vehicle Parameters (not additive, apply greatest value only)				
Vehicle with stiff primary suspension	+8 dB			Transit vehicles with stiff primary suspensions have been shown to create high vibration levels. Include this adjustment when the primary suspension has a vertical resonance frequency greater than 15 Hz.
Resilient Wheels	0 dB			Resilient wheels do not generally affect ground-borne vibration except at frequencies greater than about 80 Hz.
Worn Wheels or Wheels with Flats	+10 dB			Wheel flats or wheels that are unevenly worn can cause high vibration levels. This can be prevented with wheel truing and slip-slide detectors to prevent the wheels from sliding on the track.
Track Conditions (not additive, apply greatest value only)				
Worn or Corrugated Track	+10 dB			If both the wheels and the track are worn, only one adjustment should be used. Corrugated track is a common problem. Mill scale on new rail can cause higher vibration levels until the rail has been in use for some time.
Special Trackwork	+10 dB			Wheel impacts at special trackwork will significantly increase vibration levels. The increase will be less at greater distances from the track.
Jointed Track or Uneven Road Surfaces	+5 dB			Jointed track can cause higher vibration levels than welded track. Rough roads or expansion joints are sources of increased vibration for rubber-tire transit.
Track Treatments (not additive, apply greatest value only)				
Floating Slab Trackbed	-15 dB			The reduction achieved with a floating slab trackbed is strongly dependent on the frequency characteristics of the vibration.
Ballast Mats	-10 dB			Actual reduction is strongly dependent on frequency of vibration.
High-Resilience Fasteners	-5 dB			Slab track with track fasteners that are very compliant in the vertical direction can reduce vibration at frequencies greater than 40 Hz.

Table 10-1. Adjustment Factors for Generalized Predictions of Ground-Borne Vibration and Noise (Continued)

Factors Affecting Vibration Path		
Path Factor	**Adjustment to Propagation Curve**	**Comment**
Resiliently Supported Ties	-10 dB	Resiliently supported tie systems have been found to provide very effective control of low-frequency vibration.
Track Configuration (not additive, apply greatest value only)		
Type of Transit Structure	Relative to at-grade tie & ballast: Elevated structure -10 dB Open cut 0 dB	The general rule is the heavier the structure, the lower the vibration levels. Putting the track in cut may reduce the vibration levels slightly. Rock-based subways generate higher-frequency vibration.
	Relative to bored subway tunnel in soil: Station -5 dB Cut and cover -3 dB Rock-based - 15 dB	
Ground-borne Propagation Effects		
Geologic conditions that promote efficient vibration propagation	Efficient propagation in soil +10 dB	Refer to the text for guidance on identifying areas where efficient propagation is possible.
	Propagation in rock layer **Dist.** / **Adjust.** 50 ft / +2 dB 100 ft / +4 dB 150 ft / +6 dB 200 ft / +9 dB	The positive adjustment accounts for the lower attenuation of vibration in rock compared to soil. It is generally more difficult to excite vibrations in rock than in soil at the source.
Coupling to building foundation	Wood Frame Houses -5 dB 1-2 Story Masonry -7 dB 3-4 Story Masonry -10 dB Large Masonry on Piles -10 dB Large Masonry on Spread Footings -13 dB Foundation in Rock 0 dB	The general rule is the heavier the building construction, the greater the coupling loss.
Factors Affecting Vibration Receiver		
Receiver Factor	**Adjustment to Propagation Curve**	**Comment**
Floor-to-floor attenuation	1 to 5 floors above grade: -2 dB/floor 5 to 10 floors above grade: -1 dB/floor	This factor accounts for dispersion and attenuation of the vibration energy as it propagates through a building.
Amplification due to resonances of floors, walls, and ceilings	+6 dB	The actual amplification will vary greatly depending on the type of construction. The amplification is lower near the wall/floor and wall/ceiling intersections.
Conversion to Ground-borne Noise		
Noise Level in dBA	Peak frequency of ground vibration: Low frequency (<30 Hz): -50 dB Typical (peak 30 to 60 Hz): -35 dB High frequency (>60 Hz): -20 dB	Use these adjustments to estimate the A-weighted sound level given the average vibration velocity level of the room surfaces. See text for guidelines for selecting low, typical or high frequency characteristics. Use the high-frequency adjustment for subway tunnels in rock or if the dominant frequencies of the vibration spectrum are known to be 60 Hz or greater.

Without careful consideration of the shape of the actual vibration spectra, an inappropriate vibration control measure may be selected that could actually cause an increase in the vibration levels.

