SANTA CLARA UNIVERSITY HOUSING NOISE AND VIBRATION ASSESSMENT

San José, California

October 22, 2019

Prepared for:

Shannon George
David J. Powers & Associates, Inc.
1871 The Alameda, Suite 200
San José, CA 95126

Prepared by:

Manasi Biwalkar
Dana M. Lodico, PE, INCE Bd. Cert.

ILLINGWORTH & RODKIN, INC.
Acoustics • Air Quality
429 E. Cotati Avenue
Cotati, CA 94931
(707) 794-0400

I&R Job No.: 18-236

INTRODUCTION

The project proposes to demolish existing structures at 1200/1202 and 1250 Campbell Avenue in San José, California and construct a 7-story mixed-use project that would include up to 290 housing units and 54,000 square feet of technology incubator (office) space. The residential housing portion of the project is intended to provide affordable housing options for faculty and staff at SCU and other Jesuit educational institutions.

This report evaluates the project's potential to result in significant environmental noise or vibration impacts with respect to applicable California Environmental Quality Act (CEQA) guidelines. The report is divided into three sections: 1) the Setting Section provides a brief description of the fundamentals of environmental noise, summarizes applicable regulatory criteria, and discusses the results of the ambient noise monitoring survey completed to document existing noise conditions; 2) the General Plan Consistency section discusses land use compatibility utilizing noise and vibration-related policies in the City's General Plan; and, 3) the Impacts and Mitigation Measures Section describes the significance criteria used to evaluate project impacts, provides a discussion of each project impact, and presents measures, where necessary, to mitigate the impacts to a less-than-significant level.

SETTING

Fundamentals of Environmental Noise

Noise may be defined as unwanted sound. Noise is usually objectionable because it is disturbing or annoying. The objectionable nature of sound could be caused by its *pitch* or its *loudness*. *Pitch* is the height or depth of a tone or sound, depending on the relative rapidity (*frequency*) of the vibrations by which it is produced. Higher pitched signals sound louder to humans than sounds with a lower pitch. *Loudness* is intensity of sound waves combined with the reception characteristics of the ear. Intensity may be compared with the height of an ocean wave in that it is a measure of the amplitude of the sound wave.

In addition to the concepts of pitch and loudness, there are several noise measurement scales which are used to describe noise in a particular location. A *decibel (dB)* is a unit of measurement which indicates the relative amplitude of a sound. The zero on the decibel scale is based on the lowest sound level that the healthy, unimpaired human ear can detect. Sound levels in decibels are calculated on a logarithmic basis. An increase of 10 decibels represents a ten-fold increase in acoustic energy, while 20 decibels is 100 times more intense, 30 decibels is 1,000 times more intense, etc. There is a relationship between the subjective noisiness or loudness of a sound and its intensity. Each 10 decibel increase in sound level is perceived as approximately a doubling of loudness over a fairly wide range of intensities. Technical terms are defined in Table 1.

There are several methods of characterizing sound. The most common in California is the *A-weighted sound level (dBA).* This scale gives greater weight to the frequencies of sound to which the human ear is most sensitive. Representative outdoor and indoor noise levels in units of dBA are shown in Table 2. Because sound levels can vary markedly over a short period of time, a method for describing either the average character of the sound or the statistical behavior of the variations must be utilized. Most commonly, environmental sounds are described in terms of an average level that has the same acoustical energy as the summation of all the time-varying events. This *energy-equivalent sound/noise descriptor* is called L_{eq}. The most common averaging period is hourly, but L_{eq} can describe any series of noise events of arbitrary duration.

The scientific instrument used to measure noise is the sound level meter. Sound level meters can accurately measure environmental noise levels to within about plus or minus 1 dBA. Various computer models are used to predict environmental noise levels from sources, such as roadways and airports. The accuracy of the predicted models depends upon the distance the receptor is from the noise source. Close to the noise source, the models are accurate to within about plus or minus 1 to 2 dBA.

Since the sensitivity to noise increases during the evening and at night -- because excessive noise interferes with the ability to sleep -- 24-hour descriptors have been developed that incorporate artificial noise penalties added to quiet-time noise events. The *Community Noise Equivalent Level* (*CNEL*) is a measure of the cumulative noise exposure in a community, with a 5 dB penalty added to evening (7:00 pm - 10:00 pm) and a 10 dB addition to nocturnal (10:00 pm - 7:00 am) noise levels. The *Day/Night Average Sound Level* (*DNL* or L_{dn}) is essentially the same as CNEL, with the exception that the evening time period is dropped and all occurrences during this three-hour period are grouped into the daytime period.

Effects of Noise

The thresholds for speech interference indoors are about 45 dBA if the noise is steady and above 55 dBA if the noise is fluctuating. Outdoors the thresholds are about 15 dBA higher. Steady noises of sufficient intensity (above 35 dBA) and fluctuating noise levels above about 45 dBA have been shown to affect sleep. Interior residential standards for multi-family dwellings are set by the State of California at 45 dBA DNL. Typically, the highest steady traffic noise level during the daytime is about equal to the DNL and nighttime levels are 10 dBA lower. The standard is designed for sleep and speech protection and most jurisdictions apply the same criterion for all residential uses. Typical structural attenuation is 12 to 17 dBA with open windows. With closed windows in good condition, the noise attenuation factor is around 20 dBA for an older structure and 25 dBA for a newer dwelling. Sleep and speech interference is therefore possible when exterior noise levels are about 57 to 62 dBA DNL with open windows and 65 to 70 dBA DNL if the windows are closed. Levels of 55 to 60 dBA are common along collector streets and secondary arterials, while 65 to 70 dBA is a typical value for a primary/major arterial. Levels of 75 to 80 dBA are normal noise levels at the first row of development outside a freeway right-of-way. In order to achieve an acceptable interior noise environment, bedrooms facing secondary roadways need to be able to have their windows closed, those facing major roadways and freeways typically need special glass windows.

TABLE 1 Definition of Acoustical Terms Used in this Report

Term	Definition
Decibel, dB	A unit describing, the amplitude of 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. The reference pressure for air is 20 micro Pascals.
Sound Pressure Level	Sound pressure is the sound force per unit area, usually expressed in micro Pascals (or 20 micro Newtons per square meter), where 1 Pascal is the pressure resulting from a force of 1 Newton exerted over an area of 1 square meter. The sound pressure level is expressed in decibels as 20 times the logarithm to the base 10 of the ratio between the pressures exerted by the sound to a reference sound pressure (e. g., 20 micro Pascals). Sound pressure level is the quantity that is directly measured by a sound level meter.
Frequency, Hz	The number of complete pressure fluctuations per second above and below atmospheric pressure. Normal human hearing is between 20 Hz and 20,000 Hz. Infrasonic sound are below 20 Hz and Ultrasonic sounds are above 20,000 Hz.
A-Weighted Sound Level, dBA	The sound pressure level in decibels as measured on a sound level meter using the A-weighting 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 frequency response of the human ear and correlates well with subjective reactions to noise.
Equivalent Noise Level, L_{eq}	The average A-weighted noise level during the measurement period.
L_{max}, L_{min}	The maximum and minimum A-weighted noise level during the measurement period.
L_{01}, L_{10}, L_{50}, L_{90}	The A-weighted noise levels that are exceeded 1%, 10%, 50%, and 90% of the time during the measurement period.
Day/Night Noise Level, L_{dn} or DNL	The average A-weighted noise level during a 24-hour day, obtained after addition of 10 decibels to levels measured in the night between 10:00 pm and 7:00 am.
Community Noise Equivalent Level, CNEL	The average A-weighted noise level during a 24-hour day, obtained after addition of 5 decibels in the evening from 7:00 pm to 10:00 pm and after addition of 10 decibels to sound levels measured in the night between 10:00 pm and 7:00 am.
Ambient Noise Level	The composite of noise from all sources near and far. The normal or existing level of environmental noise at a given location.
Intrusive	That noise which intrudes over and above the existing ambient noise at a given location. The relative intrusiveness of a sound depends upon its amplitude, duration, frequency, and time of occurrence and tonal or informational content as well as the prevailing ambient noise level.

Source: Handbook of Acoustical Measurements and Noise Control, Harris, 1998.

TABLE 2 Typical Noise Levels in the Environment

Common Outdoor Activities	Noise Level (dBA)	Common Indoor Activities
	110 dBA	Rock band
Jet fly-over at 1,000 feet		
	100 dBA	
Gas lawn mower at 3 feet		
	90 dBA	
Diesel truck at 50 feet at 50 mph		Food blender at 3 feet
	80 dBA	Garbage disposal at 3 feet
Noisy urban area, daytime		
Gas lawn mower, 100 feet	70 dBA	Vacuum cleaner at 10 feet
Commercial area		Normal speech at 3 feet
Heavy traffic at 300 feet	60 dBA	
		Large business office
Quiet urban daytime	50 dBA	Dishwasher in next room
Quiet urban nighttime	40 dBA	Theater, large conference room
Quiet suburban nighttime		
	30 dBA	Library
Quiet rural nighttime		Bedroom at night, concert hall (background)
	20 dBA	
		Broadcast/recording studio
	10 dBA	
	0 dBA	

Source: Technical Noise Supplement (TeNS), California Department of Transportation, September 2013.

Fundamentals of Groundborne Vibration

Ground vibration consists of rapidly fluctuating motions or waves with an average motion of zero. Several different methods are typically used to quantify vibration amplitude. One method is the Peak Particle Velocity (PPV). The PPV is defined as the maximum instantaneous positive or negative peak of the vibration wave. In this report, a PPV descriptor with units of mm/sec or in/sec is used to evaluate construction generated vibration for building damage and human complaints. Table 3 displays the reactions of people and the effects on buildings that continuous or frequent intermittent vibration levels produce. The guidelines in Table 3 represent syntheses of vibration criteria for human response and potential damage to buildings resulting from construction vibration.

Construction activities can cause vibration that varies in intensity depending on several factors. The use of pile driving and vibratory compaction equipment typically generates the highest construction related groundborne vibration levels. Because of the impulsive nature of such activities, the use of the PPV descriptor has been routinely used to measure and assess groundborne vibration and almost exclusively to assess the potential of vibration to cause damage and the degree of annoyance for humans.

The two primary concerns with construction-induced vibration, the potential to damage a structure and the potential to interfere with the enjoyment of life, are evaluated against different vibration limits. Human perception to vibration varies with the individual and is a function of physical setting and the type of vibration. Persons exposed to elevated ambient vibration levels, such as people in an urban environment, may tolerate a higher vibration level.

Structural damage can be classified as cosmetic only, such as paint flaking or minimal extension of cracks in building surfaces; minor, including limited surface cracking; or major, that may threaten the structural integrity of the building. Safe vibration limits that can be applied to assess the potential for damaging a structure vary by researcher. The damage criteria presented in Table 3 include several categories for ancient, fragile, and historic structures, the types of structures most at risk to damage. Most buildings are included within the categories ranging from “Historic and some old buildings” to “Modern industrial/commercial buildings”. Construction-induced vibration that can be detrimental to the building is very rare and has only been observed in instances where the structure is at a high state of disrepair and the construction activity occurs immediately adjacent to the structure.

The annoyance levels shown in Table 3 should be interpreted with care since vibration may be found to be annoying at lower levels than those shown, depending on the level of activity or the sensitivity of the individual. To sensitive individuals, vibrations approaching the threshold of perception can be annoying. Low-level vibrations frequently cause irritating secondary vibration, such as a slight rattling of windows, doors, or stacked dishes. The rattling sound can give rise to exaggerated vibration complaints, even though there is very little risk of actual structural damage.

