Appendix 6.13-2: Vibration Technical Report

Kimley»Horn

TECHNICAL MEMORANDUM

To: Amanda Acuna and Lisa Kranitz, City of Gardena

From: Olivia Chan and Rita Garcia, Kimley-Horn and Associates

Date: January 26, 20234

Subject: **Vibration Technical Report 1610 West Artesia Boulevard Project, California Peer Review**

Kimley-Horn has conducted a follow-up third-party peer review of the Project's Vibration Technical Report (CAJA Environmental Services and DKA Planning, November 2023) on behalf of the City of Gardena to verify that Kimley-Horn's September 22, 2023 recommendations and Project updates have been incorporated. The revised November 2023 report addresses the third-party peer review comments and thus is in compliance with Kimley-Horn's recommendations. The analysis, as revised, meets the applicable provisions of CEQA and the State CEQA Guidelines and is adequate for inclusion in the Project SCEA.

Please do not hesitate to contact Olivia Chan at 714.939.1030 or olivia.chan@kimley-horn.com with any questions.

Vibration Technical Report

for the

1610 Artesia Boulevard Project

City of Gardena

Prepared by

CAJA Environmental Services and DKA Planning

November 2023

VIBRATION TECHNICAL REPORT

Introduction

This report, prepared by CAJA Environmental Services in conjunction with DKA Planning, evaluates vibration impacts from construction and operation of the Project at 1610 Artesia Boulevard in the City of Gardena. The analysis compares these impacts to applicable thresholds of significance. Vibration calculation worksheets are included in the attached Technical Appendix.

The Proposed Project would redevelop an approximately 3.43-acre property into a multi-family residential development with 300 apartment units (283 market rate units and 17 affordable units) in a six-story, podium apartment building. Various apartment types (i.e., studios, and one- and two-bedroom units ranging from 515 square feet to 1,280 square feet) are proposed on levels two to six, with amenities (i.e., pool courtyard, fitness center, golf lounge, business center, and roof deck) on the podium level. Additionally, 528 onsite parking spaces in an on-grade parking garage with one subterranean level are proposed.

Fundamentals of Vibration

Characteristics of Vibration

Vibration is an oscillatory motion through a solid medium in which the motion's amplitude can be described in terms of displacement, velocity, and acceleration. Unlike noise, vibration is not a common environmental problem, as it is unusual for vibration from vehicle sources to be perceptible. Common sources of vibration include trains, construction activities, and certain industrial operations.

Vibration Definitions

This analysis discusses vibration in terms of Peak Particle Velocity (PPV). PPV is commonly used to describe and quantify vibration impacts to buildings and other structures. PPV levels represent the maximum instantaneous peak of a vibration signal and are usually measured in inches per second.[1] This analysis also discusses the vibration of events in decibel scale, known as Vibration Decibels (VdB), which is a unitless measure of vibration that is expressed on a logarithmic scale.

Effects of Vibration

High levels of vibration may cause physical personal injury or damage to buildings. However, groundborne vibration levels rarely affect human health. Instead, most people consider groundborne vibration to be an annoyance that can disrupt concentration or disturb sleep. Groundborne vibration can also interfere with certain types of highly sensitive equipment and machines, especially imaging devices used in medical laboratories.

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[1] California Department of Transportation, Transportation and Construction Vibration Guidance Manual, April 2020; https://dot.ca.gov/-/media/dot-media/programs/environmental-analysis/documents/env/tcvgm-apr2020-a11y.pdf.

Perceptible Vibration Changes

Unlike noise, groundborne vibration is not an environmental issue that most people experience every day. Background vibration levels in residential areas are usually well below the threshold of perception for humans, approximately 0.01 inches per second.[2] Perceptible indoor vibrations are most often caused by sources within buildings themselves, such as slamming doors or heavy footsteps. Common outdoor sources of groundborne vibration include construction equipment, trains, and traffic on rough or unpaved roads. Traffic vibration from smooth and well-maintained roads is typically not perceptible.