The following guidelines are used to select the appropriate adjustment factors. Note that the adjustments for wheel and rail condition are not cumulative. The general rule-of-thumb to use when more than one adjustment may apply is to apply only the largest adjustment. For example: the adjustment for jointed track is 5 decibels and the adjustment for wheel flats is 10 decibels. In an area where there is jointed track and many vehicles have wheel flats, the projected vibration levels should be increased by 10 decibels, not 15 decibels.

- **Train Speed:** The levels of ground-borne vibration and noise vary approximately as 20 times the logarithm of speed. This means that doubling train speed will increase the vibration levels approximately 6 decibels and halving train speed will reduce the levels by 6 decibels. Table 10-1 tabulates the adjustments for reference vehicle speeds of 30 mph for rubber-tired vehicles and 50 mph for steel-wheel vehicles. The following relationship should be used to calculate the adjustments for other speeds.

$$adjustment(dB) = 20 \times \log\left(\frac{speed}{speed_{ref}}\right)$$

- **Vehicle:** The most important factors for the vehicles are the suspension system, wheel condition, and wheel type. Most new heavy rail and light rail vehicles have relatively soft primary suspensions. However, experience in Atlanta, New York, and other cities has demonstrated that a stiff primary suspension (vertical resonance frequency greater than 15 Hz) can result in higher than normal levels of ground-borne vibration. Vehicles for which the primary suspension consists of a rubber or neoprene "donut" around the axle bearing usually have a very stiff primary suspension with a vertical resonance frequency greater than 40 Hz.

  Deteriorated wheel condition is another factor that will increase vibration levels. It can be assumed that a new system will have vehicles with wheels in good condition. However, when older vehicles will be used on new track, it may be appropriate to include an adjustment for wheel condition. The reference curves account for wheels without defects, but wheels with flats or corrugations can cause vibration levels that are 10 VdB higher than normal. Resilient wheels will reduce vibration levels at frequencies greater than the effective resonance frequency of the wheel. Because this resonance frequency is relatively high, often greater than 80 Hz, resilient wheels usually have only a marginal effect on ground-borne vibration.

  It is important to use only one of the adjustments in this category, the greatest one that applies.

- **Track System and Support:** This category includes the type of rail (welded, jointed or special trackwork), the track support system, and the condition of the rail. The base curves all assume good-condition welded rail. Jointed rail causes higher vibration levels than welded rail; the amount higher depends on the condition of the joints. The wheel impacts at special trackwork, such as frogs at crossovers, create much higher vibration forces than normal. Because of the higher vibration levels at special trackwork, crossovers often end up being the principal areas of vibration impact on new systems. Modifying the track support system is one method of mitigating the vibration impact. Special track support systems such as ballast mats, high-resilience track fasteners, resiliently supported ties, and floating slabs have all been shown to be effective in reducing vibration levels.

  The condition of the running surface of the rails can strongly affect vibration levels. Factors such as corrugations, general wear, or mill scale on new track can cause vibration levels that are 5 to 15 decibels higher than normal. Mill scale will usually wear off after some time in service; however, the track must be ground to remove corrugations or to reduce the roughness from wear.

  Again, apply only one of the adjustments.

  Roadway surfaces in the case of rubber-tired systems are assumed to be smooth. Rough washboard surfaces, bumps or uneven expansion joints are the types of running surface defects that cause increased vibration levels over the smooth road condition.

- **Transit Structure:** The weight and size of a transit structure affects the vibration radiated by that structure. The general rule-of-thumb is that vibration levels will be lower for heavier transit structures. Hence, the vibration levels from a cut-and-cover concrete double-box subway can be assumed to be lower than the vibration from a lightweight concrete-lined bored tunnel. The vibration from elevated structures is lower than from at-grade track because of the mass and damping of the structure and the extra distance that the vibration must travel before it reaches the receiver. Elevated structures in automated guideway transit applications sometimes are designed to bear on building elements. These are a special case and may require detailed design considerations.

- **Propagation Characteristics:** In the General Assessment it is necessary to make a selection among the general propagation characteristics. For a subway, the selection is a fairly straightforward choice of whether or not the subway will be founded in bedrock. Bedrock is considered to be hard rock. It is usually appropriate to consider soft siltstone and sandstone to be more similar to soil than hard rock. As seen in Table 10-1, whether the subway is founded in soil or rock can be a 15 VdB difference in the vibration levels.

