1050 ST. ELIZABETH DRIVE CONSTRUCTION NOISE & VIBRATION ASSESSMENT

San José, California

July 21, 2022

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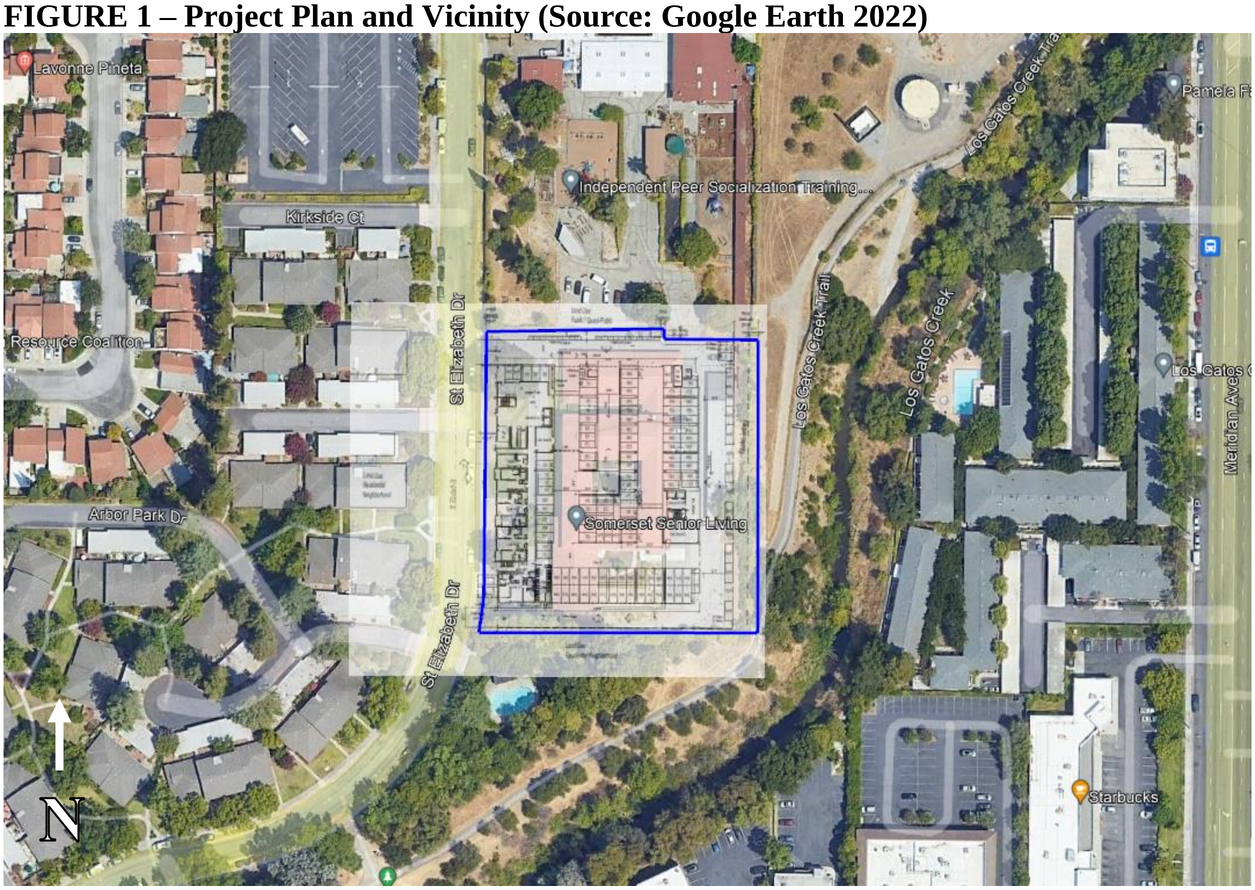
INTRODUCTION

This report summarizes the assessment of potential construction noise and vibration impacts due to the proposed residential development located at 1050 St. Elizabeth Drive in San José, California. A summary of the proposed project, a setting section that includes fundamentals of environmental noise and ground-borne vibration, 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 is presented in the sections below.