Regulatory Framework

Federal

Federal Transit Administration

In 2018, the Federal Transit Administration (FTA) published the Transit Noise and Vibration Impact Assessment Manual to aid in the estimation and analysis of vibration impacts. Typically, potential building and structural damages are the foremost concern when evaluating the impacts of construction-related vibrations. Table 1 summarizes FTA's vibration guidelines for building and structural damage. While these are reference values for vibration levels at 25 feet of distance, this analysis uses logarithmic equations to determine whether building damage would occur regardless of actual distance between construction activity and nearby buildings.

Table 1
FTA Vibration Damage Threshold Criteria

Structure and Condition	Threshold Criteria (in/sec PPV) at 25 Feet
I. Reinforced-concrete, steel or timber (no plaster)	0.5
II. Engineered concrete and masonry (no plaster)	0.3
III. Non-engineered timber and masonry buildings	0.2
IV. Buildings extremely susceptible to vibration damage	0.12
Source: Federal Transit Administration "Transit Noise and Vibration Impact Assessment Manual", September 2018.	

The FTA Assessment Manual also cites criteria for cases where more detailed analysis may be required. For buildings consisting of concrete wall and floor foundations, masonry or concrete walls, or stone masonry retaining walls, continuous vibrations of 0.3 inches per second PPV can be damaging. For buildings consisting of steel or reinforced concrete, such as factories, retaining walls, bridges, steel towers, open channels, underground chambers and tunnels with and without concrete alignment, continuous vibrations of 0.5 inches per second PPV can be damaging.

[2] Ibid.

State

California Civil Code

California's Civil Code Section 832 protects adjacent properties when excavation of a site occurs.

> *Each coterminous owner is entitled to the lateral and subjacent support which his land receives from the adjoining land, subject to the right of the owner of the adjoining land to make proper and usual excavations on the same for purposes of construction or improvement, under the following conditions:*
>
> *1. Any owner of land or his lessee intending to make or to permit an excavation shall give reasonable notice to the owner or owners of adjoining lands and of buildings or other structures, stating the depth to which such excavation is intended to be made, and when the excavating will begin.*
>
> *2. In making any excavation, ordinary care and skill shall be used, and reasonable precautions taken to sustain the adjoining land as such, without regard to any building or other structure which may be thereon, and there shall be no liability for damage done to any such building or other structure by reason of the excavation, except as otherwise provided or allowed by law.*
>
> *3. If at any time it appears that the excavation is to be of a greater depth than are the walls or foundations of any adjoining building or other structure, and is to be so close as to endanger the building or other structure in any way, then the owner of the building or other structure must be allowed at least 30 days, if he so desires, in which to take measures to protect the same from any damage, or in which to extend the foundations thereof, and he must be given for the same purposes reasonable license to enter on the land on which the excavation is to be or is being made.*
>
> *4. If the excavation is intended to be or is deeper than the standard depth of foundations, which depth is defined to be a depth of nine feet below the adjacent curb level, at the point where the joint property line intersects the curb and if on the land of the coterminous owner there is any building or other structure the wall or foundation of which goes to standard depth or deeper then the owner of the land on which the excavation is being made shall, if given the necessary license to enter on the adjoining land, protect the said adjoining land and any such building or other structure thereon without cost to the owner thereof, from any damage by reason of the excavation, and shall be liable to the owner of such property for any such damage, excepting only for minor settlement cracks in buildings or other structures.*

California Department of Transportation

The California Department of Transportation (Caltrans) has identified building damage significance guidance that provides thresholds for different categories of structures, including historic buildings that may not be considered extremely fragile (Table 2).

