

# ***CAMBRIANNA AVENUE CONSTRUCTION NOISE AND VIBRATION ASSESSMENT***

***San José, California***

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## INTRODUCTION

The purpose of this report is to address the potential construction noise and vibration impacts associated with the re-development of the site at 1975 Cambrianna Drive with single-family residential dwelling units. The report presents background information on environmental noise and definitions of the technical terms used in the assessment, the applicable regulatory criteria used in the assessment, and an evaluation of construction related noise and vibration impacts.

## PROJECT DESCRIPTION

The approximately 2.7-acre project site is located north of Cambrianna Drive, between Union Avenue and Taper Avenue. The project site is located within the eastern portion of an approximately 9.7-acre parcel partially developed with an elementary school, including classroom buildings and playground facilities. The school is no longer used, so the buildings are currently rented by the School District. The project would redevelop the site with up to 21 dwelling units, all of which are single-family homes. 14 of the homes would include an accessory dwelling unit (ADU). The single-family homes would be two stories, approximately 26-27 feet in height, and all proposed units would be between 1,600 square feet and 3,920 square feet in size. Figure 1 shows an image overlay of the proposed construction phasing plan over the aerial view of the project site.

**FIGURE 1 – Project Plan and Vicinity (Source: Google Earth 2021)**



## 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.

**TABLE 1 Definition of Acoustical Terms Used in this Report**

<b>Term</b>	<b>Definition</b>
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	
	10 dBA	Broadcast/recording studio
	0 dBA	

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

People are usually more sensitive to noise in the nighttime than they are during the daytime. Two factors contribute to this increased sensitivity. First, during the evening and nighttime, outdoor ambient noise levels are generally lower than in the daytime. Most offices and businesses are closed and automobile traffic has decreased. Second, as household noise levels decrease during the evening, changes in exterior nighttime noise levels can be more noticeable and annoying than such changes are during the day.

To account for this sensitivity, a calculation called the Community Noise Equivalent Level (CNEL) is used to divide the 24-hour day into three time periods: daytime (7:00 a.m. to 7:00 p.m.), evening (7:00 p.m. to 10:00 p.m.), and nighttime (10:00 p.m. to 7:00 a.m.). The evening sound levels are assigned a five decibel penalty (or weighting) and the nighttime sound levels are assigned a 10 decibel penalty (or weighting) prior to averaging with daytime hourly sound levels. In this way, the CNEL is a noise metric that, if used to regulate noise, provides for a quieter evening and nighttime environment.

## **Effects of Noise**

### *Sleep and Speech Interference*

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 12-17 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 57-62 dBA DNL with open windows and 65-70 dBA DNL if the windows are closed. Levels of 55-60 dBA are common along collector streets and secondary arterials, while 65-70 dBA is a typical value for a primary/major arterial. Levels of 75-80 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.

### *Annoyance*

Attitude surveys are used for measuring the annoyance felt in a community for noises intruding into homes or affecting outdoor activity areas. In these surveys, it was determined that the causes for annoyance include interference with speech, radio and television, house vibrations, and interference with sleep and rest. The DNL as a measure of noise has been found to provide a valid correlation of noise level and the percentage of people annoyed. People have been asked to judge the annoyance caused by aircraft noise and ground transportation noise. There continues to be disagreement about the relative annoyance of these different sources. When measuring the percentage of the population highly annoyed, the threshold for ground vehicle noise is about 50 dBA DNL. At a DNL of about 60 dBA, approximately 12 percent of the population is highly annoyed. When the DNL increases to 70 dBA, the percentage of the population highly annoyed increases to about 25-30 percent of the population. There is, therefore, an increase of about 2 percent per dBA between a DNL of 60-70 dBA. Between a DNL of 70-80 dBA, each decibel increase increases by about 3 percent the percentage of the population highly annoyed. People appear to respond more adversely to aircraft noise. When the DNL is 60 dBA, approximately 30-35 percent of the population is believed to be highly annoyed. Each decibel increase to 70 dBA adds about 3 percentage points to the number of people highly annoyed. Above 70 dBA, each

decibel increase results in about a 4 percent increase in the percentage of the population highly annoyed.