PROJECT DESCRIPTION

The 2.2-acre project site is currently occupied with an existing two-story, 28,223-square-foot (sf) senior housing facility and associated parking lot. The project proposes to demolish the existing improvements and construct a seven-story multi-family apartment building with 206 residential units. Parking would be provided through a combination of 16 surface parking spaces at the rear of the project site and 295 spaces within one level of below-grade parking and two levels of podium parking for a combined total of 311 parking spaces. The project would also include a 225-kilowatt (kW) emergency back-up generator powered by a 302-horsepower (HP) diesel engine located in the northeast corner of the project site. Figure 1 shows a Google Earth snapshot of the project plan and vicinity.

FIGURE 1 – Project Plan and Vicinity (Source: Google Earth 2022)



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

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.

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

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	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, April 2020.

REGULATORY BACKGROUND

Regulatory Background - Noise & Vibration

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.

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.

***San José Zoning Code*:** The City of San José Zoning Code establishes allowable construction hours in the vicinity of residential properties.

20.100.450 A. Hours of Construction Within 500 Feet of a Residential Unit- Unless otherwise expressly allowed in a development permit or other planning approval, no applicant or agent of an applicant shall suffer or allow any construction activity on a site located within 500 feet of a residential unit before 7:00 a.m. or after 7:00 p.m., Monday through Friday, or at any time on weekends.

EXISTING NOISE ENVIRONMENT

The project site is located at 1050 St. Elizabeth Drive in the City of San José. Residential land uses border the site to the west (across St. Elizabeth Drive) and the east (across Los Gatos Creek). The Morgan Autism Center (Special Education School) borders the site to the north and commercial uses are located to the south of the site across the Los Gatos Creek.

The noise environment at the site and surrounding areas consists primarily of limited local vehicular traffic along St. Elizabeth Drive, with other contributing noise sources including occasional aircraft flyovers associated with Mineta San José International Airport.

A noise monitoring survey consisting of two long-term (LT-1, LT-2) and two short-term (ST-1, ST-2) measurements was conducted at the site between Tuesday, November 29, 2022, and Wednesday, November 30, 2022. All measurement locations are shown in Figure 2. Long term noise monitoring data is provided in Appendix A.

Long-term noise measurement LT-1 was made at the Los Gatos Creek Trail towards the southeast of the project site to represent typical ambient noise levels near residences located across the Los Gatos Creek. Hourly average noise levels at LT-1 typically ranged from 47 to 55 dBA L_{eq} during daytime hours (7:00 a.m. and 10:00 p.m.) and from 46 to 54 dBA L_{eq} during nighttime hours (10:00 p.m. and 7:00 a.m.). The day-night average noise levels were 56 dBA DNL during the 24-hour measurement period between Tuesday, November 29, 2022, to Wednesday, November 30, 2022.

Long-term noise measurement LT-2 was made at St. Elizabeth Drive towards the west of the site to represent typical ambient noise levels in the vicinity of residential uses. Hourly average noise levels at LT-2 typically ranged from 56 to 63 dBA L_{eq} during daytime hours (7:00 a.m. and 10:00 p.m.) and from 48 to 57 dBA L_{eq} during nighttime hours (10:00 p.m. and 7:00 a.m.). The day-night average noise levels were 62 dBA DNL during the 24-hour measurement period between Tuesday, November 29, 2022, to Wednesday, November 30, 2022.

The noise measurement survey also included two short-term measurements (ST-1, ST-2). Results for these measurements are summarized in Table 4 below.

FIGURE 2 Aerial Image of the Project Site and Surrounding Area, with the Noise Measurement Locations Identified

