HAYWARD PARK RESIDENTIAL NOISE AND VIBRATION ASSESSMENT

San Mateo, California

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INTRODUCTION

The project proposes to develop 191 apartment homes north of Concar Drive and east of the Hayward Park Caltrain station in San Mateo, California. The apartments would be in a four-story wood-frame building constructed on a concrete podium over one level of parking. This study evaluates the significance of the project's noise and vibration impacts with respect to applicable California Environmental Quality Act (CEQA) guidelines. The report is divided into three sections: 1) the Setting Section provides a brief description of the fundamentals of environmental noise and vibration, summarizes applicable regulatory criteria, and discusses the results of the ambient noise and vibration monitoring surveys completed to document existing conditions; 2) the General Plan Consistency Section discusses noise/vibration and land use compatibility utilizing applicable policies in the City's General Plan and Federal Transit Administration (FTA) Guidance; and, 3) the Impacts and Mitigation Measures Section describes the significance criteria used to evaluate project impacts, provides a discussion of each project impact, and presents mitigation measures, where necessary, to provide a compatible project in relation to adjacent noise sources and land uses.

SETTING

Fundamentals of Environmental Noise

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

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

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

This *energy-equivalent sound/noise descriptor* is called L_{eq}. The most common averaging period is hourly, but L_{eq} can describe any series of noise events of arbitrary duration.

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

Since the sensitivity to noise increases during the evening and at night -- because excessive noise interferes with the ability to sleep -- 24-hour descriptors have been developed that incorporate artificial noise penalties added to quiet-time noise events. The *Community Noise Equivalent Level* (*CNEL*) is a measure of the cumulative noise exposure in a community, with a 5 dB penalty added to evening (7:00 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.

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 L_{dn}. Typically, the highest steady traffic noise level during the daytime is about equal to the L_{dn} 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 L_{dn} with open windows and 65-70 dBA L_{dn} 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 L_{dn} 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 L_{dn}. At a L_{dn} of about 60 dBA, approximately 12 percent of the population is highly annoyed. When the L_{dn} 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 L_{dn} of 60-70 dBA. Between a L_{dn} 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 L_{dn} 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 piledriving and vibratory compaction equipment typically generates the highest construction related groundborne vibration levels. Because of the impulsive nature of such activities, the use of the PPV descriptor has been routinely used to measure and assess groundborne vibration and almost exclusively to assess the potential of vibration to cause damage and the degree of annoyance for humans.

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

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

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

Railroad and light-rail operations are potential sources of substantial ground vibration depending on distance, the type and the speed of trains, and the type of railroad track. People's response to ground vibration has been correlated best with the average velocity of the ground. Because the net average of a vibration signal is zero, the Root-mean-square (RMS) amplitude is used to describe smoothed vibration amplitude. Although it is not universally accepted, vibration is commonly expressed in decibel notation using a reference velocity of 1×10^{-6} in./sec. RMS, which equals 0 VdB, and 1 in./sec. equals 120 VdB. The abbreviation "VdB" is used in this document for vibration decibels to reduce the potential for confusion with sound decibels.

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

TABLE 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.

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

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

Source: Transportation and Construction Vibration Guidance Manual, California Department of Transportation, April 2020.

TABLE 4 Typical Levels of Groundborne Vibration

Human/Structural Response	Velocity Level, VdB	Typical Events (50-foot setback)
Threshold, minor cosmetic damage for fragile buildings	100	Blasting from construction projects
		Bulldozers and other heavy tracked construction equipment
Difficulty with tasks such as reading a computer screen	90	
		Commuter rail, upper range
Residential annoyance, infrequent events	80	Rapid transit, upper range
Residential annoyance, occasional events		Commuter rail, typical Bus or truck over bump
Residential annoyance, frequent events	70	Rapid transit, typical
Limit for vibration sensitive equipment, Approximate threshold for human		Bus or truck, typical
	60	
		Typical background vibration
	50	

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

Regulatory Background

This section describes the relevant guidelines, policies, and standards established by The State of California, the City of San Mateo, and the Federal Transit Agency (FTA). The State CEQA Guidelines, Appendix G, are used to assess the potential significance of impacts pursuant to local General Plan policies, Municipal Code standards, or the applicable standards of other agencies. A summary of the applicable regulatory criteria is provided below.