Railroad and light-rail operations are potential sources of substantial ground vibration depending on distance, the type and the speed of trains, and the type of railroad track. People’s response to ground vibration from rail vehicles has been correlated best with the average, root mean square

(RMS) velocity of the ground. The velocity of the ground is expressed on the decibel scale. The reference velocity is 1 x 10-6 in/sec RMS, which equals 0 VdB, and 1 in/sec equals 120 VdB. Although not a universally accepted notation, the abbreviation "VdB" is used in this document for vibration decibels to reduce the potential for confusion with sound decibels.

Typical background vibration levels in residential areas are usually 50 VdB or lower, well below the threshold of perception for most humans. Perceptible vibration levels inside residences are attributed to the operation of heating and air conditioning systems, door slams and foot traffic. Construction activities, train operations, and street traffic are some of the most common external sources of vibration that can be perceptible inside residences. Table 4 illustrates some common sources of vibration and the association to human perception or the potential for structural damage.

TABLE 3 Reaction of People and Damage to Buildings from Continuous or Frequent Intermittent Vibration Levels

Velocity Level, PPV (in/sec)	Human Reaction	Effect on Buildings
0.01	Barely perceptible	No effect
0.04	Distinctly perceptible	Vibration unlikely to cause damage of any type to any structure
0.08	Distinctly perceptible to strongly perceptible	Recommended upper level of the vibration to which ruins and ancient monuments should be subjected
0.1	Strongly perceptible	Threshold at which there is a risk of damage to fragile buildings with no risk of damage to most buildings
0.25	Strongly perceptible to severe	Threshold at which there is a risk of damage to historic and some old buildings.
0.3	Strongly perceptible to severe	Threshold at which there is a risk of damage to older residential structures
0.5	Severe - Vibrations considered unpleasant	Threshold at which there is a risk of damage to new residential and modern commercial/industrial structures

Source: Transportation and Construction Vibration Guidance Manual, California Department of Transportation, September 2013.

TABLE 4 Typical Levels of Groundborne Vibration

Human/Structural Response	Velocity Level, VdB	Typical Events (50-foot setback)
Threshold, minor cosmetic damage	100	Blasting, pile driving, vibratory compaction equipment
		Heavy tracked vehicles (Bulldozers, cranes, drill rigs)
Difficulty with tasks such as reading a video or computer screen	90	
		Commuter rail, upper range
Residential annoyance, infrequent events	80	Rapid transit, upper range
Residential annoyance, occasional events		Commuter rail, typical Bus or truck over bump or on rough roads
Residential annoyance, frequent events	70	Rapid transit, typical
Approximate human threshold of perception to vibration		Buses, trucks and heavy street traffic
	60	
		Background vibration in residential settings in the absence of activity
Lower limit for equipment ultra-sensitive to vibration	50	

Source: Transit Noise and Vibration Impact Assessment, US Department of Transportation Federal Transit Administration, September 2018.

Regulatory Background – Noise

The State of California, Santa Clara County, and the City of San José have established regulatory criteria that are applicable in this assessment. The State CEQA Guidelines, Appendix G, are used to assess the potential significance of impacts pursuant to local General Plan policies, Municipal Code standards, or the applicable standards of other agencies. A summary of the applicable regulatory criteria is provided below.

2018 State CEQA Guidelines. The CEQA contains guidelines to evaluate the significance of effects of environmental noise attributable to a proposed project. Under CEQA, noise impacts would be considered significant if the project would result in:

(a) Generation of a substantial temporary or permanent increase in ambient noise levels in the vicinity of the project in excess of standards established in the local general plan or noise ordinance, or applicable standards of other agencies;

(b) Generation of excessive groundborne vibration or groundborne noise levels;

(c) For a project located within the vicinity of a private airstrip or an airport land use plan or where such a plan has not been adopted within two miles of a public airport or public use airport, if the project would expose people residing or working in the project area to excessive noise levels.

Checklist items (a), (b), and (c) are applicable to the proposed project.

2016 California Building Code, Title 24, Part 2. The current version of the California Building Code (CBC) requires interior noise levels in any new multi-family residential, residential care, or transit lodging, attributable to exterior environmental noise sources, be limited to a level not exceeding 45 dBA DNL/CNEL in any habitable room.

2016 California Green Building Standards Code (Cal Green Code). The State of California established exterior sound transmission control standards for new non-residential buildings as set forth in the 2016 California Green Building Standards Code (Section 5.507.4.1 and 5.507.4.2). Section 5.507 states that either the prescriptive (Section 5.507.4.1) or the performance method (Section 5.507.4.2) shall be used to determine environmental control at indoor areas. The prescriptive method is very conservative and not practical in most cases; however, the performance method can be quantitatively verified using exterior-to-interior calculations. For the purposes of this report, the performance method is utilized to determine consistency with the Cal Green Code. The sections that pertain to this project are as follows:

> **5.507.4.1 Exterior noise transmission, prescriptive method.** Wall and roof-ceiling assemblies exposed to the noise source making up the building envelope shall meet a composite STC rating of at least 50 or a composite OITC rating of no less than 40, with exterior windows of a minimum STC of 40 or OITC of 30 when the building falls within the 65 dBA DNL noise contour of a freeway or expressway, railroad, industrial source or fixed-guideway noise source, as determined by the local general plan noise element.

5.507.4.2 Performance method. For buildings located, as defined by Section 5.507.4.1, wall and roof-ceiling assemblies exposed to the noise source making up the building envelope shall be constructed to provide an interior noise environment attributable to exterior sources that does not exceed an hourly equivalent noise level ($L_{eq\ (1\text{-}hr)}$) of 50 dBA in occupied areas during any hour of operation.

The performance method, which establishes the acceptable interior noise level, is the method typically used when applying these standards.

Santa Clara County Airport Land Use Commission Comprehensive Land Use Plan. The Comprehensive Land Use Plan (CLUP) adopted by the Santa Clara County Airport Land Use Commission contains standards for projects within the vicinity of San José International Airport which are relevant to this project;

4.3.2.1 Noise Compatibility Policies

Policy N-3 Noise impacts shall be evaluated according to the Aircraft Noise Contours presented on Figure 5 (2022 Aircraft Noise Contours). [Note: The figure references the CLUP and the updated contours are for the year 2027.]

Policy N-4 No residential or transient lodging construction shall be permitted within the 65 dB CNEL contour boundary unless it can be demonstrated that the resulting interior sound levels will be less than 45 dB CNEL and there are no outdoor patios or outdoor activity areas associated with the residential portion of a mixed use residential project or a multi-unit residential project. (Sound wall noise mitigation measures are not effective in reducing noise generated by aircraft flying overhead.)

City of San José General Plan. The Environmental Leadership Chapter in the Envision San José 2040 General Plan sets forth policies with the goal of minimizing the impact of noise on people through noise reduction and suppression techniques, and through appropriate land use policies in the City of San José. The following policies are applicable to the proposed project:

EC-1.1 Locate new development in areas where noise levels are appropriate for the proposed uses. Consider federal, state, and City noise standards and guidelines as a part of new development review. Applicable standards and guidelines for land uses in San José include:

Interior Noise Levels

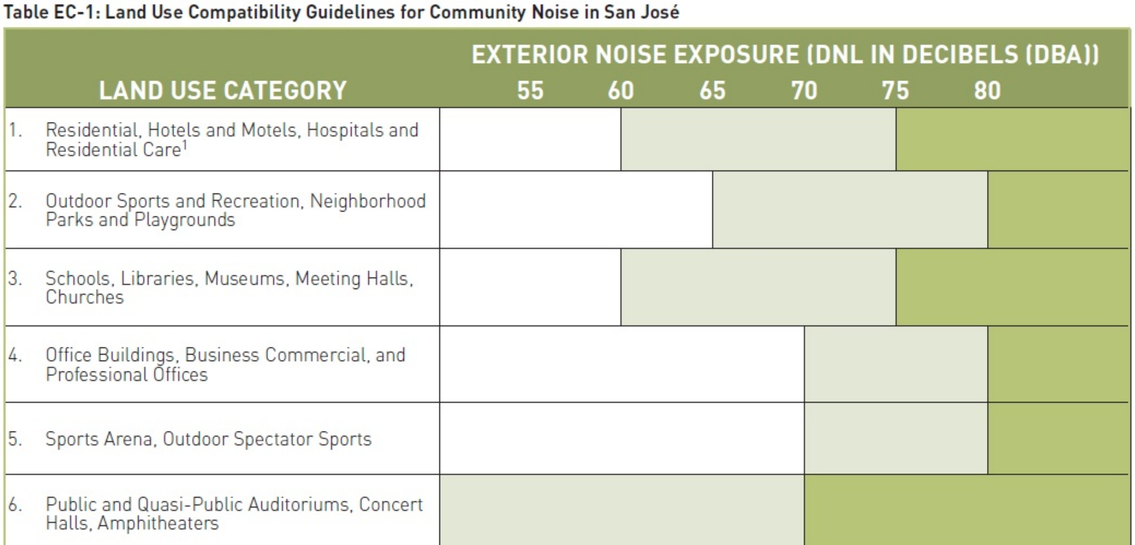
- The City's standard for interior noise levels in residences, hotels, motels, residential care facilities, and hospitals is 45 dBA DNL. Include appropriate site and building design, building construction and noise attenuation techniques in new development to meet this standard. For sites with exterior noise levels of 60 dBA DNL or more, an acoustical analysis following protocols in the City-adopted California Building Code is required to demonstrate that development projects can meet this standard. The acoustical analysis shall base required noise attenuation techniques on expected Envision General Plan traffic volumes to ensure land use compatibility and General Plan consistency over the life of this plan.

Exterior Noise Levels

- The City's acceptable exterior noise level objective is 60 dBA DNL or less for residential and most institutional land uses (Table EC-1). The acceptable exterior noise level objective is established for the City, except in the environs of the San José International Airport and the Downtown, as described below:

  - For new multi-family residential projects and for the residential component of mixed-use development, use a standard of 60 dBA DNL in usable outdoor activity areas, excluding balconies and residential stoops and porches facing existing roadways. Some common use areas that meet the 60 dBA DNL exterior standard will be available to all residents. Use noise attenuation techniques such as shielding by buildings and structures for outdoor common use areas. On sites subject to aircraft overflights or adjacent to elevated roadways, use noise attenuation techniques to achieve the 60 dBA DNL standard for noise from sources other than aircraft and elevated roadway segments.

Table EC-1: Land Use Compatibility Guidelines for Community Noise in San José



[1]Noise mitigation to reduce interior noise levels pursuant to Policy EC-1.1 is required.

Normally Acceptable:
- Specified land use is satisfactory, based upon the assumption that any buildings involved are of normal conventional construction, without any special noise insulation requirements.

Conditionally Acceptable:
- Specified land use may be permitted only after detailed analysis of the noise reduction requirements and needed noise insulation features included in the design.

Unacceptable:
- New construction or development should generally not be undertaken because mitigation is usually not feasible to comply with noise element policies.

EC-1.2 Minimize the noise impacts of new development on land uses sensitive to increased noise levels (Categories 1, 2, 3 and 6) by limiting noise generation and by requiring use of noise attenuation measures such as acoustical enclosures and sound barriers, where feasible. The City considers significant noise impacts to occur if a project would:

- Cause the DNL at noise sensitive receptors to increase by five dBA DNL or more where the noise levels would remain "Normally Acceptable;" or
- Cause the DNL at noise sensitive receptors to increase by three dBA DNL or more where noise levels would equal or exceed the "Normally Acceptable" level.

EC-1.3 Mitigate noise generation of new nonresidential land uses to 55 dBA DNL at the property line when located adjacent to existing or planned noise-sensitive residential and public/quasi-public land uses.

EC-1.6 Regulate the effects of operational noise from existing and new industrial and commercial development on adjacent uses through noise standards in the City's Municipal Code.