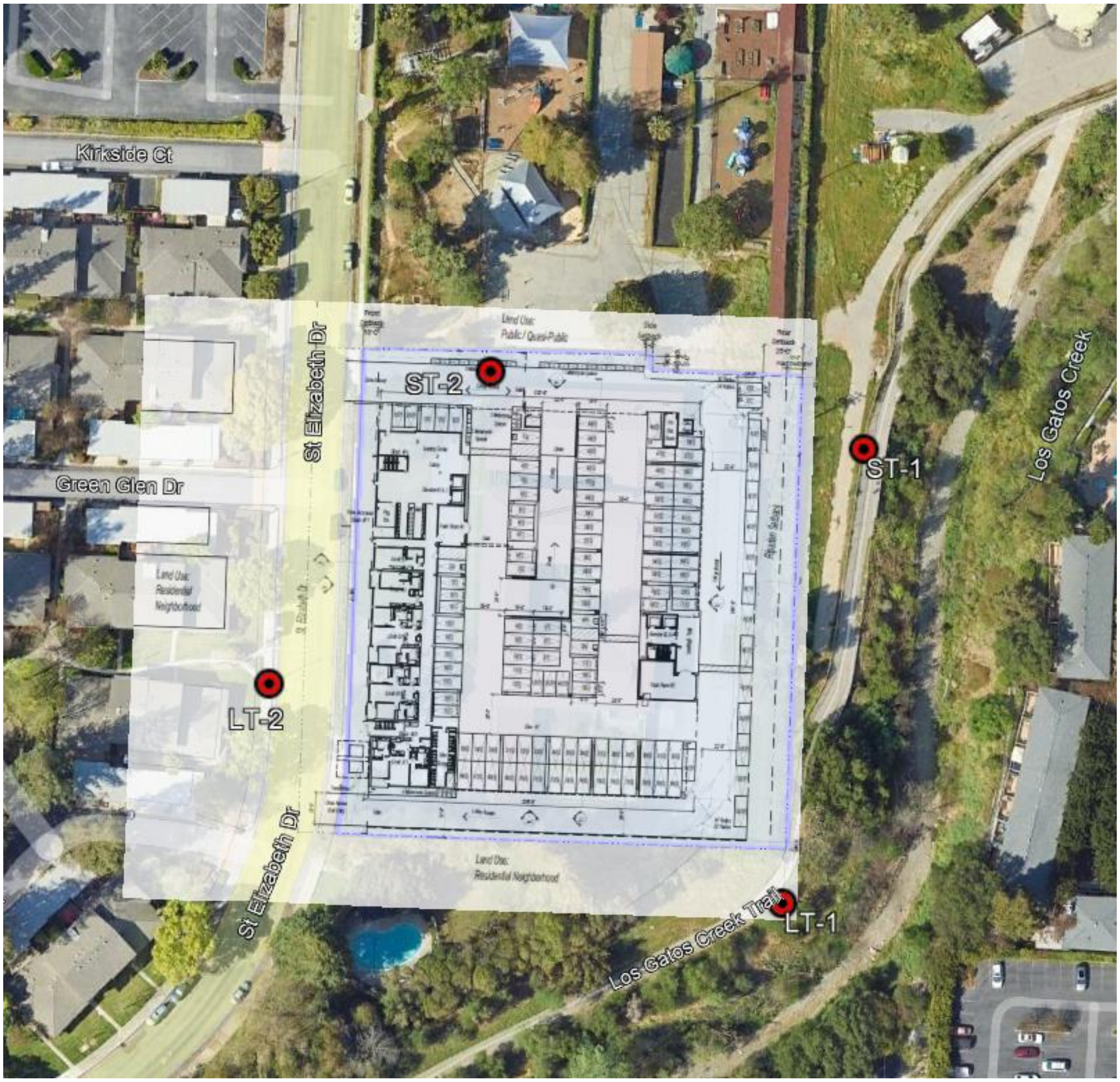


TABLE 4 Summary of Short-Term Noise Measurements (dBA)

Noise Measurement Location	Date, Time	Measured Noise Level, dBA					
		L_{max}	$L_{(1)}$	$L_{(10)}$	$L_{(50)}$	$L_{(90)}$	L_{eq}
ST-1: Bike trail to the east at Los Gatos Creek	11/29/2022, 10:40-10:50	53	52	48	45	44	46
ST-2: ~110 feet from the centerline of St. Elizabeth Dr. towards the north of project site	11/29/2022, 11:00-11:10	61	59	55	48	42	51

IMPACTS

Construction Noise Impacts

Policy EC-1.7 of the City's General Plan requires that all construction operations within the City to use best available noise suppression devices and techniques and to limit construction hours near residential uses per the Municipal Code allowable hours, which are between the hours of 7:00 a.m. and 7:00 p.m. Monday through Friday when construction occurs within 500 feet of a residential land use. Further, the City considers significant construction noise impacts to occur if a project that is 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.