### **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.

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

<b>Velocity Level, PPV (in/sec)</b>	<b>Human Reaction</b>	<b>Effect on Buildings</b>
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	Virtually no risk of damage to normal 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 dwellings such as plastered walls or ceilings
0.5	Severe - Vibrations considered unpleasant	Threshold at which there is a risk of damage to newer residential structures

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

## **REGULATORY BACKGROUND**

### **Regulatory Background - Noise**

The City of San José has established regulatory criteria that are applicable in this assessment. A summary of the applicable regulatory criteria is provided below.

***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-1.7** 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.

### **Regulatory Background – Vibration**

*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-2.3** Require new development to minimize continuous vibration impacts to adjacent uses during demolition and construction. For sensitive historic structures, including ruins and ancient monuments or building that are documented to be structurally weakened, a continuous 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 continuous vibration limit of 0.20 in/sec PPV will be used to minimize the potential for cosmetic damage at buildings of normal conventional construction. Equipment or activities typical of generating continuous vibration include but are not limited to: excavation equipment; static compaction equipment; vibratory pile drivers; pile-extraction equipment; and vibratory compaction equipment. Avoid use of impact pile drivers within 125 feet of any buildings, and within 300 feet of historical buildings, or buildings in poor condition. On a project-specific basis, this distance of 300 feet may be reduced where warranted by a technical study by a qualified professional that verifies that there will be virtually no risk of cosmetic damage to sensitive buildings from the new development during demolition and construction. Transient vibration impacts may exceed a vibration limit of 0.08 in/sec PPV only when and where warranted by a technical study by a qualified professional that verifies that there will be virtually no risk of cosmetic damage to sensitive buildings from the new development during demolition and construction.

## **IMPACTS**

### **Construction Noise Impacts**

Construction activities generate considerable amounts of noise, especially during earth-moving activities when heavy equipment is used. A list of typical maximum instantaneous noise levels measured at 50 feet are provided in Table 4. Maximum noise levels typically range from about 80 to 90 dBA  $L_{max}$  at 50 feet from the noise source. Typical hourly average construction-generated noise levels for residences are about 81 to 88 dBA  $L_{eq}$  measured at 50 feet from the center of the site during busy construction periods (e.g., earth moving equipment, impact tools, etc.), as shown in Table 5.

**TABLE 4 Construction Equipment 50-foot Noise Emission Limits**

<b>Equipment Category</b>	<b>L<sub>max</sub> Level (dBA)<sup>1,2</sup></b>	<b>Impact/Continuous</b>
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 <sup>3</sup>	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:

<sup>1</sup> Measured at 50 feet from the construction equipment, with a “slow” (1 sec.) time constant.<sup>2</sup> Noise limits apply to total noise emitted from equipment and associated components operating at full power while engaged in its intended operation.<sup>3</sup> Portable Air Compressor rated at 75 cfm or greater and that operates at greater than 50 psi.

Source: Mitigation of Nighttime Construction Noise, Vibrations and Other Nuisances, National Cooperative Highway Research Program, 1999.

**TABLE 5 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
<b>I</b> - All pertinent equipment present at site.								
<b>II</b> - Minimum required equipment present at site.								

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

Project construction is expected to start in September 2022 and would be built out over a period of approximately one year (to be completed by mid-September 2023). Construction hours are assumed to be 7:00 a.m. to 7:00 p.m. Monday through Friday. Construction activities generate considerable amounts of noise, especially during earth-moving activities when heavy equipment is used. The construction of the proposed project would involve demolition, site preparation, grading, excavation to lay foundations, trenching, building erection, and paving. During each stage of construction, there would be a different mix of equipment operating, and noise levels would vary by stage and vary within stages, based on the amount of equipment in operation and the location at which the equipment is operating. These construction activities along with the respective levels expected from each phase of construction are summarized in Table 6 below.