EC-1.7 Require construction operations within San José to use best available noise suppression devices and techniques and limit construction hours near residential uses per the City's Municipal Code. The City considers significant construction noise impacts to occur if a project located within 500 feet of residential uses or 200 feet of commercial or office uses would:

- Involve substantial noise generating activities (such as building demolition, grading, excavation, pile driving, use of impact equipment, or building framing) continuing for more than 12 months.

- For such large or complex projects, a construction noise logistics plan that specifies hours of construction, noise and vibration minimization measures, posting or notification of construction schedules, and designation of a noise disturbance coordinator who would respond to neighborhood complaints will be required to be in place prior to the start of construction and implemented during construction to reduce noise impacts on neighboring residents and other uses.

EC-1.9 Require noise studies for land use proposals where known or suspected loud intermittent noise sources occur which may impact adjacent existing or planned land uses. For new residential development affected by noise from heavy rail, light rail, BART or other single-event noise sources, implement mitigation so that recurring maximum instantaneous noise levels do not exceed 50 dBA L_{max} in bedrooms and 55 dBA L_{max} in other rooms.

EC-1.11 Require safe and compatible land uses within the Mineta San José International Airport noise zone (defined by the 65 CNEL contour as set forth in State law) and encourage aircraft operating procedures that minimize noise.

City of San José Municipal Code. The City's Municipal Code contains a Zoning Ordinance that limits noise levels at adjacent properties. Chapter 20.30.700 states that sound pressure levels generated by any use or combination of uses on a property shall not exceed 55 dBA at any property line shared with land zoned for residential use, except upon issuance and in compliance with a Conditional Use Permit. Chapter 20.40.600 states the sound pressure level generated by any use or combination of uses shall not exceed 60 dBA at any property line shared with land zoned for commercial/industrial uses, except upon issuance and in compliance with a Conditional Use Permit. This code is not explicit in terms of the acoustical descriptor associated with the noise level limit. Consistent with General Plan policy E.C.-1.3, a reasonable interpretation of this standard would identify the ambient base noise level criteria as the day/night noise level (DNL).

Chapter 20.100.450 of the Municipal Code establishes allowable hours of construction within 500 feet of a residential unit between 7:00 am and 7:00 pm Monday through Friday unless permission is granted with a development permit or other planning approval. No construction activities are permitted on the weekends at sites within 500 feet of a residence.

Regulatory Background – Vibration

The Federal Transit Administration and the City of San José have established vibration guidelines applicable to this analysis.

Federal Transit Administration. The Federal Transit Authority (FTA) has developed vibration impact assessment criteria for evaluating vibration impacts associated with transit projects.[1] The proposed vibration impact criteria is based on maximum overall levels for a single event. The impact criteria for vibration are shown in Table 5. Note that there are criteria for frequent events (more than 70 events of the same source per day), occasional events (30 to 70 vibration events of the same source per day), and infrequent events (less than 30 vibration events of the same source per day).

[1]U.S. Department of Transportation, Federal Transit Administration, Transit Noise and Vibration Impact Assessment, October 2018, FTA-VA-90-1003-06.

TABLE 5 Indoor Groundborne Vibration (GBV) and Groundborne Noise (GBN) Impact Criteria for General Vibration Assessment

Land Use Category	GBV Impact Levels (VdB re 1 µinch/sec, RMS)			GBN Impact Levels (dBA 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[5]	N/A[5]	N/A[5]
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

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. For equipment that is more sensitive, a Detailed Vibration Analysis must be performed.
5. Vibration sensitive equipment is generally not sensitive to groundborne noise; however, the manufacturer's specifications should be reviewed for acoustic and vibration sensitivity.

Source: U.S. Department of Transportation, Federal Transit Administration, Transit Noise and Vibration Impact Assessment, October 2018, FTA-VA-90-1003-06.

City of San José General Plan. The Environmental Leadership Chapter in the Envision San José 2040 General Plan sets forth policies to achieve the goal of minimizing vibration impacts on people, residences, and business operations in the City of San José. The following policies are applicable to the proposed project:

EC-2.1 Near light and heavy rail lines or other sources of ground-borne vibration, minimize vibration impacts on people, residences, and businesses through the use of setbacks and/or structural design features that reduce vibration to levels at or below the guidelines of the Federal Transit Administration. Require new development within 100 feet of rail lines to demonstrate prior to project approval that vibration experienced by residents and vibration sensitive uses would not exceed these guidelines.

EC-2.3 Require new development to minimize vibration impacts to adjacent uses during demolition and construction. For sensitive historic structures, a vibration limit of 0.08 in/sec PPV (peak particle velocity) will be used to minimize the potential for cosmetic damage to a building. A vibration limit of 0.20 in/sec PPV will be used to minimize the potential for cosmetic damage at buildings of normal conventional construction.

Existing Environment

Noise Monitoring Survey

The project site is located at 1200/1202 and 1250 Campbell Avenue, San José, California. The site is surrounded by existing Santa Clara University to the west, residences to the east, and a baseball stadium to the south. The northern property line of the site is located as close as 50 feet from train tracks used by Caltrain, Altamont Commuter Express (ACE) and Amtrak Capitol Corridor Inner-City Rail. Caltrains run every 15 to 20 minutes on weekdays in both the northbound and southbound directions between 5:00 a.m. and 8:00 p.m. Trains are less frequent after 8:00 p.m. and on weekends. An average of 4 freight trains per day also utilize the adjacent train tracks[2].

A noise monitoring survey was performed between Wednesday, December 19, 2018 and Friday, December 21, 2018 to quantify and characterize ambient noise levels at the site and in the project vicinity. The monitoring survey included two long-term noise measurements (LT-1 and LT-2) as shown in Figure 1. The noise environment at the site and at the nearby land uses results primarily from train passbys. Secondary noise sources affecting the site include vehicular traffic noise from Campbell Avenue, nearby construction activity, and aircraft activity associated with Mineta San José International Airport.

Long-term noise measurement LT-1 was made at the southeast edge of the property, approximately 40 feet from the centerline of Campbell Avenue. This location was selected to quantify noise levels due to traffic along Campbell Avenue. Hourly average noise levels at this location ranged from 59 to 65 dBA L_{eq} during the day and from 46 to 62 dBA L_{eq} at night. The day-night average noise level on Thursday, December 20, 2018 was 65 dBA DNL. The daily trend in noise levels at LT-1 is shown in Figure 2.

Long-term noise measurement LT-2 was made at the northwest edge of the property. This location was selected to quantify noise levels due to train passbys. Hourly average noise levels at this location ranged from 58 to 76 dBA L_{eq} during the day and from 42 to 70 dBA L_{eq} at night. Maximum noise levels generated by train movements at this location ranged from 79 to 99 dBA L_{max}. The day-night average noise level on Thursday, December 20, 2018 was 71 dBA DNL. The daily trend in noise levels at LT-2 is shown in Figure 3.

Vibration monitoring survey

Vibration measurements of individual train passbys were conducted on January 10, 2019 at setbacks of 120 feet (V-1) and 160 feet (V-2) from the center of northbound tracks and 105 feet (V-1) and 145 feet (V-2) from center of southbound tracks, as shown in Figure 1. The two setbacks were used to develop a drop-off rate for ground borne vibration with distance. The instrumentation used to conduct measurements included a Larson Davis 831 Sound Level Meter and low noise

[2] Bay Area Regional Rail Plan, Technical Memorandum, Conditions, Configuration, & Traffic on Existing System, November 15, 2006.

accelerometers firmly fixed to the ground. This system is capable of accurately measuring very low vibration levels. Vibration levels were measured in the vertical axis because ground vibration is typically most dominant on this axis. Vibration levels were measured at the ground level and were representative of the levels that would enter a building's foundation.

A total of five individual train passbys, including three northbound and two southbound passbys were observed and recorded at each measurement setback. Vibration levels measured at each measurement position during train passby events are summarized in Table 6. Train vibration levels ranged from approximately 72 to 78 VdB at a distance of 120 feet from the northbound tracks (V-1) and 57 to 63 VdB at 160 feet from the northbound tracks (V-2). The average vibration generated by Caltrain/Amtrack passing the site during the vibration monitoring survey was 74 VdB at V-1 and 60 VdB at V-2. Vibration levels at V-1 and V-2 for each train passby event is shown in Figures 4 and 5, respectively.

TABLE 6 Results of Caltrain Vibration Measurements

Event	Maximum Vibration Level (VdB re 1µinch/sec, RMS)	
	Position V-1	Position V-2
NB Caltrain	72 VdB	62 VdB
NB Amtrak	78 VdB	60 VdB
SB Caltrain	74 VdB	61 VdB
NB Caltrain	75 VdB	63 VdB
SB Caltrain	72 VdB	57 VdB
Average	74 VdB	60 VdB

Notes: V-1: 120 feet from the center of the northbound tracks and 105 feet from the center of the southbound tracks.
V-2: 160 feet from the center of the northbound tracks and 145 feet from the center of the southbound tracks.
RMS – root-mean-square