However, the City of San José does not establish noise level thresholds for construction activities. As an alternative, this analysis uses the noise limits established by the Federal Transit Administration (FTA) to identify the potential for impacts due to substantial temporary construction noise. The FTA identifies construction noise limits in the *Transit Noise and Vibration Impact Assessment Manual*.[1] During daytime hours, an exterior threshold of 80 dBA L_{eq} shall be enforced at residential land uses and 90 dBA L_{eq} shall be enforced at commercial and industrial land uses.

Construction activities generate varying levels of noise throughout the construction period. A list of typical maximum instantaneous noise levels measured at 50 feet are provided in Table 5. 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 residential housing projects are about 65 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 6.

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1 Federal Transit Administration, *Transit Noise and Vibration Impact Assessment Manual*, FTA Report No. 0123, September 2018.

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
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.

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

TABLE 6 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.

Project construction is expected to start mid May 2023 and the project would be built out over a period of approximately 21 months (to be completed by February 2025). The construction of the proposed project would involve demolition, grading/excavation, trenching/foundation, building – exterior, building interior and paving as per the supplied construction data sheet. During each stage of construction, there would be a different mix of equipment operating, and noise levels at nearby properties 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. The phases involving substantial noise generating activities such as demolition, grading/excavation, trenching/foundation, building-exterior, and paving phases would last approximately 317 days. Less intensive construction phases such as building-interior/architectural coating, which is a less intensive construction phase because it involves less heavy equipment and activities are primarily indoors, would last approximately 210 days. However, the building-interior/architectural coating phase would overlap with planned exterior phases over a period of about 5-6 months.

Standard methods for acoustical analysis of construction sites are based on the distance from the "acoustical center" or construction activity center of the site to the nearest noise-sensitive receptor, as was the case for this analysis. In other words, the proposed pieces of construction equipment are not modeled at the construction area boundary, but rather at the approximate center of the area in which most construction activity is likely to occur.

The nearest noise sensitive receptors are residences located along St. Elizabeth Drive to the west, a special education school to the north and residences across Los Gatos Creek to the east (shown in Figure 3) at distances ranging from approximately 220 to 400 feet from the “acoustical center”. Table 7 below presents the construction activities expected from the proposed project along with the respective noise levels calculated from each phase of construction at a distance of 50 feet and at the closest receptor R3 (220 feet away).

FIGURE 3 – Project site with nearest noise sensitive receptors (Source: Google Earth 2022)

The construction noise levels were calculated to range from 73 to 86 dBA L_{eq} at 50 feet, using FHWA’s Roadway Construction Noise Model (RCNM), which assumes that all the equipment could be operated simultaneously, for a worst-case scenario. At the closest residence (R3) located about 220 feet to the west (along St. Elizabeth Drive), hourly average noise levels are calculated to range from about 60 to 73 dBA L_{eq} (as shown in Table 7).

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.

TABLE 7 Total Calculated Noise Levels at 50 feet and closest affected receptor

Construction Phase	Equipment	Quantity	Total Calculated L_{eq} (dBA)	
			At 50 feet	Closest receptor (At 220 feet)
Demolition	Excavators	1	82	69
	Tractors/Loaders/Backhoes	1		
Grading/Excavation	Excavators	2	86	73
	Graders	1		
	Tractors/Loaders/Backhoes	2		
Trenching/Foundation	Tractors/Loaders Backhoes	1	80	67
Building - Exterior	Cranes	1	81	68
	Forklifts	2		
	Tractors/Loaders/Backhoes	1		
Building - Interior/Architectural Coating	Aerial Lift	3	73	60
Paving	Pavers	1	82	70
	Paving Equipment	1		
	Rollers	1		
	Tractors/Loaders/Backhoes	1		

As shown in Table 7, construction noise levels would produce noise levels that would intermittently range from 73 to 86 dBA L_{eq} when activities occur approximately 50 feet from nearby receptors and produce noise levels that would typically range from 60 to 73 dBA L_{eq} when focused near the center of the project site. The ambient noise levels measured in the vicinity of the nearest receptor typically ranged from 56 to 63 dBA L_{eq} during daytime hours as discussed in the previous section. Comparing noise levels from construction activities to the existing ambient noise levels, a substantial temporary increase in noise levels can be observed in the vicinity of the project site. Construction noise levels during the grading/excavation phase would exceed the exterior threshold of 80 dBA L_{eq} when the activities occur within 100 feet. Much of the noise emanating from heavy equipment is at or near ground level.