Table 2
Caltrans Vibration Damage Threshold Criteria

Structure and Condition	Significance Thresholds (in/sec PPV)	
	Transient Sources	Continuous/ Frequent/ Intermittent Sources
Extremely fragile historic buildings, ruins, ancient monuments	0.12	0.08
Fragile buildings	0.2	0.1
Historic and some old buildings	0.5	0.25
Older residential structures	0.5	0.3
New residential structures	1.0	0.5
Modern industrial/commercial buildings	2.0	0.5
Source: California Department of Transportation, 2013.		

City of Gardena

Gardena Municipal Code

Chapter 8.36 of the Gardena Municipal Code (GMC) governs construction-related vibration issues and public notification. Most provisions address groundborne vibration in commercial and industrial zones. Section 17.12.110(B) requires that unless deemed impracticable by the City, any factors that cause undue vibration in the City shall be corrected.

Existing Conditions

Existing Ambient Vibration Levels

The Project Site is improved with two commercial buildings totaling approximately 39,510 square feet. Approximately 31,010 square feet is occupied by auto repair uses while the remaining 8,500 square feet are vacant. There is negligible groundborne vibration from these existing uses, as most work is done on elevated platforms.

The primary source of groundborne vibration near the Project Site is vehicle travel. For example, Artesia Boulevard carries approximately 2,854 vehicles at Western Avenue in the A.M. peak hour.[3] The blend of passenger vehicles, trucks, delivery trucks, transit buses, and other light-, medium-, and heavy-duty vehicles generate minimal levels of vibration. As noted by federal guidance, "[i]t is unusual for vibration from sources such as buses and trucks to be perceptible…"[4] As such, vehicle movement generates imperceptible ground vibration, with the occasional exception of heavy-duty

[3] Linscott Law & Greenspan, Memorandum: TPG 1610 Artesia Project – Vehicle Miles Traveled Assessment; July 21, 2023.

[4] Federal Transit Administration, Transit Noise and Vibration Impact Assessment Manual, September 2018.

vehicles that travel over speed bumps, potholes, and other street irregularities. Vehicles accessing the existing commercial auto center contribute approximately 822 daily vehicle trips to traffic volumes on Artesia Boulevard.[5]

There are several buildings near the Project Site that could be exposed to groundborne vibration during construction and operation of the Project, including:

- Residences, 1580-1608 Artesia Square, as close as approximately 20 feet to the east of the Project Site. These three-story timber and stucco structures would be considered Category III structures (Non-engineered timber and masonry) under FTA guidelines.
- Warehouse building, 1650 Artesia Boulevard, approximately 50 feet west of the Project Site. This one-story timber and stucco structure would conservatively be considered a Category III structure (Non-engineered timber and masonry) under FTA guidelines.
- Residence, 17338 Denker Avenue, approximately 125 feet to the northeast of the Project Site. This one-story timber and stucco structure would be considered a Category III structure (Non-engineered timber and masonry) under FTA guidelines.

Methodology

Construction

Groundborne vibration impacts during construction activities were evaluated for both on-site and off-site construction activities by identifying potential vibration sources (e.g., construction equipment), estimating the vibration levels at off-site structures, and comparing the proposed impacts against applicable vibration significance thresholds.

Operation

As with many non-industrial projects, the Project does not include land uses that would generate high levels of groundborne vibration. Instead, any vibration related to operation of the Project would involve vehicle activity traveling to and from the Project Site. However, vibration from vehicle activities using rubber-tired wheels is unlikely to be perceptible by people. Rubber-tired vehicles traveling at a distance of 50 feet typically generate groundborne vibration of approximately 63.5 VdB.[6] The typical threshold of perception for groundborne vibration is approximately 65 VdB.[7] As such, operational impacts on groundborne vibration are not analyzed further.

Threshold of Significance

There are no adopted City standards or other applicable regulations that would govern the Project's vibration impacts. In assessing impacts related to noise and vibration in this report, the City uses Appendix G as the thresholds of significance. The FTA's criteria in its 2018 Transit Noise and Vibration Impact Assessment manual will be used where applicable and relevant to assist in

[5] Linscott Law & Greenspan, Memorandum: TPG 1610 Artesia Project – Vehicle Miles Traveled Assessment; July 21, 2023.

