

THE COTTAGES AT KERN CONSTRUCTION NOISE AND VIBRATION ASSESSMENT

Gilroy, California

February 10, 2021

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INTRODUCTION

The project proposes to construct 29 single-family homes with a corresponding private street and common open space. The approximately 3.74-acre project site is currently vacant.

This study evaluates the potential for construction related noise and vibration impacts at adjacent land uses. This report includes a brief description of the fundamentals of environmental noise and vibration, summarizes applicable regulatory criteria, and discusses construction noise and vibration levels expected at receptors near the project site. Based on a review of construction information provided by the applicant, recommendations are made to mitigate construction noise and vibration impacts to less-than-significant levels.

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 p.m. - 10:00 p.m.) and a 10 dB addition to nocturnal (10:00 p.m. - 7:00 a.m.) noise levels. The *Day/Night Average Sound Level (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.

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 p.m. and 7:00 a.m.
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 p.m. to 10:00 p.m. and after addition of 10 decibels to sound levels measured in the night between 10:00 p.m. and 7:00 a.m.
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 vibration levels produce.

The annoyance levels shown in Table 3 should be interpreted with care since vibration may be found to be annoying at much 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.

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 induce structural 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. Studies have shown that the threshold of perception for average persons is in the range of 0.008 to 0.012 in/sec PPV. 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 minor cracking of building elements, or may threaten the integrity of the building. Safe vibration limits that can be applied to assess the potential for damaging a structure vary by researcher and there is no general consensus as to what amount of vibration may pose a threat for structural damage to the building. 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.

TABLE 3 Reactions 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.

Regulatory Background

The California Department of Transportation (Caltrans) and City of Gilroy have established regulatory criteria that are applicable in this assessment. A summary of the applicable regulatory criteria is provided below.

California Department of Transportation

Caltrans recommends a vibration limit of 0.5 in/sec PPV for buildings structurally sound and designed to modern engineering standards, 0.3 in/sec PPV for buildings that are found to be structurally sound but where structural damage is a major concern, and a conservative limit of 0.25 in/sec PPV for historic and some old buildings (see Table 3).

City of Gilroy 2040 General Plan

The noise-related goal of the City’s General Plan is to “*Protect Gilroy residents from exposure to excessive noise and its effects through appropriate mitigation measures and responsive land use planning, especially in regard to noise-sensitive land uses such as schools, hospitals, and housing for seniors.*” The following policies, applicable to the development of the site, are set forth in the General Plan to facilitate this goal:

PH 6.10 Construction Noise

Require proposed development projects subject to discretionary approval to assess potential construction noise impacts on nearby sensitive uses and to minimize impacts on those uses, to the extent feasible.

PH 6.12 Vibration Impact Assessment

Require a vibration impact assessment for proposed development projects in which heavy-duty construction equipment would be used (e.g., pile driving, bulldozing) within 200 feet of an existing structure or sensitive receptor. If applicable, require all feasible mitigation measures to be implemented to ensure that no damage or disturbance to structures or sensitive receptors would occur.

Gilroy City Code

Chapter 16.38 of the City Code defines the allowable construction hours. This section states the following:

- (a) Unless otherwise provided for in a validly issued permit or approval, construction activities shall be limited to the hours of seven (7:00) a.m. and seven (7:00) p.m., Monday through Friday, and nine (9:00) a.m. to seven (7:00) p.m. on Saturday. Construction activities shall not occur on Sundays or City holidays, which include: New Year's Day, Independence Day, Labor Day, Thanksgiving Day and Christmas. "Construction activities" are defined as including but not limited to, excavation, grading, paving, demolitions, construction, alteration or repair of any building, site, street or highway, delivery or removal of construction material to a site, or movement of construction materials on a site.
- (b) In the event the chief building official or his or her designee determines that the public health and safety will not be impaired by the construction activities between the hours of seven (7:00) p.m. and seven (7:00) a.m., and that loss or inconvenience would result to any party in interest, the chief building official may grant permission for such work to be done between the hours of seven (7:00) p.m. and seven (7:00) a.m. upon an application being made at the time the permit for the work is issued or during the progress of the work.
- (d) No third person, including but not limited to, landowners, construction company owners, contractors, subcontractors, or employers, shall permit or allow any person working on construction activities, which are under their ownership, control or direction to violate this provision. The provisions prescribed herein may be enforced by the chief building official or his or her designee or the police department. Violation of this section shall be a misdemeanor and each day such violation is committed or permitted to continue constitutes a separate offense and shall be punishable as such (Ord. No. 2004-15, § I, 9-7-04).