Since project construction would last for a period of more than one year and considering that the project site is within 500 feet of existing residential uses and within 200 feet of existing commercial uses, this temporary construction impact would be considered **significant** in accordance with Policy EC-1.7 of the City's General Plan.

Mitigation Measure : Pursuant to General Plan Policy EC-1.7, a construction noise logistics plan shall be prepared 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. Project construction operations shall use best available noise suppression devices and techniques including, but not limited to the following:

- Limit construction hours to 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. 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 PBCE that the construction noise mitigation plan is adequate to prevent noise disturbance of affected residential uses.
- Construct solid plywood fences or similar adjacent to noise-sensitive land uses. A temporary 8-foot noise barrier shall be constructed along the north, west, and south property line of the project site to shield adjacent noise-sensitive land uses from ground-level construction equipment and activities. The noise barrier shall be solid over the face and at the base of the barrier in order to provide a 6 dBA noise reduction.
- Equip all internal combustion engine-driven equipment with intake and exhaust mufflers that are in good condition and appropriate for the equipment.
- Prohibit unnecessary idling of internal combustion engines.
- 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.
- 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.
- Notify noise-sensitive land uses of the construction schedule in writing.
- 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.
- 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 current the problem. Conspicuously post a telephone number for the disturbance coordinator at the construction site and include it in the notice sent to neighbors regarding the construction schedule.

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

Construction Vibration Impacts

Proposed construction phases would include demolition, grading/excavation, trenching/foundation, building exterior, building interior/architectural coating and paving. Perceptible vibration may occur when heavy equipment or impact tools are used in close proximity to sensitive receptors. However, the proposed project would not require pile driving, which can cause excessive vibration.

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.

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 structures nearby according to the San José Historic Resource Inventory. Vibration levels would vary depending on soil conditions, construction methods, and equipment used. 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 8 presents typical vibration levels that could be expected from construction equipment at 25 feet and summarizes the expected vibration levels at residences bordering the site, the closest being 75 feet away from the project site. At this distance (75 feet), vibration levels due to construction are conservatively calculated to reach up to 0.06 in/sec PPV for a clam shovel drop and up to 0.063 in/sec PPV for a vibratory roller, which would be well below the 0.2 in/sec PPV threshold for conventional buildings.

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 8) 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 US Bureau of Mines has analyzed the effects of blast-induced vibration on buildings in USBM RI 8507,[2] and these findings have been applied to vibrations emanating from construction equipment on buildings.[3] Figure 4 presents the damage probability, as reported in USBM RI 8507 and reproduced by Dowding, assuming a maximum vibration level expected from the project (0.063 in/sec PPV). Based on the data summarized in Figure 4, the projected vibration levels would be below the "threshold damage," "minor damage," or "major damage" at buildings of normal conventional construction when vibration levels were 0.063 in/sec PPV or less.

Project-generated vibration levels would fall below the 0.2 in/sec PPV structural damage threshold at all surrounding residential buildings beyond 26 feet for all equipment including vibratory rollers and clam shovel drops. 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, perceptible vibration can be kept to a minimum.