[6] Federal Transportation Administration, Transit Noise and Vibration Impact Assessment Manual; Generalized Ground Surface Vibration Equations (Table 6-10); September 2018.

[7] Ibid.

analyzing the Appendix G thresholds. In addition, Caltrans' thresholds for historic buildings will be used when structures are not Category IV structures considered extremely susceptible to vibration damage.

Analysis of Project Impacts

a. Generation of excessive groundborne vibration or groundborne noise levels?

Less Than Significant Impact.

Construction

On-Site Construction Vibration

Construction equipment can produce groundborne vibration depending on equipment and construction methods employed. While vibration spreads through the ground and diminishes in strength with distance, buildings on nearby soil can be affected. This ranges from no perceptible effects at the lowest levels, low rumbling sounds and perceptible vibration at moderate levels, and slight damage at the highest levels. Table 3 summarizes vibratory levels for common construction equipment.

Table 3
Vibration Source Levels for Construction Equipment

Equipment	Approximate PPV at 25 feet (in/sec)
Pile Driver (impact)	0.644
Pile Drive (sonic)	0.170
Clam shovel drop (slurry wall)	0.202
Hydromill (slurry wall)	0.008
Vibratory Roller	0.210
Hoe Ram	0.089
Large Bulldozer	0.089
Caisson Drilling	0.089
Loaded Truck	0.076
Jackhammer	0.035
Small Bulldozer	0.003
Source: Federal Transit Administration, Transit Noise and Vibration Impact Assessment Manual, 2018.	

Groundborne vibration would be generated by a number of construction activities at the Project Site. As a result of equipment that could include on-site bulldozer operations or the vibrational equivalent, vibration velocities of up to 0.111 inches per second PPV are projected to occur. These impacts are below the 0.2 in/sec PPV threshold of significance for Category III structures. Other potential construction activities would produce less vibration and have lesser potential impacts on nearby sensitive receptors. As a result, construction-related structural vibration impacts would be considered less than significant.

Table 4
Building Damage Vibration Levels – On-Site Sources

Off-Site Receptor Location	Distance to Project Site (feet)	Vibration Velocity Levels at Off-Site Sensitive Receptors from Construction Equipment (in/sec PPV)					Significance Criterion (PPV)	Potentially Significant Impact?
		Large Bulldozer	Caisson Drilling	Loaded Trucks	Jack-hammer	Small Bulldozer		
FTA Reference Vibration Level (25 Feet)	N/A	0.089	0.089	0.076	0.035	0.003	--	--
Residences – 1580-1608 Artesia Square	20	0.111	0.111	0.095	0.044	0.004	0.20[a]	No
Warehouse, 1650 Artesia Bl.	50	0.045	0.045	0.038	0.018	0.002	0.20[a]	No
Residence – 17338 Denker Ave.	125	0.018	0.018	0.015	0.007	0.001	0.20[a]	No

[a] FTA criterion for Category III (non-engineered timber and masonry buildings).
Source: DKA Planning, 2023.

Construction of the Project would protect adjacent properties during the excavation process by complying with California Civil Code Section 832.

Off-Site Construction Vibration

Construction of the Project would generate trips from large trucks including haul trucks, concrete mixing trucks, concrete pumping trucks, and vendor delivery trucks. With respect to building damage, based on FTA data, the vibration generated by a typical heavy-duty truck would be approximately 63 VdB (0.006 PPV) at a distance of 50 feet from the truck.[8] According to the FTA "[i]t is unusual for vibration from sources such as buses and trucks to be perceptible, even in locations close to major roads." Nonetheless, there are buildings along the Project's anticipated haul route(s) that could be exposed to groundborne vibration levels of approximately 0.006 PPV. This estimated vibration generated by construction trucks traveling along the anticipated haul route(s) would be well below the most stringent building damage criteria of 0.12 PPV for buildings extremely susceptible to vibration. The Project's potential to damage roadside buildings and structures as the result of groundborne vibration generated by its truck trips would therefore be considered less than significant.