FIGURE 1 Noise Measurement Locations

Source: Google Earth

FIGURE 2 Daily Trend in Noise Levels at LT-1

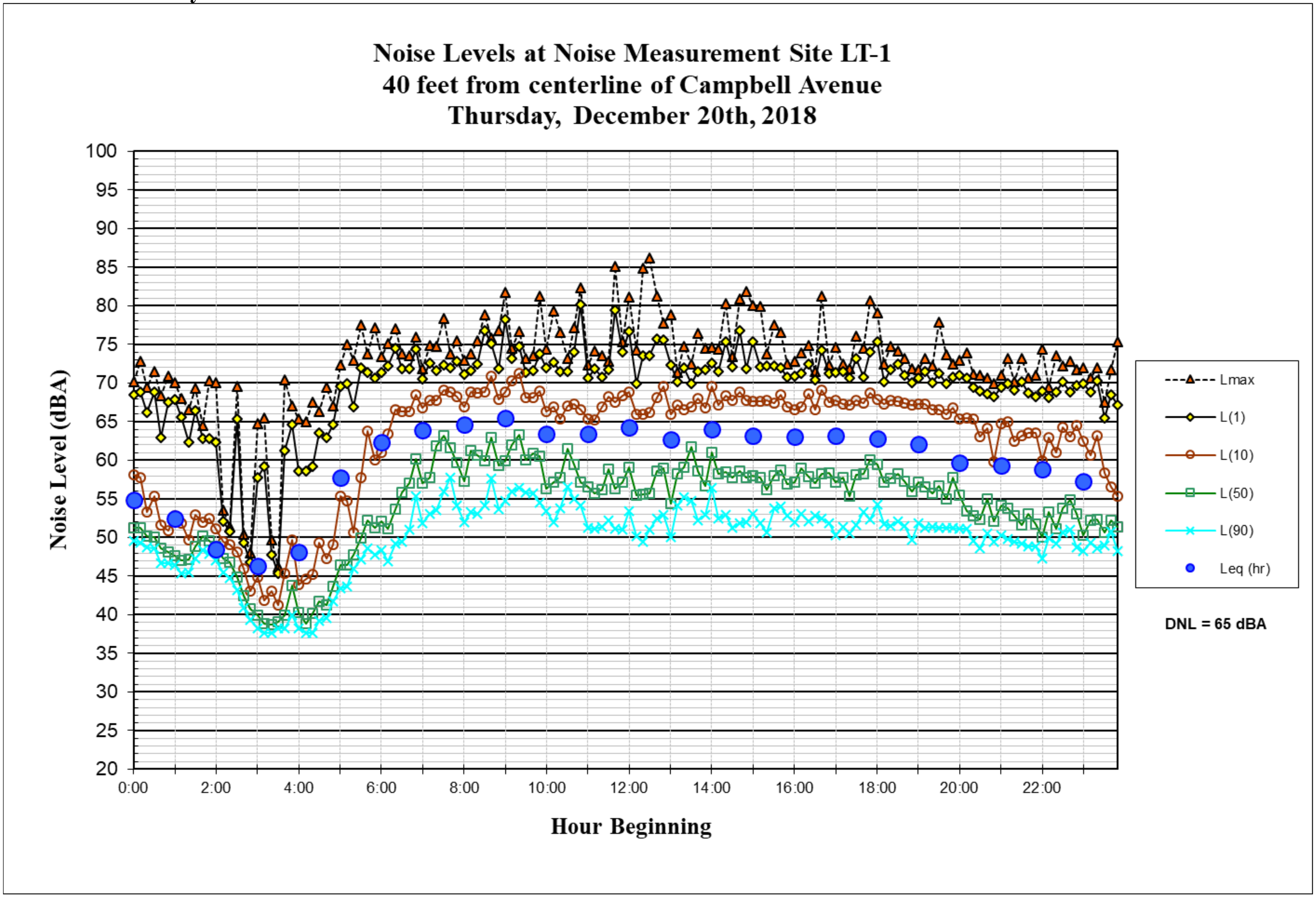


FIGURE 3 Daily Trend in Noise Levels at LT-2

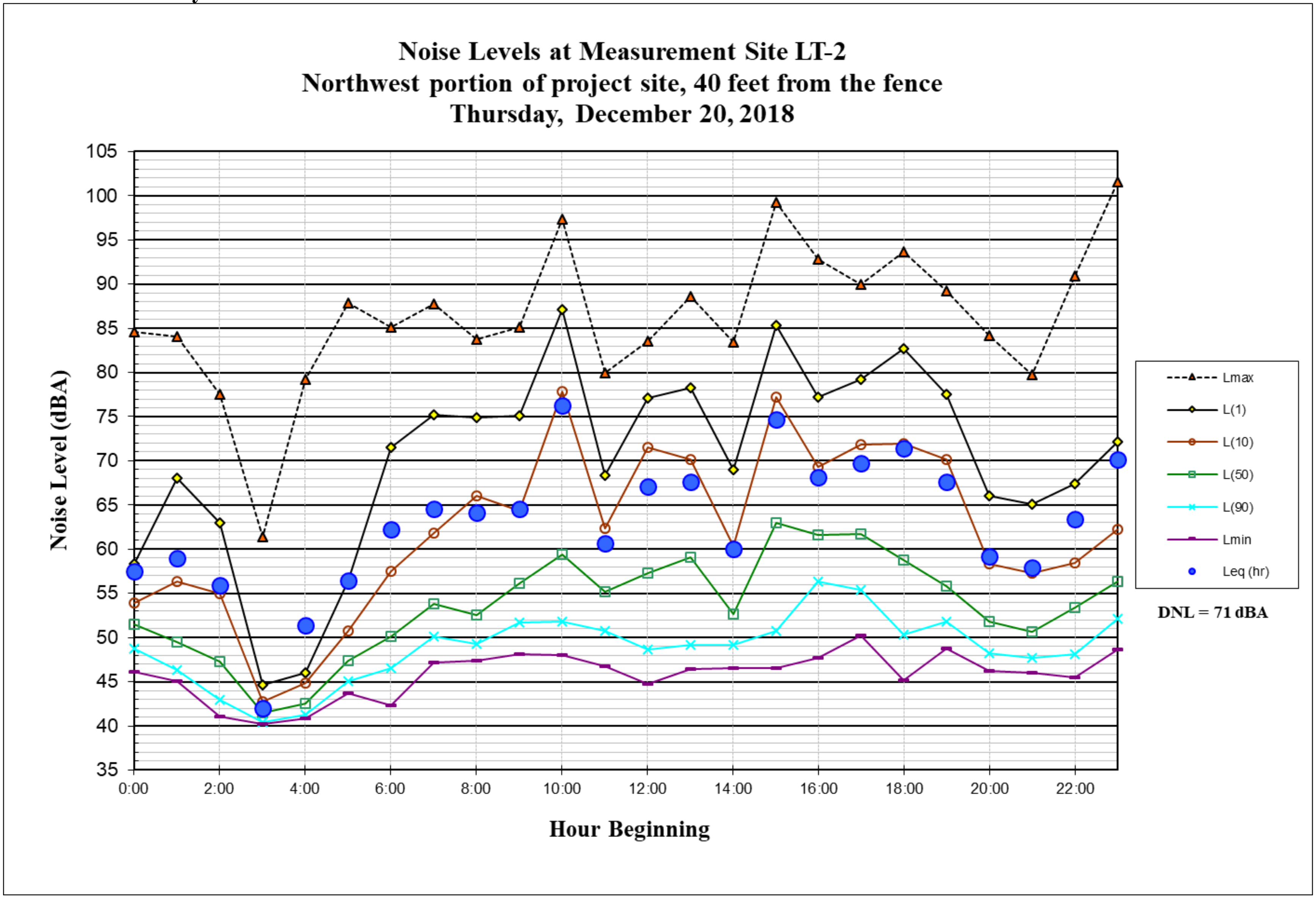


FIGURE 4 Railroad Train Vibration Levels at V-1

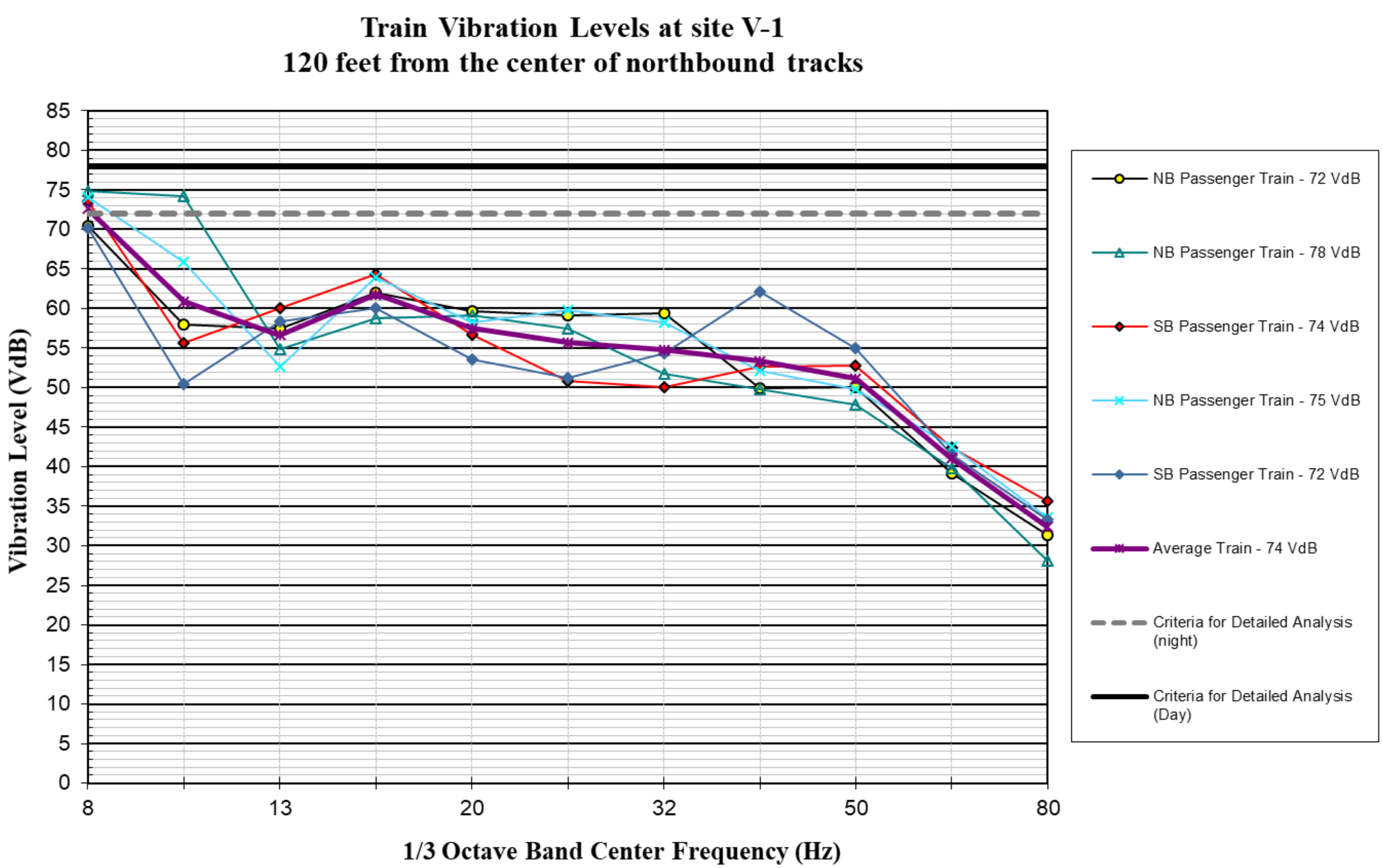
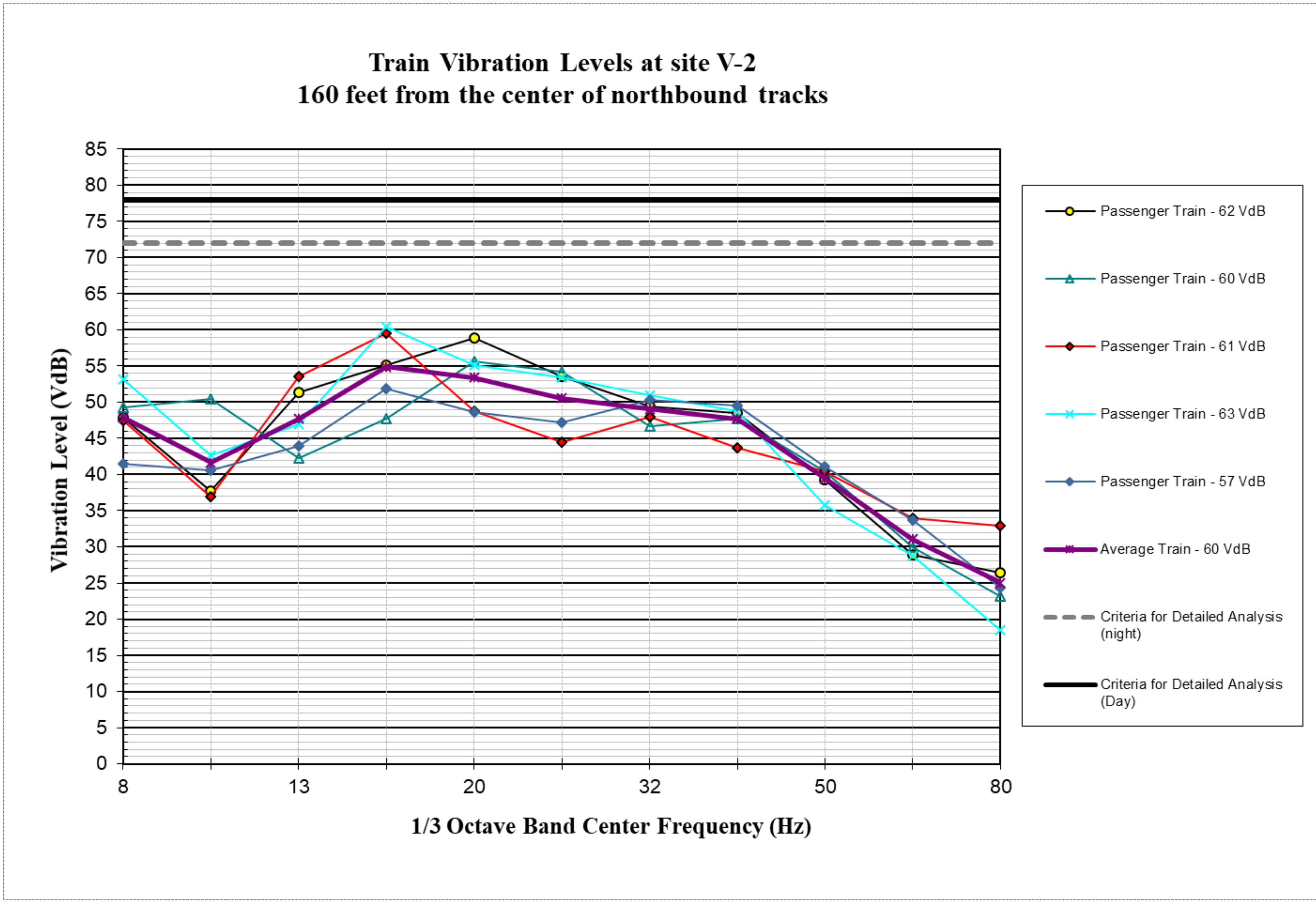


FIGURE 5 Railroad Train Vibration Levels at V-2



GENERAL PLAN CONSISTENCY ANALYSIS

The impacts of site constraints such as exposure of the proposed project to excessive levels of noise and vibration are not considered under CEQA. This section addresses Noise and Vibration and Land Use Compatibility for consistency with the policies set forth in the City's General Plan.