TABLE 8 Construction Vibration Levels at Nearby Buildings

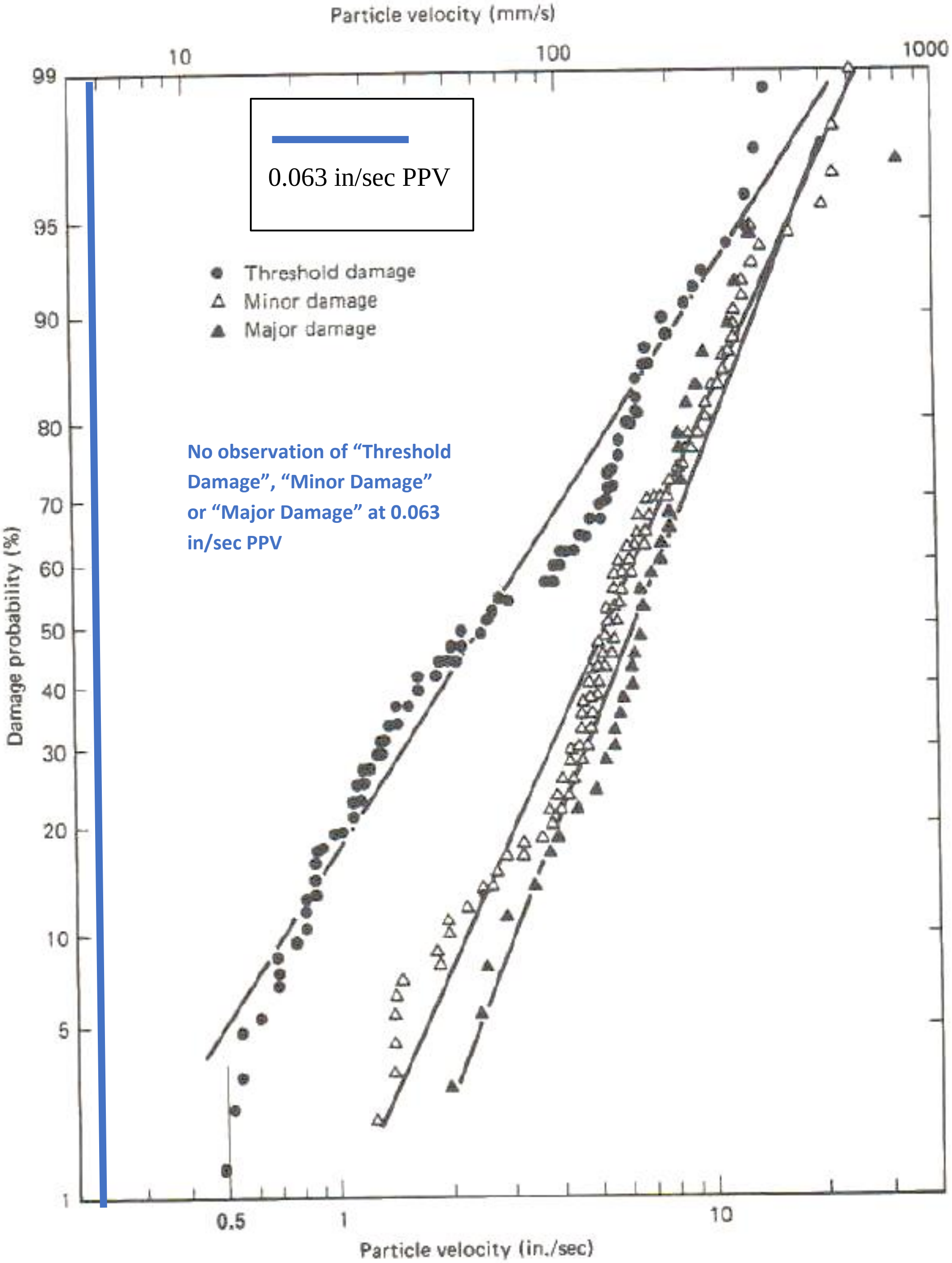
Equipment		PPV (in/sec)	
		Source Level (25 ft)	West Residences (75 ft)
Clam shovel drop		0.202	0.060
Hydromill (slurry wall)	in soil	0.008	0.002
	in rock	0.017	0.005
Vibratory Roller		0.210	0.063
Hoe Ram		0.089	0.027
Large bulldozer		0.089	0.027
Caisson drilling		0.089	0.027
Loaded trucks		0.076	0.023
Jackhammer		0.035	0.010
Small bulldozer		0.003	0.001

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 2022.

3 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.