The construction noise levels were calculated to range from 78 to 90 dBA  $L_{max}$  and from 77 to 87 dBA  $L_{eq}$  at 50 feet, using FHWA's Roadway Construction Noise Model (Table 6). These project-specific construction noise levels generally agree with the range of typical maximum and average noise levels presented above. Construction-generated noise levels drop off at a rate of about 6 dBA per doubling of the distance between the source and receptor. Shielding by buildings or terrain can provide an additional 5 to 10 dBA noise reduction at distant receptors.

Noise sensitive residential land uses are located to the immediate north and east of the project site. Theoretically, the maximum noise levels could reach 100 to 110 dBA at the property plane if equipment is used within about 5 feet. Typically, however, a receptor would not be located at the property line of the adjacent property when construction occurs in close proximity. Therefore, construction noise levels are calculated from the center of the proposed project site, in order to

credibly represent typical noise levels experienced at adjacent receptors over the duration of the construction. The nearest receptors include existing residences to the north and east along with an elementary school building to the west and are located at distances ranging from 100 to 200 feet from the center of the project site. At the closest receptor (100 feet away), maximum noise levels generated by project construction would typically range from about 72 to 84 dBA  $L_{max}$ , and hourly average noise levels would typically range from about 71 to 81 dBA  $L_{eq}$ .

**TABLE 6 Total Calculated  $L_{max}$  and  $L_{eq}$  Noise Levels from RCNM**

Description	Equipment	Quantity	Total Calculated (dBA) at 50 feet	
			$L_{max}$ *	$L_{eq}$
Demolition	Concrete/Industrial Saws	1	90	87
	Excavators	2		
	Tractors/Loaders/Backhoes	2		
Site Preparation	Tractors/Loaders/Backhoes	1	84	80
Grading/Excavation	Excavators	1	85	87
	Graders	1		
	Scrapers	1		
	Tractors/Loaders/Backhoes	2		
Trenching/Foundation	Tractors/Loaders/Backhoes	2	84	84
	Excavators	1		
Building – Exterior	Forklifts	2	84	83
	Tractors/Loaders/Backhoes	2		
Building - Interior	Air Compressors	2	78	77
Paving	Pavers	1	85	84
	Paving Equipment	2		
	Rollers	2		

\* Total  $L_{max}$  is the value for the loudest piece of equipment

Ambient noise levels at the surrounding land uses would be substantially increased during various times throughout the duration of construction, which is estimated to be approximately 13 months. Per Policy EC-1.7 of the City’s General Plan, the temporary construction impact would be significant because the project would involve noise generating activities continuing for approximately 13 months. Per Policy EC-1.7 of the City’s General Plan, the temporary construction impact would be significant because the project would involve substantial noise generating activities continuing for 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.

The following standard noise control measures shall be implemented:

- Construction will be limited to the hours of 7:00 a.m. to 7:00 p.m. Monday through Friday for any on-site or off-site work within 500 feet of any residential unit. Construction outside of these hours may be approved through a development permit based on a site-specific “construction noise mitigation plan” and a finding by the Director of Planning, Building and Code Enforcement that the construction noise mitigation plan is adequate to prevent noise disturbance of affected residential uses.
- The contractor shall use “new technology” power construction equipment with state-of-the-art noise shielding and muffling devices. All internal combustion engines used on the project site shall be equipped with adequate mufflers and shall be in good mechanical condition to minimize noise created by faulty or poorly maintained engines or other components.
- The unnecessary idling of internal combustion engines shall be prohibited.
- Staging areas and stationary noise-generating equipment shall be located as far as possible from noise-sensitive receptors such as residential uses (a minimum of 200 feet).
- The surrounding neighborhood shall be notified early and frequently of the construction activities.
- A “noise disturbance coordinator” shall be designated to respond to any local complaints about construction noise. The disturbance coordinator would determine the cause of the noise complaints (e.g., beginning work too early, bad muffler, etc.) and institute reasonable measures warranted to correct the problem. A telephone number for the disturbance coordinator would be conspicuously posted at the construction site.