Noise and Land Use Compatibility

The applicable General Plan policies were presented in detail in the Regulatory Background section and are summarized below for the proposed project:

- The City's acceptable exterior noise level objective is 60 dBA DNL or less for specified outdoor areas at the proposed residential uses (Table EC-1).

- The City's acceptable exterior noise level objective is 70 dBA DNL for the proposed office uses (Table EC-1).

- The City's standard for interior noise levels in residences is 45 dBA DNL.

- The Cal Green Code standards specify an interior noise environment attributable to exterior sources not to exceed an hourly equivalent noise level ($L_{eq\ (1\text{-}hr)}$) of 50 dBA in occupied areas of non-residential uses during any hour of operation. (Cal Green Code)

- Recurring maximum instantaneous noise levels from trains are limited to 50 dBA L_{max} in bedrooms and 55 dBA L_{max} in other rooms. (EC 1-9)

Noise and Land Use Compatibility

The project proposes a 7-story mixed-use building that would include up to 290 housing units and 54,000 square feet of technology incubator (office) space. Parking will be provided on the first, second, and third floors.

Future Exterior Noise Environment

The future noise environment at the project site would continue to result primarily from railroad train movements to the north of the project site and vehicular traffic on Campbell Avenue. Calculations based on future projected traffic volumes provided[3] indicate an increase in traffic noise of up to 1 dBA on Campbell Avenue under future buildout conditions. Based on review of the Caltrain schedule and the Bay Area Regional Rail Plan, approximately 92 Caltrain trains and 4 freight trains currently pass the site daily. Altamont Commuter Express (ACE) and Amtrak Capitol Corridor Inner-City Rail also utilize the tracks. Considering that Caltrain operations are already very frequent, and 24-hour operations are not proposed, the noise environment at the site is not anticipated to change substantially from existing conditions (increase would be less than 1 dBA DNL).

[3] SCU Residential Development – Transportation Analysis, Hexagon Transportation Consultants, Inc., September 10, 2019.

Mineta San José International Airport is located approximately 0.6 miles north of the project site. The project area lies outside the 60 dBA CNEL 2027 noise contour of the airport.[4] Although aircraft-related noise would occasionally be audible at the project site, noise from aircraft would not substantially contribute to ambient noise levels.

Based on the results of the noise monitoring survey and the discussion above, future noise levels are calculated to be 71 dBA DNL along the northernmost site boundary, resulting primarily from train movements along the adjacent tracks. Exterior areas would include two courtyards on the fourth floor, a west fronting roof deck, and private balconies on levels three through seven.

The courtyards on level four are well shielded from the surrounding noise sources by the proposed building and would be exposed to noise levels in the range of 55 to 57 dBA DNL. Courtyard facing balconies would be exposed to similar noise levels. These levels would be considered compatible with residential use.

The roof deck faces west and is well shielded to the north, east, and south by the proposed building. The roof deck would be exposed to up to 61 dBA DNL, not taking into account any shielding provided by the rooftop itself or any parapet walls located along the western edge of the roof. Noise levels in western portions of the rooftop deck, near the roof deck edge, would exceed the City's acceptable exterior noise level criteria of 60 dBA DNL for residential use. A three-foot high solid parapet wall (relative to the floor height of the roof deck) could be provided to reduce the exterior noise levels on the roof deck to acceptable levels.

Noise levels in non-courtyard facing balconies would range from 61 to 75 dBA DNL, which would exceed the City's acceptable exterior noise level criteria for residential use. Due to the small size of these outdoor use areas, it is not acoustically feasible to reduce exterior noise levels in these balconies to meet the City's 60 dBA DNL exterior noise level objective without providing full enclosures. However, all residents would have access to the common outdoor use area which would be exposed to "normally acceptable" noise levels.

Future Interior Noise Environment

The calculated exterior noise level exposures of building façades are summarized in Table 7, based on the results of the noise monitoring survey and future increase in traffic noise levels.

TABLE 7 Predicted Exterior Noise Levels at Building Façades

Building façade	Predicted Noise Levels at Façades (dBA)		
	DNL (20 to 50 feet)	DNL (above 50 feet)	L_{max}
North façade facing train tracks	71	70	79 to 99
East and West façade near train tracks	67	66	75 to 95
East and West façade near Campbell Avenue	61	61	68 to 88
Southern façade facing Campbell Avenue	65	62	59 to 79
Façades facing courtyards	55-57	55-57	55 to 75

[2] City of San José, "Norman Y. Mineta San José International Airport Master Plan Update Project: Eighth Addendum to the Environmental Impact Report," City of San José Public Project File No. PP 10-024, February 10, 2010.

Interior noise levels would vary depending upon the design of the buildings (relative window area to wall area) and the selected construction materials and methods. Standard residential construction provides approximately 15 dBA of exterior-to-interior noise reduction, assuming the windows are partially open for ventilation. Standard new construction with the windows closed provides approximately 25 dBA of noise reduction in interior spaces. Where exterior noise levels range from 60 to 70 dBA DNL, the inclusion of adequate forced-air mechanical ventilation is often the method selected to reduce interior noise levels to acceptable levels by providing a habitable interior environment and closing the windows to control noise. Where noise levels exceed 70 dBA DNL, forced-air mechanical ventilation systems and sound-rated construction methods are normally required. Such methods or materials may include a combination of smaller window and door sizes as a percentage of the total building façade facing the noise source, sound-rated windows and doors, sound-rated exterior wall assemblies, and mechanical ventilation so windows may be kept closed at the occupant's discretion.

Considering the average façade noise losses, the following general observations can be made relative to the exterior-to-interior noise control. These calculations assume a window to wall ratio of 40 % or less.

1. In noise environments with exterior façade noise exposure up to 60 dBA DNL and typical maximum noise levels from intermittent train events up to 65 dBA L_{max}, the interior noise levels in residences would be considered acceptable with standard construction and windows in the open or closed position. (Highlighted in Green in Table 7)

2. In noise environments with exterior façade noise exposures of 60 to 70 dBA DNL and typical maximum noise levels from intermittent train events of 65 to 75 dBA L_{max}, the interior noise levels in residences would be considered acceptable with incorporation of an adequate forced air mechanical ventilation system in each residential unit to allow occupants the option of keeping the windows closed for noise control. To meet the Cal Green Code, office uses would also require forced air mechanical ventilation to allow occupants an option to keep the windows closed. (Highlighted in Blue in Table 7)

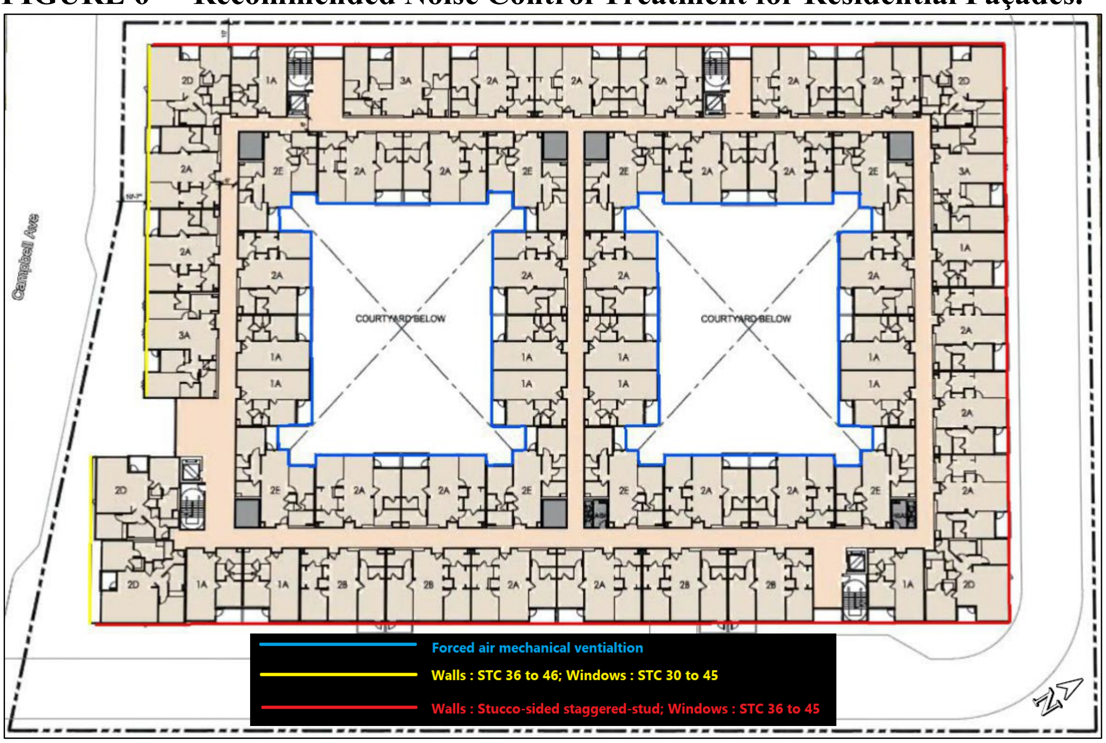
3. In noise environments with exterior façade noise in the range of 70 to 80 dBA DNL and/or typical maximum noise levels from intermittent train events ranging from 75 to 85 dBA L_{max}, a combination of forced air mechanical ventilation and sound-rated construction methods (typically walls with STC ratings of 39 to 46 and windows with STC ratings of 30 to 45) would be required to meet the interior residential noise level limits. To meet the Cal Green Code, office uses would require forced air mechanical ventilation and windows with sound ratings of STC 32 to 34. (Highlighted in Yellow in Table 7)

4. In noise environments with exterior façade noise exceeding 80 dBA DNL and/or typical maximum noise level from intermittent train events ranging from 85 to 99 dBA L_{max}, the construction materials and techniques necessary to reduce interior noise levels to acceptable levels become more expensive and difficult to implement. Noise insulation features such as stucco-sided staggered-stud walls and high STC-rated windows and doors (STC 36 to 45) would be required in residential units and office uses. Units would also require full heating and air-conditioning system because it is unlikely that the residents would open their windows for ventilation. (Highlighted in Red in Table 7)

Figure 6 shows a typical floor plan of proposed building with facades highlighted as per the recommended noise control treatment. As shown in Table 7, residential units with northern façades facing the train tracks would be exposed to exterior noise levels of up to 71 dBA DNL and maximum intermittent noise ranging from 79 to 99 dBA L_{max}. Western and eastern facing units would be exposed to exterior noise levels of up to 67 dBA DNL and maximum intermittent noise level ranging from 75 to 95 dBA L_{max} in units closer to the train tracks; and 61 dBA DNL with maximum intermittent noise levels from 68 to 88 dBA L_{max} in units closer to Campbell Avenue. Façades of southern facing units fronting Campbell Avenue would be exposed to exterior noise levels up to 65 dBA DNL, with maximum intermittent noise levels from trains ranging from 59 to 79 dBA L_{max}. Courtyard facing units would be exposed to exterior noise levels up to 57 dBA DNL and maximum intermittent noise levels ranging from 55 to 75 dBA L_{max}.