Operation

During operation of the proposed residential uses, there would be no significant stationary sources of groundborne vibration, such as heavy equipment or industrial operations. Project operations would include typical commercial-grade stationary mechanical and electrical equipment, such as air handling units, condenser units, and exhaust fans. This equipment would be located on the roof or inside the development structure itself, which would help attenuate any impacts on groundborne vibration, thereby producing a negligible amount of vibration. Operational groundborne vibration in the Project Site's vicinity would be generated by vehicle travel on local roadways. However as

[8] Federal Transit Administration, "Transit Noise and Vibration Impact Assessment," May 2006, Figure 7-3.

previously discussed, road vehicles rarely create vibration levels perceptible to humans. As a result, the Project's long-term vibration impacts would be less than significant.

Cumulative Impacts

Construction

On-Site Construction Vibration

During construction of the Project, vibration impacts are generally limited to buildings and structures located near a construction site (i.e., within 15 feet as related to building damage). As noted earlier, the Project would not have the potential to damage nearby buildings and its impact would be less than significant. However, nearby structures could be subject to cumulative vibration impacts if concurrent construction and vibration activities were to occur within close proximity.

There were 22 potential related projects identified by the City of Gardena, illustrated in Figure 1. However, the closest of these projects is approximately 970 feet east of the Project Site. As such, any concurrent groundborne vibration from the Project in combination with that related project would not have cumulative vibration impacts due to the significant attenuation from nearly 1,000 feet of distance. As such, there is no potential for a cumulative construction vibration impact that subjects nearby buildings to vibration levels that exceed the FTA's vibration damage criteria or Caltrans criteria for historic buildings, and this impact would be less than significant.