A “construction noise logistics plan,” in accordance with Policy EC-1.7, would be required. Typical construction noise logistics plan would include, but not be limited to, the following measures to reduce construction noise levels as low as practical:

- Utilize ‘quiet’ models of air compressors and other stationary noise sources where technology exists.
- Equip all internal combustion engine-driven equipment with mufflers, which are in good condition and appropriate for the equipment.
- If stationary noise-generating equipment must be located near receptors, adequate muffling (with enclosures where feasible and appropriate) shall be used. Any enclosure openings or venting shall face away from sensitive receptors.

- Ensure that generators, compressors, and pumps are housed in acoustical enclosures.
- Locate cranes as far from adjoining noise-sensitive receptors as possible.
- During final grading, substitute graders for bulldozers, where feasible. Wheeled heavy equipment are quieter than track equipment and should be used where feasible.
- Substitute nail guns for manual hammering, where feasible.
- Substitute electrically powered tools for noisier pneumatic tools, where feasible.
- If complaints are received or excessive noise levels cannot be reduced using the measures above, erect a temporary noise control blanket barrier along surrounding building facades that face the construction sites.
- The Construction Noise Logistic Plan, inclusive of the above shall be signed by a qualified acoustical specialist verifying that the implementation measures included in this Plan meets the reduction to noise levels as required by this mitigation measure.

With the implementation of GP Policy EC-1.7, Municipal Code requirements, and the above measures, the temporary construction noise impact would be reduced to a **less-than-significant** level.

### **Construction Vibration Impacts**

According to Policy EC-2.3 of the City of San José General Plan, a vibration limit of 0.08 in/sec PPV shall be used to minimize the potential for cosmetic damage to sensitive historical structures, and a vibration limit of 0.2 in/sec PPV shall be used to minimize damage at buildings of normal conventional construction. Cosmetic damage (also known as threshold damage) is defined as hairline cracking in plaster, the opening of old cracks, the loosening of paint or the dislodging of loose objects. Minor damage is defined as hairline cracking in masonry or the loosening of plaster. Major structural damage is defined as wide cracking or the shifting of foundation or bearing walls. The vibration limits contained in this policy are conservative and designed to provide the ultimate level of protection for existing buildings in San José.

Construction activities associated with the project would include demolition, site preparation, grading & excavation, foundation work, and new building framing and finishing. Foundation construction techniques involving impact or vibratory pile driving, which can cause excessive vibration, are not anticipated as part of the project. Heavy vibration generating construction equipment, such as vibratory rollers or the dropping of heavy equipment (e.g., clam shovel drops), would have the potential to produce vibration levels of 0.08 in/sec PPV or more at historic buildings within 60 feet of the project site. This same equipment would have the potential to produce vibration levels of 0.2 in/sec PPV or more at buildings of normal conventional construction located within 30 feet of the project site.

Table 7 presents typical vibration levels that could be expected from construction equipment at 25 feet and summarizes the vibration levels at the nearest adjacent buildings surrounding the site. Project construction activities, such as 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. Jackhammers typically generate vibration levels of 0.035 in/sec PPV and drilling typically generates vibration levels of 0.09 in/sec PPV at 25 feet. Vibration levels would vary depending on soil conditions, construction methods, and equipment used.

Construction vibration received at off-site buildings would be dependent on the distance between individual pieces of equipment on the project site and the off-site building. For example, a vibratory roller operating near the project site boundary would generate the worst-case vibration levels for the building sharing that property line. Construction vibration impacts are assessed based on the potential for damage to buildings on receiving land uses, not at receptors at the nearest property lines. Therefore, the distance used to propagate construction vibration levels (as shown in Table 7) was estimated under the assumption that each piece of equipment could operate along the nearest boundary of the project site representing the worst-case scenario.