As indicated in Table 7, courtyard facing units and units fronting and perpendicular to Campbell Avenue would meet the 45 dBA DNL interior thresholds with incorporation of forced air mechanical ventilation and windows in closed position. Courtyard facing units would also meet the 50 dBA L_{max} criteria with the inclusion of forced air ventilation. To meet the 50 dBA L_{max} criteria units fronting Campbell Avenue would require windows with sound rating STC 39 or higher or a combination of higher sound rated walls and sound rated windows. All other residential units would require upgraded walls (STC 60 to 62) and high STC-rated windows and doors (STC 36 to 45). The office space, which fronts Campbell Avenue, would require forced air mechanical ventilation with windows in closed position to achieve interior noise levels of 50 dBA L_{eq} or lower, in order to comply with the Cal Green Code.

FIGURE 6 Recommended Noise Control Treatment for Residential Façades.



Recommended Measures to Ensure Noise and Land Use Compatibility

For consistency with the General Plan the following Conditions of Approval are recommended for consideration by the City:

- When refining the project's site plan, locate common outdoor areas away from adjacent noise sources and continue to shield noise-sensitive outdoor spaces with buildings or noise barriers where feasible.

- All residential and office units shall be provided forced-air mechanical ventilation to allow windows to be kept closed at the occupant's discretion to control noise.

- Project specific acoustical analyses shall be required by the state building code to confirm that interior noise levels in residences will be reduced to 45 dBA DNL and 50 dBA L_{max} or lower and interior levels in office uses will be reduced to 50 dBA L_{eq} or lower. The specific determination of what treatments would be necessary will be conducted on a unit-by-unit basis. Results of the analysis, including the description of the necessary noise control treatments, would be submitted to the City along with the building plans and approved prior to issuance of a building permit.

- Special building techniques (e.g., sound-rated windows and building facade treatments) may be required to maintain interior noise levels at or below acceptable levels. These treatments would include, but are not limited to, a combination of smaller window and door sizes as a percentage of the total building façade facing the noise source, sound-rated windows and doors, sound-rated exterior wall assemblies, and mechanical ventilation so windows may be kept closed at the occupant's discretion, acoustical caulking, protected ventilation openings, etc.

Vibration and Land Use Compatibility

The FTA has developed vibration impact assessment criteria for evaluating vibration impacts associated with transit projects (see Table 5). Approximately 92 Caltrain and 4 freight trains currently pass the site daily. Altamont Commuter Express (ACE) and Amtrak Capitol Corridor Inner-City Rail also utilize the tracks. Given the frequency of train events at the site, the Category 2 'frequent event' impact level of 72 VdB would be appropriate for the proposed project, which includes residential use.

As described in the Setting Section of this report, vibration levels from measured trains ranged from 72 to 78 VdB at the building setback (V-1), with an average train vibration level of 74 VdB. Of the five trains measured, three trains exceeded the 'frequent event' criteria of 72 VdB. One event also exceeded the "occasional event" limit of 75 VdB.

Based on the calculated drop off rate between the vibration monitoring positions, all adjusted train vibration levels would be 72 VdB or less at a distance of 130 feet or greater from center of the southbound (near) railroad tracks. Project structures located within 130 feet of the tracks could occasionally be exposed to ground vibration levels which exceed the 72 VdB vibration limit for "frequent events".

Recommended Measures to Ensure Vibration and Land Use Compatibility

For consistency with the General Plan, the following Conditions of Approval are recommended for consideration by the City:

- The project applicant shall submit a Vibration Reduction Plan prepared by a qualified acoustical consultant for City review and approval that contains vibration reduction measures to reduce groundborne vibration to acceptable levels per FTA standards. Methods available to reduce vibration levels include, but are not limited to, the following:

    - Based on the adjustment factors provided by FTA[5] some vibration attenuation could be realized depending on the specific construction type of the building. In general, the heavier the building, the greater the coupling loss between the ground and the building.

    - Isolation of foundation and footings using resilient elements such as rubber bearing pads or springs, such as a "spring isolation" system that consists of resilient spring supports that can support the podium or residential foundations. The specific system shall be selected so that it can properly support the structural loads, and provide adequate filtering of groundborne vibration to the residences above.

    - Trenching, which involves excavating soil between the railway and the project so that the vibration path is interrupted, thereby reducing the vibration levels before they enter the project's structures. Since the reduction in vibration level is based on a ratio between trench depth and vibration wavelength, additional measurements shall be conducted to determine the vibration wavelengths affecting the project. Based on the resulting measurement findings, an adequate trench depth and, if required, suitable fill shall be identified (such as foamed styrene packing pellets [i.e., Styrofoam] or low-density polyethylene).

[5]See Table 10-1 of Transit Noise and Vibration Impact Assessment, Office of Planning and Environment, Federal Transit Administration, May 2006.

NOISE AND VIBRATION IMPACTS AND MITIGATION MEASURES

This section describes the significance criteria used to evaluate project impacts under CEQA, provides a discussion of each project impact, and presents mitigation measures, where necessary, to provide a compatible project in relation to adjacent noise sources and land uses.

Significance Criteria

The following criteria were used to evaluate the significance of environmental noise resulting from the project:

1. **Temporary or Permanent Noise Increases in Excess of Established Standards:** A significant impact would be identified if project construction or operations would result in a substantial temporary or permanent increase in ambient noise levels at sensitive receivers in excess of the local noise standards contained in the San José General Plan or Municipal Code, as follows:

    a. Operational Noise in Excess of Standards. A significant noise impact would be identified if on-site project operations (i.e., mechanical equipment or parking) would generate noise levels that would exceed 55 dBA DNL at adjacent residential property lines or 60 dBA DNL at adjacent commercial property lines.

    b. Permanent Noise Increase. A significant permanent noise increase would occur if project traffic resulted in an increase of 3 dBA DNL or greater at noise-sensitive land uses where existing or projected noise levels would equal or exceed the noise level considered satisfactory for the affected land use (60 dBA DNL for single-family residential areas) and/or an increase of 5 dBA DNL or greater at noise-sensitive land uses where noise levels would continue to be below those considered satisfactory for the affected land use.

    Temporary Noise Increase. A significant temporary noise impact would be identified if construction-related noise would occur outside of the hours specified in the Municipal Code or if construction noise levels were to exceed the City's construction noise limits at adjacent noise sensitive land uses.

2. **Generation of Excessive Groundborne Vibration:** A significant impact would be identified if the construction of the project would expose persons to excessive vibration levels. Groundborne vibration levels exceeding 0.2 in/sec PPV would have the potential to result in cosmetic damage to normal buildings. Groundborne vibration levels exceeding 0.08 in/sec PPV would have the potential to result in cosmetic damage to sensitive historic structures.

3. **Exposure to excessive aircraft noise:** For a project located in the vicinity of a private airstrip or an airport land use plan, a significant impact would be identified if the project were to expose people residing or working in the project area to excessive noise levels.

Impact 1: **Temporary or Permanent Noise Increases in Excess of Standards.** Project traffic would not result in substantial permanent noise level increase at existing noise-sensitive uses in the project vicinity. However, existing noise sensitive land uses could be exposed to operational and construction noise levels in excess of applicable noise thresholds. This is a **potentially significant** impact.

A significant noise impact would occur if construction, traffic, or activities generated by the project would substantially increase noise levels at sensitive receptors in the project vicinity.

a. Permanent Noise from On-site Operations

Noise generating on-site operational components of the project would include mechanical equipment and parking lot activities. Operational noise levels are limited to 55 dBA DNL at adjacent residential property lines or 60 dBA DNL at adjacent commercial property lines.

Parking Lot Noise

Parking would be provided in a garage located on Levels 1, 2, and 3 of the proposed building. Surface parking spaces are not proposed. Access to the site and parking would be provided from Campbell Avenue, to the south of the proposed building. Parking activities occurring in a closed garage would not be anticipated to be audible outside the building's parking structure. Parking lot activities would not exceed the City's 55 dBA DNL limit at residences or 60 dBA DNL limit at commercial uses and would not measurably contribute to the existing ambient noise environment. This is a **less-than-significant** impact.

Mechanical Equipment

The proposed project would include mechanical equipment such as heating, ventilation and air conditioning systems (HVAC). The site plans[6], dated November 1st, 2018, do not include detailed information about the location or types of mechanical equipment. Equipment located inside or in a fully enclosed room with a roof would not be anticipated to be audible at off-site locations. Typical residential rooftop equipment is anticipated to generate noise levels of 50 to 60 dBA at 50 feet, depending on the equipment selected. Shielding from equipment enclosures and surrounding structures would provide 10 to 15 dBA of additional noise reduction. The following analysis is based on generic mechanical equipment information and locations for similar type projects that represent a worst-case scenario, with mechanical equipment installed near the edges of the rooftop.

The closest residences are located about 50 feet from the eastern edge of the proposed building. Assuming a credible worst-case scenario with unshielded equipment placed about 10 feet from the eastern edge of the building, rooftop equipment would be located about 80 feet from the closest residences and resulting noise levels could reach as high as 45 to 55 dBA L_{eq} at residences to the east, resulting in day-night average noise levels of 51 to 61 dBA DNL. These levels would exceed the 55 dBA DNL limit at the property line. Mechanical equipment located 180 feet or further from residential property lines or in shielded areas would be anticipated to meet the 55 dBA DNL limit. This is a **potentially significant** impact.

---

6 Santa Clara University – Educator Technology Innovation Center & Faculty/Staff Housing, Planned Development Zoning Application; Studio T-Square, November 1, 2018.

Mitigation Measure 1a: The following mitigation measures shall be included in the project to reduce the impact to a less-than-significant level:

Prior to the issuance of building permits, mechanical equipment shall be selected and designed to reduce impacts on surrounding uses to meet the City's requirements. A qualified acoustical consultant shall be retained by the project applicant to review mechanical noise as the equipment systems are selected in order to determine specific noise reduction measures necessary to reduce noise to comply with the City's 55 dBA DNL residential and 60 dBA DNL commercial noise limit at shared property line. Noise reduction measures could include, but are not limited to, selection of equipment that emits low noise levels and/installation of noise barriers such as enclosures and parapet walls to block the line of sight between the noise source and the nearest receptors.

b. Permanent Noise Increases from Project Traffic

A significant permanent noise increase would be identified if traffic noise generated by the project would substantially increase noise levels at sensitive receivers in the vicinity. A substantial increase would occur if: a) the noise level increase is 5 dBA DNL or greater, with a future noise level of less than 60 dBA DNL, or b) the noise level increase is 3 dBA DNL or greater, with a future noise level of 60 dBA DNL or greater. For reference, a doubling in traffic volumes would result in a noise level increase of 3 dBA.