  When considering at-grade vibration sources, the selection is between "normal" vibration propagation and "efficient" vibration propagation. Efficient vibration propagation results in approximately 10 decibels higher vibration levels. This more than doubles the potential impact zone for ground-borne vibration. One of the problems with identifying the cause of efficient propagation is the difficulty in determining whether higher than normal vibration levels are due to geologic conditions or due to special source conditions (e.g. rail corrugations or wheel flats).

  Although it is known that geologic conditions have a significant effect on the vibration levels, it is rarely possible to develop more than a broad-brush understanding of the vibration propagation characteristics for a General Assessment. The conservative approach would be to use the 10-decibel adjustment for efficient propagation to evaluate all potential vibration impact. The problem with this approach is that it tends to greatly overstate the potential for vibration impact. Hence, it is best to review available geological data and any complaint history from existing transit lines and major construction sites near the transit corridor to identify areas where efficient propagation is possible. If there is any reason to suspect efficient propagation conditions, then a Detailed Analysis during final design would include vibration propagation tests at the areas identified as potentially efficient propagation sites.

Some geologic conditions are repeatedly associated with efficient propagation. Shallow bedrock, less than 30 feet below the surface, is likely to have efficient propagation. Other factors that can be important are soil type and stiffness. In particular, stiff clayey soils have sometimes been associated with efficient vibration propagation. Investigation of soil boring records can be used to estimate depth to bedrock and the presence of problem soil conditions.

A factor that can be particularly complex to address is the effect of vibration propagation through rock. There are three factors from Table 10-1 that need to be included when a subway structure will be founded in rock. First is the -15 decibel adjustment in the "Type of Transit Structure" category. Second is the adjustment based on the propagation distance in the "Geologic Conditions" category. This positive adjustment is applied to the distances shown in Figure 10-1; the adjustment increases with distance because vibration attenuates more slowly in rock than in the soil used as a basis for the reference curve. The third factor is in the "Coupling to Building" category. When a building foundation is directly on the rock layer, there is no "coupling loss" due to the weight and stiffness of the building. Use the standard coupling factors if there is at least a 10-foot layer of soil between the building foundation and the rock layer.

- **Type of Building and Receiver Location in Building:** Since annoyance from ground-borne vibration and noise is an indoor phenomenon, the effects of the building structure on the vibration must be considered. Wood frame buildings, such as the typical residential structure, are more easily excited by ground vibration than heavier buildings. In contrast, large masonry buildings with spread footings have a low response to ground vibration.

  Vibration generally reduces in level as it propagates through a building. As indicated in Table 10-1, a 1- to 2-decibel attenuation per floor is usually assumed. Counteracting this, resonances of the building structure, particularly the floors, will cause some amplification of the vibration. Consequently, for a wood-frame structure, the building-related adjustments nearly cancel out. The adjustments for the first floor assuming a basement are: -5 decibels for the coupling loss; -2 decibels for the propagation from the basement to the first floor; and +6 decibels for the floor amplification. The total adjustment in this case is -1 decibel.

- **Vibration to Ground-Borne Noise Adjustment**: It is possible to estimate the levels of radiated noise given the average vibration amplitude of the room surfaces (floors, walls and ceiling), and the total acoustical absorption in the room. The unweighted sound pressure level is approximately equal to the vibration velocity level when the velocity level is referenced to $1x10^{-6}$ inches/second.

However, to estimate the A-weighted sound level from the velocity level, it is necessary to have some information about the frequency spectrum. The A-weighting adjustment drops rapidly at low frequencies, reflecting the relative insensitivity of human hearing to low frequencies. For example, A-weighting is -16 dB at 125 Hz, -26 dB at 60 Hz and -40 dB at 30 Hz. Table 10-1 provides adjustments for vibration depending on whether it has low-frequency, typical or high-frequency characteristics. Some general guidelines for classifying the frequency characteristics are:

- Low Frequency: Low-frequency vibration characteristics can be assumed for subways surrounded by cohesiveless sandy soil or whenever a vibration isolation track support system will be used. Low-frequency characteristics can be assumed for most surface track.
- Typical: The typical vibration characteristic is the default assumption for subways. It should be assumed for subways until there is information indicating that one of the other assumptions is appropriate. It should be used for surface track when the soil is very stiff with a high clay content.
- High Frequency: High-frequency characteristics should be assumed for subways whenever the transit structure is founded in rock or when there is very stiff clayey soil.