The 0.2 in/sec PPV vibration limit would be applicable to properties in the immediate vicinity of the project site since there are no historic buildings in the vicinity. Structures surrounding the site are assumed to be of normal conventional construction and would be 15 feet or more from areas of the site where heavy equipment would be used. Table 7 presents vibration levels from construction equipment at the nearest buildings surrounding the site. Calculations were made to estimate vibration levels at distances of 15 feet to represent the nearest residential buildings to the north and east, along with the elementary school building to the west (20 feet away). Vibration levels are highest close to the source, and then attenuate with increasing distance at the rate  $(D_{ref}/D)^{1.1}$ , where D is the distance from the source in feet and  $D_{ref}$  is the reference distance of 25 feet. Vibration levels would vary depending on soil conditions, construction methods, and equipment used. At 15 feet, vibration levels due to construction are conservatively calculated to reach up to 0.4 in/sec PPV for a vibratory roller and a clam shovel drop, which would exceed the 0.2 in/sec PPV threshold for conventional buildings.

The US Bureau of Mines has analyzed the effects of blast-induced vibration on buildings in USBM RI 8507<sup>1</sup>, and these findings have been applied to vibrations emanating from construction equipment on buildings<sup>2</sup>. As shown on Figure 2, these studies indicate a less than 5% probability of “threshold damage” (referred to as cosmetic damage elsewhere in this report) at vibration levels of 0.4 in/sec PPV or less and no observations of “minor damage” or “major damage” at vibration levels of 0.4 in/sec PPV or less. Figure 2 presents the damage probability as reported in USBM RI 8507 and reproduced by Dowding assuming a maximum vibration level of 0.4 in/sec PPV. Based on these data, cosmetic or threshold damage would be manifested in the form of hairline cracking in plaster, the opening of old cracks, the loosening of paint or the dislodging of loose objects. However, minor damage (e.g., hairline cracking in masonry or the loosening of plaster) or major structural damage (e.g., wide cracking or shifting of foundation or bearing walls) would not occur at the adjacent commercial buildings assuming a maximum vibration level of 0.4 in/sec PPV.

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

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

Project-generated vibration levels would be capable of cosmetically damaging the adjacent residential buildings to the north and east but would fall below the General Plan threshold of 0.2 in/sec PPV at other surrounding conventional buildings located 30 feet or more from the project site. Neither cosmetic, minor, or major damage would occur beyond 30 feet. At these locations, and 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. 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 residences and businesses, perceptible vibration can be kept to a minimum.

**TABLE 7 Construction Vibration Levels at Nearby Buildings**

Equipment	PPV (in/sec)		
	Source Level (25 ft)	North/East Residential (15 ft)	Elementary School (20 ft)
Clam shovel drop	0.202	<b>0.354</b>	<b>0.258</b>
Hydromill (slurry wall)	in soil	0.008	0.010
	in rock	0.017	0.022
Vibratory Roller	0.210	<b>0.368</b>	<b>0.268</b>
Hoe Ram	0.089	0.156	0.114
Large bulldozer	0.089	0.156	0.114
Caisson drilling	0.089	0.156	0.114
Loaded trucks	0.076	0.133	0.097
Jackhammer	0.035	0.061	0.045
Small bulldozer	0.003	0.005	0.004

Source: Transit Noise and Vibration Impact Assessment Manual, Federal Transit Administration, Office of Planning and Environment, U.S. Department of Transportation, FTA Report No. 0123, September 2018, as modified by Illingworth & Rodkin, Inc., July 2021.