To calculate the noise level increases attributable to project-generated traffic at nearby noise sensitive areas, net project trip traffic volumes from the project traffic study[7] were added to existing traffic volumes and then the existing + project volumes were compared to existing traffic volumes. Based on these calculations, roadways in the vicinity of the project are anticipated to result in noise increases attributable to the project of 0 to 1 dBA L_{eq} at existing noise-sensitive land uses. Day-night average (DNL) noise level increases would be anticipated to be similar. Project attributed traffic noise increases would be less than 3 dBA DNL. This is a **less-than-significant** impact.

c. Temporary Noise Increases from Project Construction

Chapter 20.100.450 of the City's Municipal Code establishes allowable hours of construction within 500 feet of a residential unit between 7:00 am and 7:00 pm Monday through Friday unless permission is granted with a development permit or other planning approval. No construction activities are permitted on the weekends at sites within 500 feet of a residence. Policy EC-1.7 of the City's General Plan states that for large or complex projects within 500 feet of residential land uses or within 200 feet of commercial land uses or offices involving substantial noise-generating activities lasting more than 12 months, a construction noise logistics plan that specifies hours of construction, noise and vibration minimization measures, posting or notification of construction schedules, and designation of a noise disturbance coordinator who would respond to neighborhood complaints will be required to be in place prior to the start of construction and implemented during construction to reduce noise impacts on neighboring residents and other uses.

---

[7] *Santa Clara University Residential Development – Transportation Analysis*, Hexagon Transportation Consultants, Inc., September 10, 2019.

Noise impacts resulting from construction depend upon the noise generated by various pieces of construction equipment, the timing and duration of noise-generating activities, and the distance between construction noise sources and noise-sensitive areas. Construction noise impacts primarily result when construction activities occur during noise-sensitive times of the day (e.g., early morning, evening, or nighttime hours), the construction occurs in areas immediately adjoining noise-sensitive land uses, or when construction lasts over extended periods of time.

Construction activities generate considerable amounts of noise, especially during earth-moving activities and during the construction of the building's foundation when heavy equipment is used. Typical hourly average construction-generated noise levels for residential buildings are about 81 to 88 dBA L_{eq} measured at a distance of 50 feet from the center of the site during busy non-pile driving construction periods (e.g., earth moving equipment, impact tools, etc.). Pile driving noise levels typically range up to 105 dBA L_{eq} at a distance of 50 feet. Construction-generated noise levels drop off at a rate of about 6 dBA per doubling of the distance between the source and receptor.

TABLE 8 Typical Ranges of Construction Noise Levels at 50 Feet, L_{eq} (dBA)

	Domestic Housing		**Office Building, Hotel, Hospital, School, Public Works**		**Industrial Parking Garage, Religious Amusement & Recreations, Store, Service Station**		**Public Works Roads & Highways, Sewers, and Trenches**	
	I	**II**	**I**	**II**	**I**	**II**	**I**	**II**
Ground Clearing	83	83	84	84	84	83	84	84
Excavation	88	75	89	79	89	71	88	78
Foundations	81	81	78	78	77	77	88	88
Erection	81	65	87	75	84	72	79	78
Finishing	88	72	89	75	89	74	84	84

I - All pertinent equipment present at site.
II - Minimum required equipment present at site.

Source: U.S.E.P.A., Legal Compilation on Noise, Vol. 1, p. 2-104, 1973.

TABLE 9 Construction Equipment 50-Foot Noise Emission Limits

Equipment Category	L_{max} Level (dBA)[1,2]	Impact/Continuous
Arc Welder	73	Continuous
Auger Drill Rig	85	Continuous
Backhoe	80	Continuous
Bar Bender	80	Continuous
Boring Jack Power Unit	80	Continuous
Chain Saw	85	Continuous
Compressor[3]	70	Continuous
Compressor (other)	80	Continuous
Concrete Mixer	85	Continuous
Concrete Pump	82	Continuous
Concrete Saw	90	Continuous
Concrete Vibrator	80	Continuous
Crane	85	Continuous
Dozer	85	Continuous
Excavator	85	Continuous
Front End Loader	80	Continuous
Generator	82	Continuous
Generator (25 KVA or less)	70	Continuous
Gradall	85	Continuous
Grader	85	Continuous
Grinder Saw	85	Continuous
Horizontal Boring Hydro Jack	80	Continuous
Hydra Break Ram	90	Impact
Impact Pile Driver	105	Impact
Insitu Soil Sampling Rig	84	Continuous
Jackhammer	85	Impact
Mounted Impact Hammer (hoe ram)	90	Impact
Paver	85	Continuous
Pneumatic Tools	85	Continuous
Pumps	77	Continuous
Rock Drill	85	Continuous
Scraper	85	Continuous
Slurry Trenching Machine	82	Continuous
Soil Mix Drill Rig	80	Continuous
Street Sweeper	80	Continuous
Tractor	84	Continuous
Truck (dump, delivery)	84	Continuous
Vacuum Excavator Truck (vac-truck)	85	Continuous
Vibratory Compactor	80	Continuous
Vibratory Pile Driver	95	Continuous
All other equipment with engines larger than 5 HP	85	Continuous

Notes:

[1] Measured at 50 feet from the construction equipment, with a "slow" (1 sec.) time constant.

[2] Noise limits apply to total noise emitted from equipment and associated components operating at full power while engaged in its intended operation.

[3] Portable Air Compressor rated at 75 cfm or greater and that operates at greater than 50 psi.

Project construction is anticipated to take 14 months. Construction activities would include demolition, site preparation, excavation, grading, trenching, building construction, paving, and architectural coating. Pile driving could be used as a method of construction. During each stage of construction, there would be a different mix of equipment operating, and noise levels would vary by stage and within stages, based on the amount of equipment in operation and the location at which the equipment is operating. The hauling of excavated materials and construction materials would generate truck trips on local roadways as well.

FHWA's Roadway Construction Noise Model (RCNM) was used to calculate the maximum and average noise levels anticipated during each phase of construction based on a provided construction equipment list. This construction noise model includes representative sound levels for the most common types of construction equipment and the approximate usage factors of such equipment that were developed based on an extensive database of information gathered during the construction of the Central Artery/Tunnel Project in Boston, Massachusetts (CA/T Project or "Big Dig"). The usage factors represent the percentage of time that the equipment would be operating at full power. Vehicles and equipment anticipated during each phase of construction were input into RCNM to calculate noise levels at a reference distance of 50 feet. Levels calculated in RCNM represent an upper bound of possible construction noise. Construction noise levels would typically range 5 to 10 dBA below these upper bound levels. The typical hourly average noise levels were calculated considering the distance from the center of the construction site to the nearest receptors.

Table 10 presents the construction noise levels calculated for each major construction phase of the project using RCNM. The nearest noise-sensitive land uses are approximately 50 feet from the site boundary and 150 to 225 feet from the center of the project site. At a distance of 50 feet, hourly average noise levels would typically range from 75 to 89 dBA L_{eq}, with pile driving resulting in hourly average noise levels of 105 dBA L_{eq}. At a distance of 150 feet, hourly average noise levels would typically range from 65 to 78 dBA L_{eq}, with pile driving resulting in hourly average noise levels of 95 dBA L_{eq}. Noise levels would be 5 to 15 dBA lower in shielded areas.

TABLE 10 Noise Levels by Construction Phase at Distances from Site Center

Construction Phase	Maximum Noise Level (L_{max}, dBA)			Hourly Average Noise Level ($L_{eq[h]}$, dBA)		
	50 ft.	80 ft.	150 ft.	50 ft.	80 ft.	150 ft.
Demolition	90	86	80	88	84	78
Site Preparation	94	80	74	84	80	74
Pile driving	105	101	95	105	101	95
Grading Excavation	85	81	75	89	83	77
Trenching	94	80	74	82	78	72
Building Exterior	94	80	74	85	81	75
Building Interior	78	74	68	75	71	65
Paving	90	86	80	84	80	74

Typically, pile driving activities for a building can occur over a period of several weeks in which hourly average noise levels would be substantially higher than average noise levels during other phases of construction. Pile driving activity could occur as close as 50 feet from the residences to the east of the project site, 80 feet from the residences to the west, 120 feet from the commercial fabrication building to the south, and 150 feet from the stadium to the southwest of the project site. Noise levels from pile driving at a distance of 50 feet from the closest residential receptors could reach 105 dBA L_{max}.

Construction would be located within 500 feet of residential land uses and within 200 feet of commercial land uses for a period of more than 12 months. This is a **potentially significant impact**.

Mitigation Measure 1c: The following mitigation measures shall be included in the project to reduce the impact to a less-than-significant level:

- Construction activities shall be limited to the hours between 7:00 am and 7:00 pm, Monday through Friday, unless permission is granted with a development permit or other planning approval. No construction activities are permitted on the weekends at sites within 500 feet of a residence.
- Construct solid plywood fences around ground level construction sites adjacent to noise-sensitive land uses.
- Equip all internal combustion engine-driven equipment with intake and exhaust mufflers that are in good condition and appropriate for the equipment.
- Unnecessary idling of internal combustion engines should be strictly prohibited.
- Locate stationary noise-generating equipment such as air compressors or portable power generators as far as possible from sensitive receptors. Construct temporary noise barriers to screen stationary noise-generating equipment when located near adjoining sensitive land uses. Temporary noise barriers could reduce construction noise levels by 5 dBA.
- Utilize "quiet" air compressors and other stationary noise sources where technology exists.
- Control noise from construction workers' radios to a point where they are not audible at existing residences bordering the project site.
- A temporary noise control blanket barrier could be erected, if necessary, along building façades facing residential areas during upper level construction. This mitigation would only be necessary if conflicts occurred which were irresolvable by proper scheduling. Noise control blanket barriers can be rented and quickly erected.
- Pre-drill foundation pile holes to minimize the number of impacts required to seat the pile.
- Consider the use of "acoustical blankets" for receptors located within 100 feet of the site during pile driving activities.

- Notify all adjacent business, residences, and other noise-sensitive land uses of the construction schedule, in writing, and provide a written schedule of “noisy” construction activities to the adjacent land uses and nearby residences.

- Designate a "disturbance coordinator" who would be responsible for responding to any complaints about construction noise. The disturbance coordinator will determine the cause of the noise complaint (e.g., bad muffler, etc.) and will require that reasonable measures be implemented to correct the problem. Conspicuously post a telephone number for the disturbance coordinator at the construction site and include in it the notice sent to neighbors regarding the construction schedule.

Impact 2: **Exposure to Excessive Groundborne Vibration due to Construction.** Construction-related vibration levels would exceed the 0.2 in/sec PPV threshold at nearby commercial buildings. This is a **potentially significant** impact.

Policy EC-2.3 of the City of San José General Plan limits construction vibration to 0.08 in/sec PPV at sensitive historical structures and to 0.2 in/sec PPV at buildings of normal conventional construction.

The construction of the project may generate perceptible vibration when heavy equipment or impact tools (e.g. pile drivers) are used. Construction activities would include demolition, site preparation work, grading and excavation, trenching, paving, and new building framing and finishing. This analysis assumes that under the worst-case scenario there could be pile driving, which can cause excessive vibration.

Table 11 presents typical vibration levels that could be expected from construction equipment at a distance of 25 feet, as given by FTA, and at distances of 50, 80, 100, and 125 feet, representative of the nearest structures. Project construction activities, such as pile driving, drilling, the use of jackhammers, rock drills and other high-power or vibratory tools, and rolling stock equipment (tracked vehicles, compactors, etc.), may generate substantial vibration in the immediate vicinity. Vibration levels would vary depending on soil conditions, construction methods, and equipment used.