Construction Noise Impacts

Temporary noise increases resulting from construction vary depending upon the noise levels generated by various pieces of construction equipment, the timing and duration of noise-generating activities, the distance between construction noise sources and noise-sensitive areas, and the presence of intervening shielding features such as buildings or terrain. 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 for individual projects are typically carried out in stages. 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. Typical construction noise levels at a distance of 50 feet are shown in Tables 4 and 5. Table 4 shows the average noise level ranges by construction phase, and Table 5 shows the maximum noise level ranges for different construction equipment. 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.

TABLE 4 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
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 5 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 place over a period of about 19 months, from January 2022 to August 2023. The construction of the proposed project would involve site preparation, grading and excavation, trenching, building erection, interior/architectural coating, and paving. Table 6 shows the anticipated construction noise levels at surrounding receptors calculated throughout all phases of construction based on the provided equipment list. Construction noise levels were calculated using the Federal Highway Administration (FHWA) Roadway Construction Noise Model (RCNM). Pile driving would not be used as a method of construction.

Noise sensitive uses surrounding the site include residential land uses to the north, south and east, and across Kern Avenue to the west. As shown in Table 6, project construction would have the potential to temporarily increase ambient noise levels in the site vicinity.

City Code Zoning Ordinance Section 16.38 establishes allowed hours of construction and construction best practices to be followed to reduce the impact of construction noise on adjacent or nearby properties. These, and additional recommended best practices which would further ensure project construction would not result in excessive noise levels at surrounding receptors, are listed below:

- Construction activities shall be limited to the hours of seven (7:00) a.m. and seven (7:00) p.m., Monday through Friday, and nine (9:00) a.m. to seven (7:00) p.m. on Saturday. Construction activities shall not occur on Sundays or City holidays.
- Equip all internal combustion engine-driven equipment with mufflers which are in good condition and appropriate for the equipment;
- Locate stationary noise-generating equipment as far as possible from sensitive receptors when sensitive receptors adjoin or are near a construction project area;
- Construct sound walls or other noise reduction measures prior to developing the project site;
- Prohibit unnecessary idling of internal combustion engines;
- Utilize "quiet" air compressors and other stationary noise sources where technology exists;
- The contractor shall prepare a detailed construction plan identifying the schedule for major noise-generating construction activities. The construction plan shall identify a procedure for coordination with nearby residential land uses so that construction activities can be scheduled to minimize noise disturbance.

Implementation of the above measures would reduce this impact to a **less-than-significant** level.

Construction Noise Mitigation Measure: None required.

TABLE 6 Estimated Construction Noise Levels at Nearby Land Uses

Phase of Construction	Time Duration (no. of days)	Construction Equipment (Quantity)	Calculated Hourly Average Noise Levels, L_{eq} (dBA)		
			Residential East (180 ft)	Residential North and South (215 ft)	Residential West (230 ft)
Site Preparation	3	Grader (1)	70	68	68
Grading & Excavation	78	Excavator (1) Rubber-Tired Dozer (1) Tractor/Loader/Backhoe (1)	70	68	68
Trenching & Foundation	4	Tractor/Loader/Backhoe (1)	62	61	60
Building Exterior	200	Crane (2) Forklift (1) Generator Set (1) Tractor/Loader/Backhoe (1)	70	68	68
Building Interior & Architectural Coating	10	Air Compressor (2)	66	64	63
Paving	10	Cement and Mortar Mixers (1) Paving Equipment (1) Roller (1)	68	66	66

All distances are relative to the approximate center of construction at the project site.