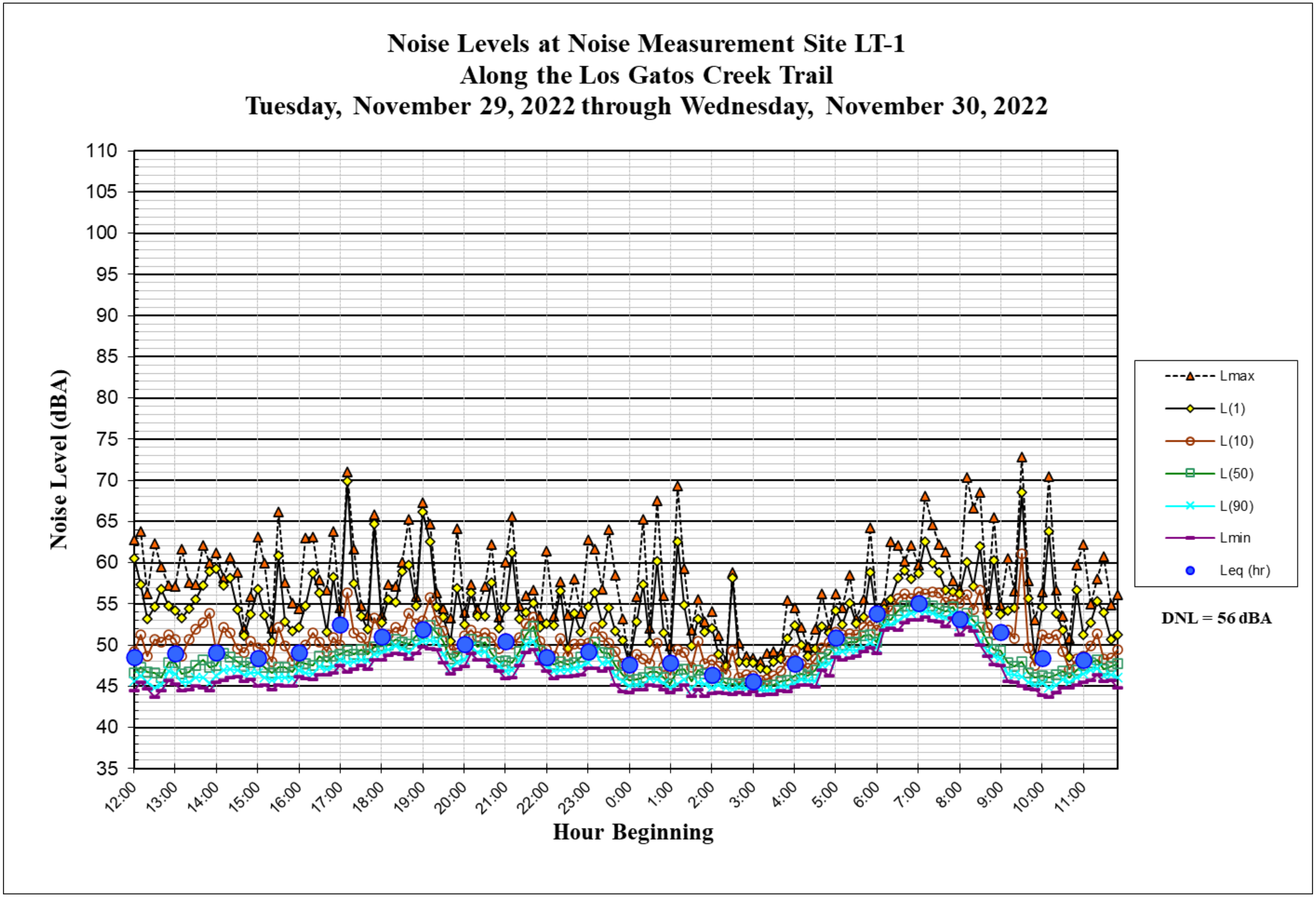
3 Dowding, C.H., Construction Vibrations, Prentice Hall, Upper Saddle River, 1996.