TABLE 11 Vibration Source Levels for Construction Equipment

Equipment		PPV at 25 ft. (in/sec)	PPV at 50 ft. (in/sec)	PPV at 80 ft. (in/sec)	PPV at 100 ft. (in/sec)	PPV at 125 ft. (in/sec)
Pile Driver (Impact)	upper range	1.158	0.540	0.322	0.252	0.197
	typical	0.644	0.300	0.179	0.140	0.110
Pile Driver (Sonic)	upper range	0.734	0.342	0.204	0.160	0.125
	typical	0.170	0.079	0.047	0.037	0.029
Clam shovel drop		0.202	0.094	0.056	0.044	0.034
Hydromill (slurry wall)	in soil	0.008	0.004	0.002	0.002	0.001
	in rock	0.017	0.008	0.005	0.004	0.003
Vibratory Roller		0.210	0.098	0.058	0.046	0.036
Hoe Ram		0.089	0.042	0.025	0.019	0.015
Large bulldozer		0.089	0.042	0.025	0.019	0.015
Caisson drilling		0.089	0.042	0.025	0.019	0.015
Loaded trucks		0.076	0.035	0.021	0.017	0.013
Jackhammer		0.035	0.016	0.010	0.008	0.006
Small bulldozer		0.003	0.001	0.001	0.001	0.001

Source: Transit Noise and Vibration Impact Assessment, United States Department of Transportation, Office of Planning and Environment, Federal Transit Administration, May 2006 as modified by Illingworth & Rodkin, Inc., February 2019.

Activities exceed 0.2 in/sec PPV vibration threshold for buildings with conventional construction (not historic).

Structures are located as close as 50 feet from construction. As indicated in Table 11, 'upper range' impact pile driving would be anticipated to generate vibration levels as high as 0.54 in/sec PPV at a distance of 50 feet, with 'typical' levels anticipated to be approximately 0.3 in/sec PPV.

Impact pile driving would have the potential to produce typical vibration levels of 0.08 in/sec PPV or more at historical buildings within 170 feet of the project site. According to the City of San José Historic Resources Inventory,[8] there are no historical buildings within 170 feet of the project site.

'Upper range' impact pile driving would have the potential to produce vibration levels of 0.2 in/sec PPV or more at buildings within 125 feet, with 'typical' impact pile driving generating levels producing vibration levels of 0.2 in/sec PPV or more at buildings within 75 feet. Conventional buildings located within 125 feet of the site include residential buildings to the east and west, a corporate fabrication center to the south, and a stadium seating area to the southwest of the project site. The US Bureau of Mines has analyzed the effects of blast-induced vibration on buildings in USBM RI 85079, and these findings have been applied to vibrations emanating from construction equipment on buildings[10]. Figure 7 presents the damage probability as reported in USBM RI 8507 and reproduced by Dowding assuming a maximum vibration level of 0.54 in/sec PPV. As shown on Figure 7, these studies indicate an approximate 5% probability of "threshold damage" (referred

[8] "City of San José Historic Resources Inventory." City of San José, February 8, 2016, www.sanjoseca.gov/DocumentCenter/View/35475 .

9 Siskind, D.E., M.S. Stagg, J.W. Kopp, and C.H. Dowding, Structure Response and Damage Produced by Ground Vibration form Surface Mine Blasting, RI 8507, Bureau of Mines Report of Investigations, U.S. Department of the Interior Bureau of Mines, Washington, D.C., 1980.

10 Dowding, C.H., Construction Vibrations, Prentice Hall, Upper Saddle River, 1996.

to as cosmetic damage elsewhere in this report) at vibration levels of 0.54 in/sec PPV or less with no observations of "minor damage" or "major damage". Based on these data, cosmetic or threshold damage (e.g., hairline cracking in plaster, the opening of old cracks, the loosening of paint or the dislodging of loose objects, minor damage (e.g., hairline cracking in masonry or the loosening of plaster) and major structural damage (e.g., wide cracking or shifting of foundation or bearing walls) to adjacent structures would not be anticipated to occur assuming a maximum vibration level of 0.54 in/sec PPV.

Other heavy vibration generating construction equipment, including 'typical' vibratory pile driving, vibratory rollers, or clam shovel drops, would not be anticipated to exceed 0.2 in/sec PPV at distances of 25 feet of further from construction. In other surrounding areas where vibration would not be expected to cause structural damage, vibration levels may still be perceptible. However, as with any type of construction, this would be anticipated and would not be considered significant, given the intermittent and short duration of the phases that have the highest potential of producing vibration (use of jackhammers and other high-power tools). By use of administrative controls, such as notifying neighbors of scheduled construction activities and scheduling construction activities with the highest potential to produce perceptible vibration during hours with the least potential to affect nearby businesses, perceptible vibration can be kept to a minimum.

The use of impact pile driving could exceed 0.2 in/sec PPV when located within 125 feet of structures. This is a **potentially significant** impact.

Mitigation Measure 2: The following measures are recommended to reduce vibration impacts from construction activities:

- Avoid impact pile driving where possible. Drilled piers or rammed aggregate piers cause lower vibration levels where geological conditions permit their use.

- Phase demolition, earth-moving, and ground impacting operations so as not to occur during the same time period.

- A list of all heavy construction equipment to be used for this project and anticipated time duration of using the equipment that is known to produce high vibration levels (clam shovel drops, vibratory rollers, tracked vehicles, vibratory compaction, jackhammers, hoe rams, etc.) shall be submitted to the City by the contractor. This list shall be used to identify equipment and activities that would potentially generate substantial vibration and to define the level of effort for reducing vibration levels below the thresholds.

- If pile driving is required, notify neighbors within 500 feet of the construction site of the construction schedule and that there could be noticeable vibration levels resulting from pile driving.

- If pile driving is required, foundation pile holes shall be pre-drilled to minimize the number of impacts required to seat the pile. Jet or partially jet piles into place to minimize the number of impacts required to seat the pile.

- A construction vibration monitoring plan shall be implemented to document conditions at all structures located within 125 feet of construction prior to, during, and after pile driving. All plan tasks shall be undertaken under the direction of a licensed Professional Structural Engineer in the State of California and be in accordance with industry-accepted standard methods. The construction vibration monitoring plan should be implemented to include the following tasks:

    - Identification of sensitivity to ground-borne vibration of nearby structures. Vibration limits should be applied to all vibration-sensitive structures located within 125 feet of any pile driving activities.

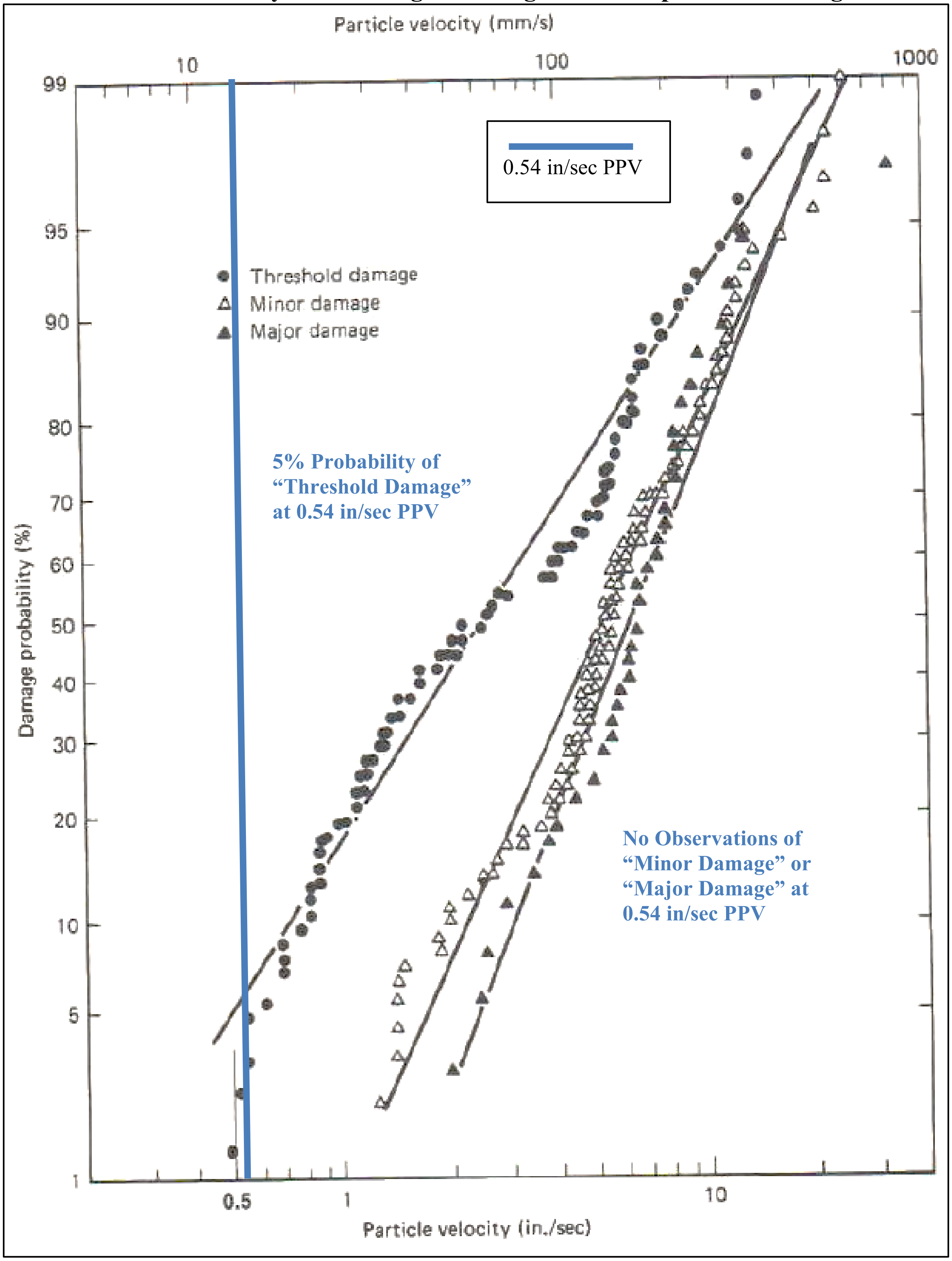
    - Performance of a photo survey, elevation survey, and crack monitoring survey for each of structure of normal construction within 125 feet of pile driving activities and/or within 25 feet of other construction activities identified as sources if high vibration levels. Surveys shall be performed prior to any pile driving activity, in regular interval during pile driving, and after completion and shall include internal and external crack monitoring in structures, settlement, and distress and shall document the condition of foundations, walls and other structural elements in the interior and exterior of said structures.

    - Conduct post-survey on structures where complaints of damage have been made. Make appropriate repairs or compensation where damage has occurred as a result of construction activities.

    - Designate a person responsible for registering and investigating claims of excessive vibration. The contact information of such person shall be clearly posted on the construction site.

The implementation of these mitigation measures would reduce the impact to a **less-than-significant** level.

FIGURE 7 Probability of Cracking and Fatigue from Repetitive Loading



Source: Dowding, C.H., Construction Vibrations, Prentice Hall, Upper Saddle River, 1996 as modified by Illingworth & Rodkin, Inc., March 2019.

Impact 3: **Exposure to Excessive Aircraft Noise.** The project site is not located within the 65 dBA CNEL noise contour for Mineta San José International Airport. This is a **less-than-significant** impact.

Santa Clara University Housing is proposed within 0.6 miles of the Mineta San José International Airport. Aircraft noise exposure would be considered significant if the project site were exposed to aircraft noise levels exceeding 65 dBA CNEL. Based on review of the 2027 CNEL Contours for Airport Master Plan[11], the project site is located outside of the 60 dBA CNEL noise contour. As described in the Setting Section, the primary noise source at the site is train activity and traffic on Campbell Avenue, which generates noise levels as high as 71 dBA DNL at the site. Aircraft noise is generally not audible above train noise at the site. This is a **less-than-significant** impact.

Mitigation Measure 3: **Not required**.

[11] Norman Y. Mineta San José International Airport – Master Plan Update Project, City of San José; February 10, 2010.