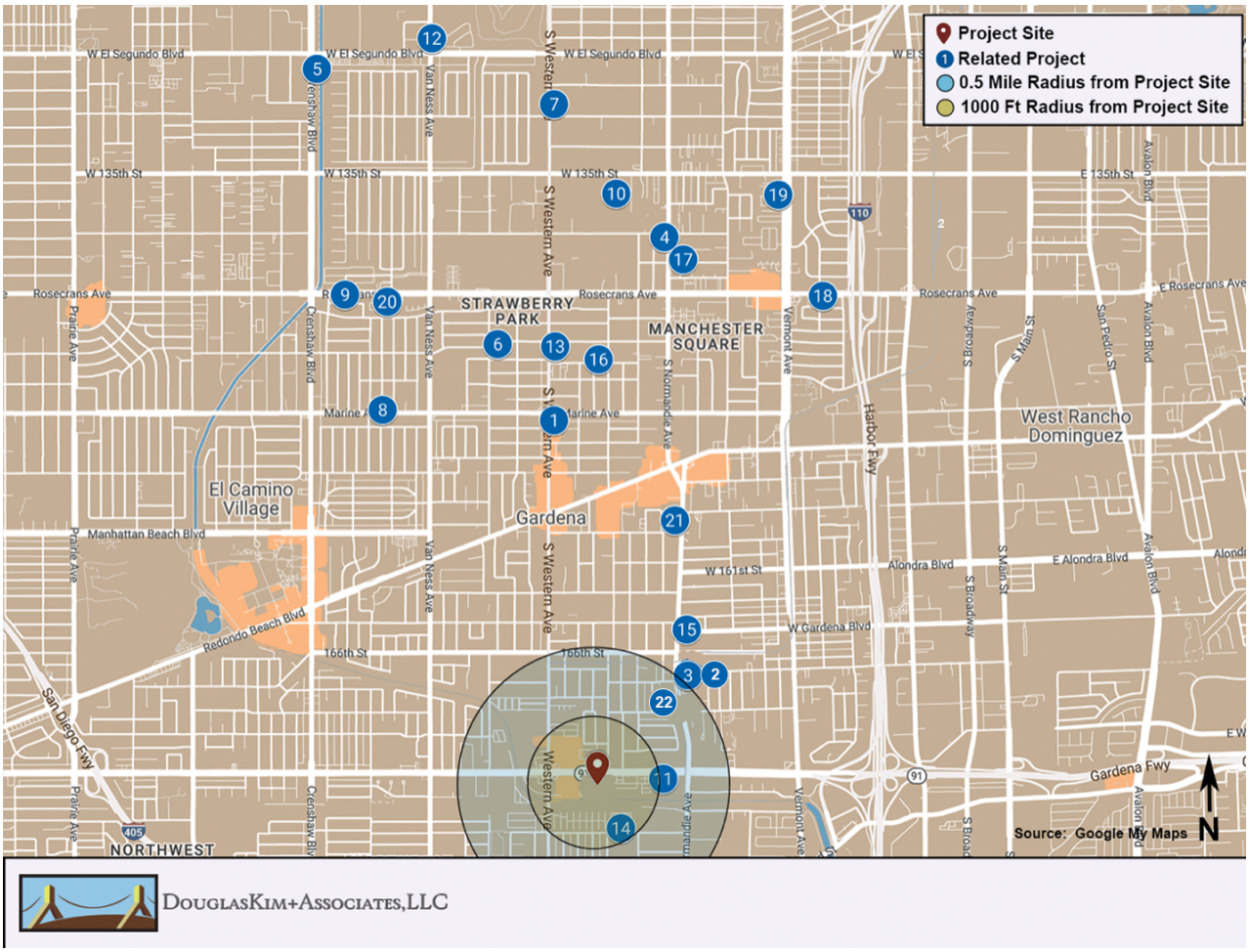

Figure 1
Related Projects

Off-Site Construction Vibration

While haul trucks from any related projects and other concurrent construction projects could generate additional vibration along haul routes, the potential to damage buildings is extremely low. The Project could generate an average of one hourly haul truck trip during the course of construction. The FTA finds that "[i]t is unusual for vibration from sources such as buses and trucks to be perceptible, even in locations close to major roads." The vibration generated by a typical heavy truck would be approximately 0.00566 in/sec PPV at a distance of 50 feet.

As discussed above, there are buildings that are near the right-of-way of the anticipated haul route for the Project (e.g., Artesia Boulevard). However, these buildings are anticipated to be exposed to groundborne vibration levels that are far less than the levels recommended by FTA as potential thresholds for building damage. Trucks from any related projects are expected to generate similar groundborne vibration levels. Therefore, the vibration levels generated from off-site construction trucks associated with the Project and other related projects along the anticipated haul route(s) would be below the most stringent building damage threshold of 0.12 PPV for buildings extremely

susceptible to vibration. Therefore, potential cumulative vibration impacts with respect to building damage from off-site construction would be less than significant.

Operation

The Project Site and surrounding Artesia Boulevard corridor have been developed with commercial, residential, and other uses that will continue to generate minimal groundborne vibration. Similar to the Project, any related projects in the vicinity of the Project Site could generate vibration from ongoing day-to-day operations. However, given the commercial and residential zoning along Artesia Boulevard and adjacent residential neighborhoods, any related projects would not be the type of use typically associated with excessive groundborne vibration from on-site sources. The potential cumulative impacts associated with on-site and off-site vibration sources are addressed below.

On-Site Operational Vibration

During operation of the Project, vibration impacts are generally limited to buildings and structures located near the construction site (i.e., within 15 feet as related to building damage). As stated above, there are no related projects within 970 feet of the Project Site. Therefore, no cumulative vibration impacts are expected, and this impact would be less than significant.