Construction Vibration Impacts

The City of Gilroy does not specify a construction vibration limit. For structural damage, Caltrans recommends a vibration limit of 0.5 in/sec PPV for buildings structurally sound and designed to modern engineering standards, 0.3 in/sec PPV for buildings that are found to be structurally sound but where structural damage is a major concern, and a conservative limit of 0.25 in/sec PPV for historic and some old buildings (see Table 3). The 0.3 in/sec PPV vibration limit would be applicable to properties in the vicinity of the project site. Based on a search with the City of Gilroy Historic Resources Inventory, historic buildings were not identified to be within 1,000 feet of the project site.

Construction activities often generate perceptible vibration levels and levels that could affect nearby structures when heavy equipment or impact tools (e.g., jackhammers, pile drivers, hoe rams) are used in the vicinity of nearby sensitive land uses. Building damage generally falls into three categories. 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.

Table 7 presents typical vibration levels from construction equipment at 25 feet. Vibration levels would vary depending on soil conditions, construction methods, and equipment used. Table 7 also presents construction vibration levels at representative distances from the construction equipment located at the closest property line to the nearest structures. 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.

TABLE 7 Vibration Source Levels for Construction Equipment

Equipment	PPV (in/sec)					
	Reference at 25 ft.	Residential Building East 5 ft.	Residential Building North 30 ft.	Residential Buildings West 60 ft.	Residential Building South 225 ft.	
Clam shovel drop	0.202	1.186	0.165	0.077	0.018	
Hydromill (slurry wall)	in soil	0.008	0.047	0.007	0.003	0.001
	in rock	0.017	0.100	0.014	0.006	0.002
Vibratory Roller	0.210	1.233	0.172	0.080	0.019	
Hoe Ram	0.089	0.523	0.073	0.034	0.008	
Large bulldozer	0.089	0.523	0.073	0.034	0.008	
Caisson drilling	0.089	0.523	0.073	0.034	0.008	
Loaded trucks	0.076	0.446	0.062	0.029	0.007	
Jackhammer	0.035	0.206	0.029	0.013	0.003	
Small bulldozer	0.003	0.018	0.002	0.001	0.000	

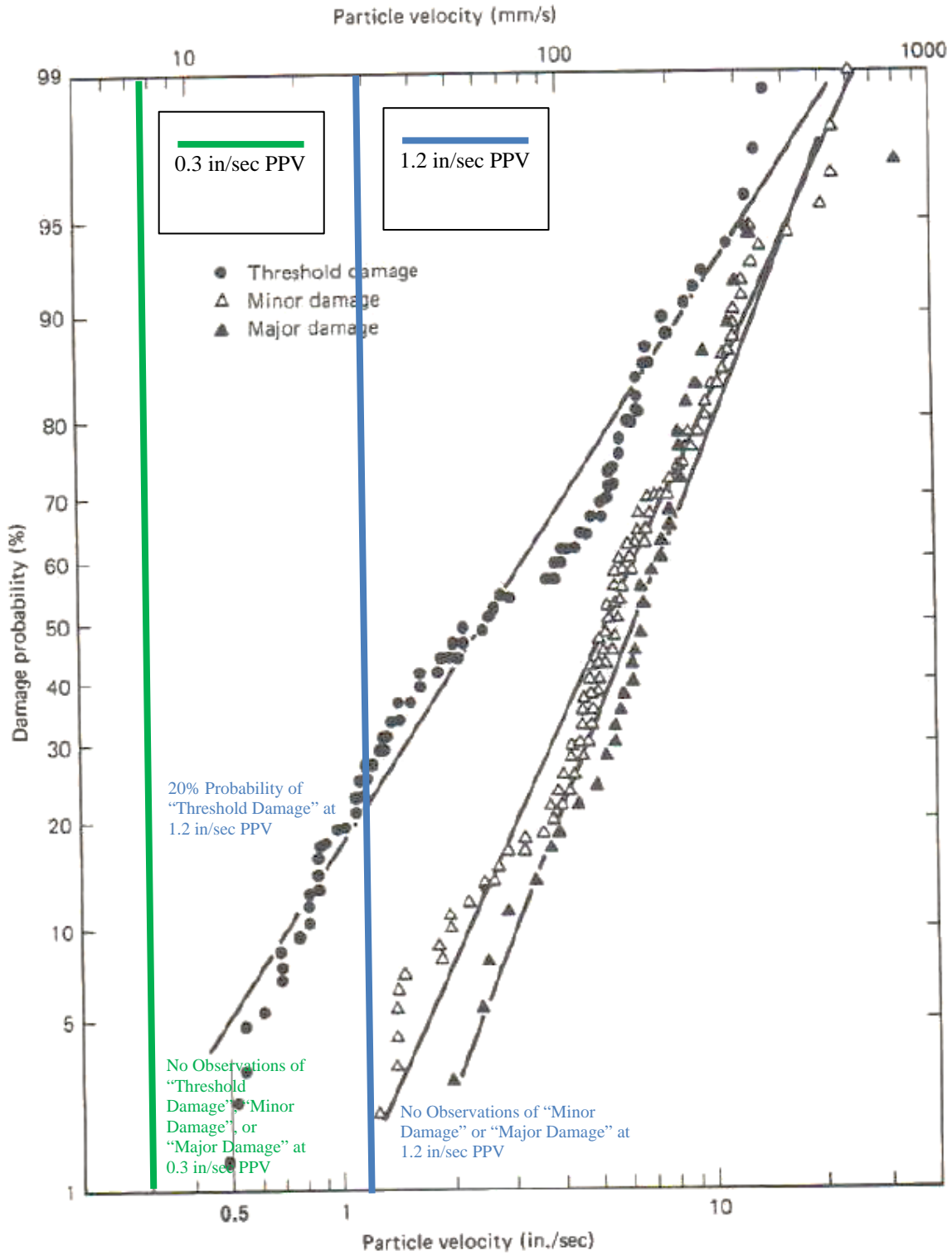
Source: Transit Noise and Vibration Impact Assessment Manual, Federal Transit Administration, Office of Planning and Environment, U.S. Department of Transportation, FTA Report No. 0123, September 2018, as modified by Illingworth & Rodkin, Inc., February 2021.