10.3 INVENTORY OF VIBRATION-IMPACTED LOCATIONS

This chapter includes generalized curves for surface vibration for different transit modes along with adjustments to apply for specific operating conditions and buildings. The projected levels are then compared with the criteria in Chapter 8 to determine whether vibration impact is likely. The results of the General Assessment are expressed in terms of an inventory of all sensitive land uses where either ground-borne vibration or ground-borne noise from the project may exceed the impact thresholds. The General Assessment may include a discussion of mitigation measures which would likely be needed to reduce vibration to acceptable levels.

The purpose of the procedure is to develop a reasonably complete inventory of the buildings that may experience ground-borne vibration or noise that exceed the impact criteria. At this point, it is preferable to make a conservative assessment of the impact. That is, it is better to include some buildings where ground-borne vibration may be below the impact threshold than to exclude buildings where it may exceed the impact threshold. The inventory should be organized according to the categories described in Chapter 8. For each building where the projected ground-borne vibration or noise exceeds the applicable impact threshold, one or more of the vibration control options from Section 11.5 should be considered for applicability. See Section 11.4 for a more complete description of how the General Vibration Assessment fits into the overall procedure.

REFERENCES

1. H.J.Saurenman, J.T. Nelson, G.P. Wilson, *Handbook of Urban Rail Noise and Vibration Control*, prepared under contract to U.S. Department of Transportation, Transportation Systems Center, Report UMTA-MA-06-0099-82-2, February 1982.

2. International Organization for Standardization, "Mechanical vibration – Ground-borne noise and vibration arising from rail systems," ISO/FDIS 14837-1:2005.

3. U.S. Department of Transportation, Volpe National Transportation Systems Center, "Vibration Characteristics of the Transrapid TR08 Maglev System," Report No. DOT-VNTSC-FRA-02-06, March 2002.

Appendix F

WYLE-LABS WCR73_5
Railroad Noise Calculations

WYLE LABS WCR73_5
Assessment of Noise Environments Around Railroad Operations

Scenario: **FUTURE RAIL CONDITIONS**

Input Data:			**Results:**
Wall Distance From Track	**25**	57.6	CNEL at 100
(25,50, 100, or 150 feet)		54.1	CNEL at 200
		50.1	CNEL at 400
Wall Height (in feet)	**10**	45.6	CNEL at 800
Observer Distance From Track	**40**	**62.3**	CNEL at 40

FUTURE RAIL CONDITIONS
CNEL WORKSHEET FOR LINE OPERATIONS

Train Category Identification	L, feet (train length)	V, mph (train speed)	% grade	Barrier (if existing)	Distance to tract, feet	(1) Pass-by Duration, sec t=L/V	(2) C_2 ('10log$_{10}$t)	(3) Car SPL at 100' dB C_1	(4) Car distance attenuation α	(5) $\alpha_{bc:}$ Car barrier correction	(6) Car Noise Adjustment: C_3	(7) SENEL (cars), dB $C_1+C_2+C_3-\alpha-\alpha_{bc}$	(8) Loco. SENEL at 100' C_4, dB	(9) Loco. distance attenuation: α	(10) α_{be} Loco. Barrier correction	(11) Helper engine adjustment C_5	(12) SENEL (loco.), dB $C4+C5-\alpha-\alpha_{be}$	(13) SENEL (Train) dB	(14) N equiv. no. of daily operations	(15) CNEL contribution	COMPOSITE CNEL AT DISTANCE INDICATED (16) 100'	(17) 200'	(18) 400'	(19) 800'	(20)
1	2000	30	0.0%	0	100'	45.3	16.6	70	0	16.75	0	69.8	100	0.0	5	0	95.0	95.0	16	57.6	57.6				
FREIGHT					200'				4	16.75	0	65.8		3.5	5		91.5	91.5		54.1		54.1			
					400'				10	16.75	0	59.8		7.5	5		87.5	87.5		50.1			50.1		
					800'				16.5	16.75	0	53.3		12.0	5		83.0	83.0		45.6				45.6	

5500 = User Inputs
45.3 = Calculated Values
84 = From Charts

WYLE LABS WCR73_5
Assessment of Noise Environments Around Railroad Operations

Scenario: FUTURE RAIL CONDITIONS

Input Data:		**Results:**
Wall Distance From Track (25,50, 100, or 150 feet)	25	57.6 CNEL at 100'
		54.1 CNEL at 200'
		50.1 CNEL at 400'
Wall Height (in feet)	10	45.6 CNEL at 800'
Observer Distance From Track	**40**	**62.3** CNEL at **40**