Off-Site Operational Vibration

Like the Project, any concurrent development near the Project Site would contribute normal passenger vehicle traffic that would generate negligible changes to roadway vibration. Use of larger heavy-duty trucks for delivery of goods and materials would be intermittent and not result in significant cumulative increases in groundborne vibration on Artesia Boulevard and other local roadways. Therefore, potential cumulative vibration impacts with respect to building damage from off-site operations would be less than significant.

TECHNICAL APPENDIX

DouglasKim+Associates,LLC

1610 Artesia Boulevard Project

Construction Vibration

Receptor: 1580-1608 Artesia Blvd.
Equipment: Large Bulldozer, Auger Drill Rig

Source PPV (in/sec)	0.089
Reference Distance (ft)	25
Ground Factor (N)	1
Distance (ft)	20
Vibration Level (in/sec)	**0.111**

Receptor: 1580-1608 Artesia Blvd.
Equipment: Loaded Trucks

Source PPV (in/sec)	0.076
Reference Distance (ft)	25
Ground Factor (N)	1
Distance (ft)	20
Vibration Level (in/sec)	**0.095**

Receptor: Warehouse building, 1650 Artesia Bl.
Equipment: Large Bulldozer, Auger Drill Rig

Source PPV (in/sec)	0.089
Reference Distance (ft)	25
Ground Factor (N)	1
Distance (ft)	50
Vibration Level (in/sec)	**0.045**

Receptor: Warehouse building, 1650 Artesia Bl.
Equipment: Loaded Trucks

Source PPV (in/sec)	0.076
Reference Distance (ft)	25
Ground Factor (N)	1
Distance (ft)	50
Vibration Level (in/sec)	**0.038**

Receptor: Residence, 17330 Denker Avenue
Equipment: Large Bulldozer, Auger Drill Rig

Source PPV (in/sec)	0.089
Reference Distance (ft)	25
Ground Factor (N)	1
Distance (ft)	125
Vibration Level (in/sec)	**0.018**

Receptor: Residence, 17330 Denker Avenue
Equipment: Loaded Trucks

Source PPV (in/sec)	0.076
Reference Distance (ft)	25
Ground Factor (N)	1
Distance (ft)	125
Vibration Level (in/sec)	**0.015**

1610 Artesia Boulevard Project

Receptor: 1580-1608 Artesia Blvd.
Equipment: Small Dozer-Type Equipment

Source PPV (in/sec)	0.003
Reference Distance (ft)	25
Ground Factor (N)	1
Distance (ft)	20
Vibration Level (in/sec)	**0.004**

Receptor: 1580-1608 Artesia Blvd.
Equipment: Jackhammer

Source PPV (in/sec)	0.035
Reference Distance (ft)	25
Ground Factor (N)	1
Distance (ft)	20
Vibration Level (in/sec)	**0.044**

Receptor: Warehouse building, 1650 Artesia Bl.
Equipment: Small Dozer-Type Equipment

Source PPV (in/sec)	0.003
Reference Distance (ft)	25
Ground Factor (N)	1
Distance (ft)	50
Vibration Level (in/sec)	**0.002**

Receptor: Warehouse building, 1650 Artesia Bl.
Equipment: Jackhammer

Source PPV (in/sec)	0.035
Reference Distance (ft)	25
Ground Factor (N)	1
Distance (ft)	50
Vibration Level (in/sec)	**0.018**

Receptor: Residence, 17330 Denker Avenue
Equipment: Small Dozer-Type Equipment

Source PPV (in/sec)	0.003
Reference Distance (ft)	25
Ground Factor (N)	1
Distance (ft)	125
Vibration Level (in/sec)	**0.001**

Receptor: Residence, 17330 Denker Avenue
Equipment: Jackhammer

Source PPV (in/sec)	0.035
Reference Distance (ft)	25
Ground Factor (N)	1
Distance (ft)	125
Vibration Level (in/sec)	**0.007**

Sources

California Department of Transportation (Caltrans), *Transportation and Construction Vibration Guidance Manual*,
Federal Transit Administration (FTA), *Transit Noise and Vibration Impact Assessment*, May 2006