The US Bureau of Mines has analyzed the effects of blast-induced vibration on buildings in USBM RI 8507¹, and these findings have been applied to vibrations emanating from construction equipment on buildings². Figure 1 presents the damage probability as reported in USBM RI 8507 and reproduced by Dowding assuming a maximum vibration level of 1.2 in/sec PPV. As shown on Figure 1, these studies indicate a less than 20% probability of “threshold damage” (referred to as cosmetic damage elsewhere in this report) at vibration levels of 1.2 in/sec PPV or less and no observations of “minor damage” or “major damage” at vibration levels of 1.2 in/sec PPV or less. 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 buildings assuming a maximum vibration level of 1.2 in/sec PPV. Other buildings of normal conventional construction located 30 to 225 feet from the project site would not be exposed to vibration levels exceeding the 0.3 in/sec PPV. Based on the data summarized in Figure 1, there were no observations of “threshold damage”, “minor damage”, or “major damage” at buildings of normal conventional construction when vibration levels were 0.3 in/sec PPV or less.

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.

FIGURE 1 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., February 2021.

As indicated in Table 7, heavy construction located within 20 feet of structures would have the potential to exceed the California Department of Transportation's recommended limit of 0.3 in/sec PPV at the nearest buildings to the east when construction activities are occurring along the shared property lines. Construction vibration levels would decrease as construction activities move towards the interior of the site. This is a potentially significant impact.

Construction Vibration Mitigation Measure:

The following measures shall be implemented where vibration levels due to construction activities would exceed 0.30 in/sec PPV at the nearby buildings east of the project site:

- Prohibit the use of heavy vibration-generating construction equipment within 20 feet of adjacent buildings.
- Use a smaller vibratory roller, such as the Caterpillar model CP433E vibratory compactor, when compacting materials within 20 feet of adjacent buildings. Only use the static compaction mode when compacting materials within 10 feet of 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 20 feet of adjacent buildings.
- The contractor shall alert heavy equipment operators to the close proximity of the adjacent structures so they can exercise extra care.
- 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 a potential impact to a less-than-significant level.