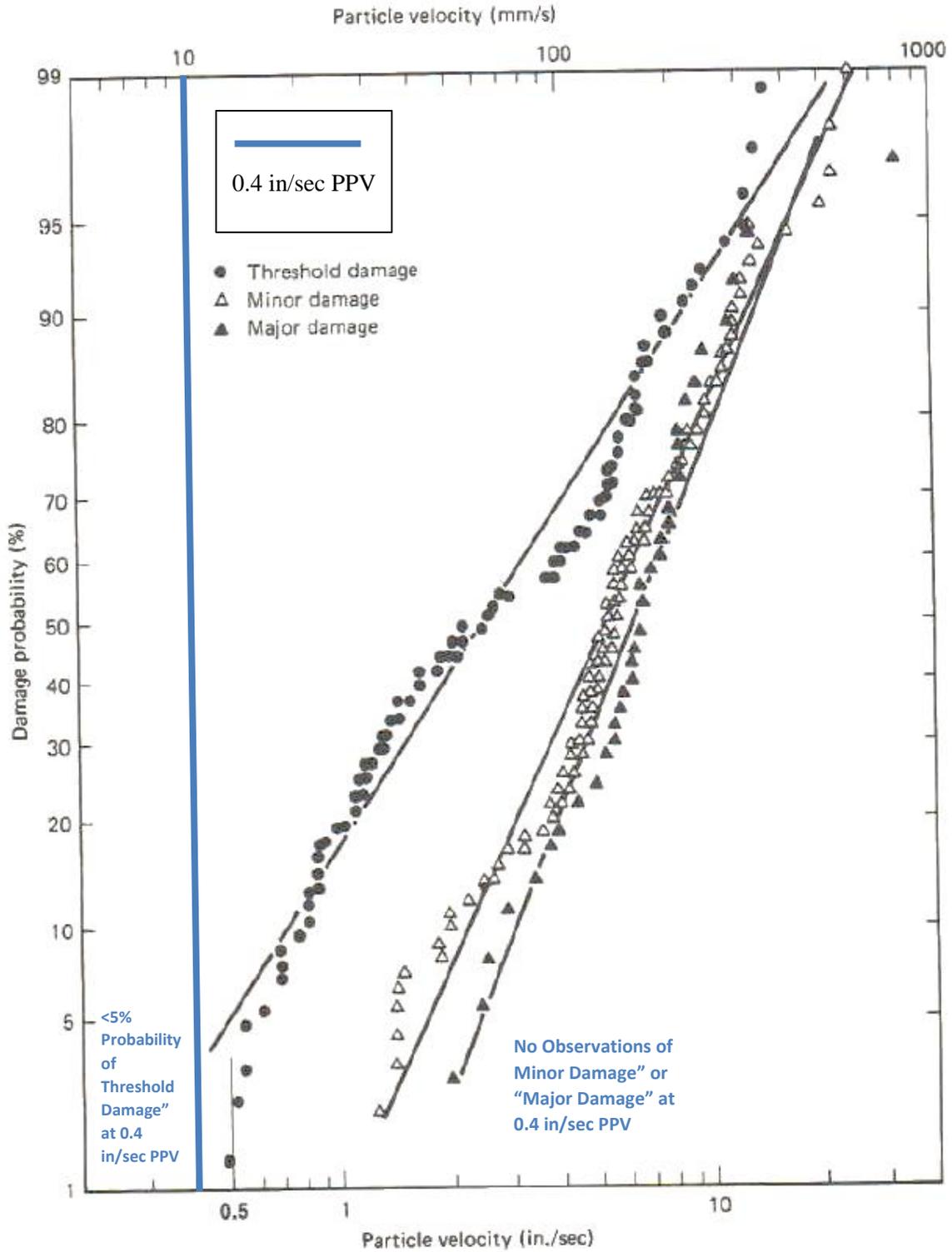
**Mitigation Measures:**

The following measures shall be implemented where vibration levels due to construction activities would exceed 0.2 in/sec PPV at nearby buildings to reduce the impact to a less-than-significant level:

- Prohibit the use of heavy vibration-generating construction equipment within 30 feet of adjacent residential buildings and the school.
- Use a smaller vibratory roller, such as the Caterpillar model CP433E vibratory compactor, when compacting materials within 30 feet of adjacent buildings. Only use the static compaction mode when compacting materials within 15 feet of adjacent buildings.

- Avoid dropping heavy equipment and use alternative methods for breaking up existing pavement, such as a pavement grinder, instead of dropping heavy objects, within 30 feet of adjacent buildings.
- 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.

**FIGURE 2 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., July 2021.