2021 State CEQA Guidelines. The CEQA contains guidelines to evaluate the significance of effects of environmental noise attributable to a proposed project. Under CEQA, noise impacts would be considered significant if the project would result in:

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

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

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

Of these guidelines, items (a) and (b) are applicable to the proposed project. The project is not located in the vicinity of a public airport or private airstrip; therefore, checklist item (c) is not carried forward in this analysis.

2019 California Building Code, Title 24, Part 2. The current version of the California Building Code (CBC) requires interior noise levels attributable to exterior environmental noise sources to be limited to a level not exceeding 45 dBA L_{dn}/CNEL in any habitable room.

City of San Mateo General Plan 2030: The Noise Element of City of San Mateo's General Plan sets forth goals and policies regarding the control of environmental noise and protection of citizens from excessive noise exposure. The goals and policies relevant to this project are mentioned below:

Goal 1: Protect "noise sensitive" land uses from excessive noise levels.

<u>Policy N 1.1: Interior Noise Level Standard.</u> Require submittal of an acoustical analysis and interior noise insulation for all "noise sensitive" land uses listed in Table N-1 that have an exterior noise level of 60 dB (L_{dn}) or above. The maximum interior noise level shall not exceed 45 dB (L_{dn}) in any habitable rooms.

<u>Policy N1.2: Exterior Noise Level Standard.</u> Require an acoustical analysis for new parks, play areas and multi-family common open space (intended for the use of the enjoyment of residents) that have an exterior noise level of 60 dB (L_{dn}) or above. Require an acoustical analysis that uses peak hour L_{eq} for new parks and play areas. Require a feasibility analysis of noise reduction

measures for public parks and play areas. Incorporate necessary mitigation measures into residential project design to minimize common open space noise levels. Maximum exterior noise should not exceed 67 dB (L_{dn}) for residential uses and should not exceed 65 dB (L_{eq}) during the noisiest hour for public park uses.

TABLE N-1
NOISE SENSITIVE LAND-USE COMPATIBILITY GUIDELINES FOR COMMUNITY NOISE ENVIRONMENTS[1]
Day-Night Average Sound Level (L_{dn}), Decibels

Land-Use Category	Normally Acceptable[2]	Conditionally Acceptable[3]	Normally Unacceptable[4]
Single-Family Residential	50 to 59	60 to 70	Greater than 70
Multi-Family Residential	50 to 59	60 to 70	Greater than 70
Hotels, Motels, and Other Lodging Houses	50 to 59	60 to 70	Greater than 70
Long-Term Care Facilities	50 to 59	60 to 70	Greater than 70
Hospitals	50 to 59	60 to 70	Greater than 70
Schools	50 to 59	60 to 70	Greater than 70
Multi-Family Common Open Space Intended for the Use and Enjoyment of Residents	50 to 67	--	Greater than 67

TABLE N-2
NOISE GUIDELINES FOR OUTDOOR ACTIVITIES
Average Sound Level (L_{eq}), Decibels

Land Use Category	Normally Acceptable[2]	Conditionally Acceptable[3]	Normally Unacceptable[4]
Parks, Playgrounds	50 to 65*	--	Greater than 65*

[1] These guidelines are derived from the California Department of Health Services, Guidelines for the Preparation and Content of the Noise Element of the General Plan, 2030. The State Guidelines have been modified to reflect San Mateo's preference for distinct noise compatibility categories and to better reflect local land-use and noise conditions. It is intended that these guidelines be utilized to evaluate the suitability of land-use changes only and not to determine cumulative noise impacts. Land uses other than those classified as being "noise sensitive" are exempt from these compatibility guidelines.
[2] Normally Acceptable – Specified land use is satisfactory, based upon the assumption that any buildings involved are of normal conventional construction, without any special noise insulation requirements.
[3] Conditionally Acceptable – New construction should be undertaken only after a detailed analysis of the noise reduction requirement is conducted and needed noise insulation features included in the design.
[4] Normally Unacceptable – New construction should be discouraged. If new construction or development does proceed, a detailed analysis of the noise reduction requirements must be made and needed noise insulation features included in the design.
* Average Sound Level (Leq) for peak hour.