FIGURE 4 Probability of Cracking and Fatigue from Repetitive Loading

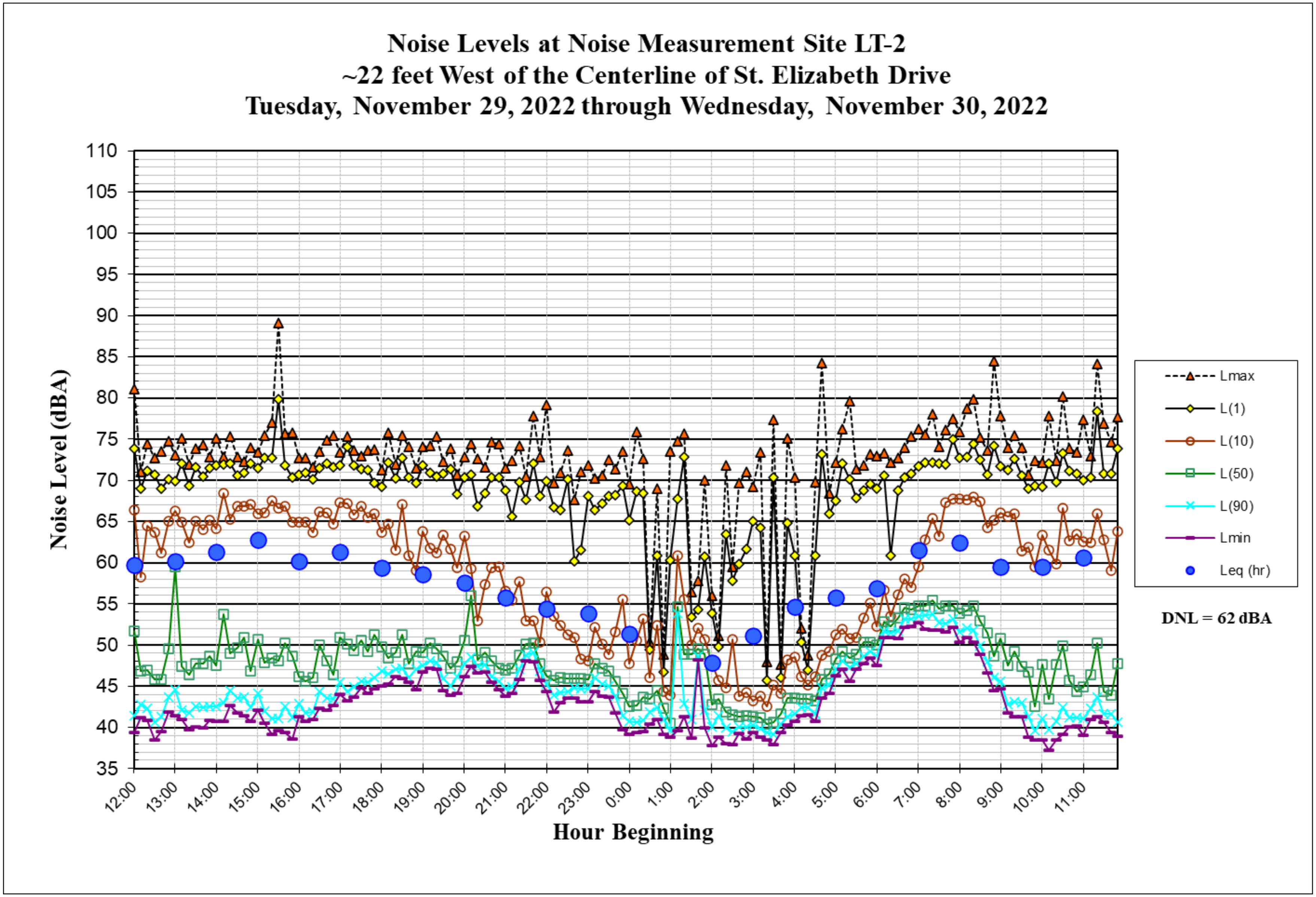


Source: Dowding, C.H., Construction Vibrations, Prentice Hall, Upper Saddle River, 1996 as modified by Illingworth & Rodkin, Inc., March 2022.

Appendix A – Long-Term Noise Data



Noise Levels at Noise Measurement Site LT-1
Along the Los Gatos Creek Trail
Tuesday, November 29, 2022 through Wednesday, November 30, 2022
Noise Level (dBA)
110
105
100
95
90
85
80
75
70
65
60
55
50
45
40
35
12:00
13:00
14:00
15:00
16:00
17:00
18:00
19:00
20:00
21:00
22:00
23:00
0:00
1:00
2:00
3:00
4:00
5:00
6:00
7:00
8:00
9:00
10:00
11:00
Hour Beginning
Lmax
L(1)
L(10)
L(50)
L(90)
Lmin
Leq (hr)
DNL = 56 dBA



Noise Levels at Noise Measurement Site LT-2
~22 feet West of the Centerline of St. Elizabeth Drive
Tuesday, November 29, 2022 through Wednesday, November 30, 2022
Noise Level (dBA)
110
105
100
95
90
85
80
75
70
65
60
55
50
45
40
35
12:00
13:00
14:00
15:00
16:00
17:00
18:00
19:00
20:00
21:00
22:00
23:00
0:00
1:00
2:00
3:00
4:00
5:00
6:00
7:00
8:00
9:00
10:00
11:00
Hour Beginning
Lmax
L(1)
L(10)
L(50)
L(90)
Lmin
Leq (hr)
DNL = 62 dBA