Goal 2: Minimize unnecessary, annoying and unhealthful noise.

Policy N2.1: Noise Ordinance. Continue implementation and enforcement of City's existing noise control ordinance: (a) which prohibits noise that is annoying or injurious to neighbors of normal sensitivity, making such activity a public nuisance, and (b) restricts the hours of construction to minimize noise impact.

Policy N2.2: Minimize Noise Impact. Protect all "noise-sensitive" land uses listed in Tables N-1 and N-2 from adverse impacts caused by noise generated on-site by new developments. Incorporate necessary mitigation measures into development design to minimize noise impacts. Prohibit long-term exposure increases of 3 dB (L_{dn}) or greater at the common property line, excluding existing ambient noise levels.

Policy N 2.3: Minimize Commercial Noise. Protect land uses other than those listed as "noise sensitive" in Table N-1 from adverse impacts caused by the on-site noise generated by new developments. Incorporate necessary mitigation measures into development design to minimize noise impacts. Prohibit new uses that generate noise levels of 65 dB (L_{dn}) or above at the property line, excluding existing ambient noise levels.

Policy N 2.4: Traffic Noise. Recognize projected increases in ambient noise levels resulting from traffic increases. Promote the installation of noise barriers along highways where "noise-sensitive" land uses listed in Table N-1 are adversely impacted by unacceptable noise levels [60 dB (L_{dn}) or above]. Require adequate noise mitigation to be incorporated into the widening of SR 92 and US 101. Accept noise increases on El Camino Real at existing development, and require new multi-family development to provide common open space having a maximum exterior noise level of 67 dB (L_{dn}).

Policy N 2.5: Railroad Noise. Promote the installation of noise barriers along the railroad corridor where "noise-sensitive" land uses are adversely impacted by unacceptable noise levels [60 dB (L_{dn}) or greater]. Promote adequate noise mitigation to be incorporated into any rail service expansion or track realignment. Study the need of depressing the rail line to eliminate at-grade crossings or other mitigation measures to decrease noise levels prior to substantial expansion of the rail service.

City of San Mateo Municipal Code: The Noise Regulations of the San Mateo Municipal Code, Chapter 7.30 are set forth to protect the inhabitants of the City against all forms of nuisances.

Section 7.30.040 Maximum Permissible Sound Levels. It is unlawful for any person to operate or cause to be operated any source of sound at any location within the city or allow the creation of any noise on property owned, leased, occupied or otherwise controlled by such person, which causes the noise level when measured on any other property to exceed:

(1) The noise level standard for that property as specified in Table 7.30.040 for a cumulative period of more than thirty minutes in any hour;
(2) The noise level standard plus five dB for a cumulative period of more than fifteen minutes in any hour;

(3) The noise level standard plus ten dB for a cumulative period of more than five minutes in any hour;
(4) The noise level standard plus fifteen dB for a cumulative period of more than one minute in any hour; or
(5) The noise level standard or the maximum measured ambient level, plus twenty dB for any period of time.

If the measured ambient level for any area is higher than the standard set in Table 7.30.040, then the ambient shall be the base noise level standard for purposes of this section. In such cases, the noise levels for purposes of subsections (2) through (5) of this section shall be increased in five dB increments above the ambient.

Table 7.30.040: Noise Level Standards

Noise Zone	Time Period	Noise Level, dBA
Noise Zone 1	10 p.m.--7 a.m.	50
	7 a.m.--10 p.m.	60
Noise Zone 2	10 p.m.--7 a.m.	55
	7 a.m.--10 p.m.	60
Noise Zone 3	10 p.m.--7 a.m.	60
	7 a.m.--10 p.m.	65
Noise Zone 4	Anytime	70

Section 7.30.060 Special Provisions e). Construction, alteration, repair, or land development activities authorized by a valid city permit shall be allowed at the following times:

- Weekdays: between 7:00 a.m. and 7:00 p.m.
- Saturdays: between 9:00 a.m. and 5:00 p.m.
- Sundays and Holidays: between 12:00 p.m. and 4:00 p.m.
- Or at other such hours as authorized or restricted by the permit, so long as they meet the following conditions:

    1. No individual piece of equipment shall produce a noise level exceeding 90 dBA at a distance of 25 feet. If the device is housed within a structure on the property, the measurement shall be made outside the structure at a distance as close to 25 feet as possible.
    2. The noise level outside of any point outside the property plane of the project shall not exceed 90 dBA.

Federal Transit Administration. The City of San Mateo has not identified quantifiable vibration limits that can be used to evaluate the compatibility of land uses with respect to vibration levels generated by railroad trains. Although there are no local standards for the allowable vibration in a new residential development, the FTA has developed vibration impact assessment criteria for evaluating vibration impacts associated with transit projects.[1] The FTA has proposed vibration impact criteria, based on maximum overall levels for a single event. The impact criteria for

[1]U.S. Department of Transportation, Federal Transit Administration, Transit Noise and Vibration Impact Assessment Manual, September 2018, FTA Report No. 0123.

vibration are shown in Table 5. Note that there are criteria for frequent events (more than 70 events of the same source per day), occasional events (30 to 70 vibration events of the same source per day), and infrequent events (less than 30 vibration events of the same source per day).

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

Land Use Category	GBV Impact Levels (VdB re 1 µinch/sec, RMS)		
	Frequent Events[1]	Occasional Events[2]	Infrequent Events[3]
Category 1 Buildings where vibration would interfere with interior operations.	65 VdB[4]	65 VdB[4]	65 VdB[4]
Category 2 Residences and buildings where people normally sleep.	72 VdB	75 VdB	80 VdB
Category 3 Institutional land uses with primarily daytime use.	75 VdB	78 VdB	83 VdB

1. "Frequent Events" is defined as more than 70 vibration events of the same source per day. Most rapid transit projects fall into this category.
2. "Occasional Events" is defined as between 30 and 70 vibration events of the same source per day. Most commuter trunk lines have this many operations.
3. "Infrequent Events" is defined as fewer than 30 vibration events of the same kind per day. This category includes most commuter rail branch lines.
4. This criterion limit is based on levels that are acceptable for most moderately sensitive equipment such as optical microscopes. For equipment that is more sensitive, a Detailed Vibration Analysis must be performed.
5. Vibration sensitive equipment is generally not sensitive to groundborne noise; however, the manufacturer's specifications should be reviewed for acoustic and vibration sensitivity.

Source: U.S. Department of Transportation, Federal Transit Administration, Transit Noise and Vibration Impact Assessment Manual, September 2018, FTA Report No. 0123.

Existing Noise and Vibration Environment

The project site is located adjacent to the Hayward Park Caltrain station with Concar Drive bordering the project to the south. State Route 92 (SR92) is about 200 feet away from the project site to the south. The primary sources of noise and vibration at the site are railroad trains along the adjacent rail line as well as vehicular traffic along SR92. Based on a review of the Caltrain schedule for the Hayward Park Station, about 104 Caltrain passenger trains travel along the rail line per weekday between 5:25 a.m. and 12:42 a.m. There are also unscheduled freight trains that utilize the rail line. The noise monitoring survey indicates that train passby's occurred as early as 5:20 a.m. each weekday. Noise and vibration monitoring locations are shown in Figures 1 and 2.

Noise Monitoring Survey

A noise monitoring survey was performed from Tuesday, January 11, 2022 through Friday, January 14, 2022. The survey included two long-term (LT) noise measurements and four short-term (ST) noise measurements to quantify existing ambient noise levels. Long-term noise measurement data is provided in Appendix A.

Measurement position LT-1 was located at the northern portion of the proposed site, about 105 feet from the center of the nearest railroad track. The primary noise sources at this location were trains traveling along the adjacent tracks. Trains typically generated maximum instantaneous noise levels of 81 to 104 dBA L_{max} at this location, with occasional trains generating maximum instantaneous noise levels as high as 110 dBA L_{max}. Trains sound their horns near the site and the higher noise levels are likely associated with closer soundings of the horn. Hourly average daytime noise levels, which included all train activity, ranged from 65 to 80 dBA L_{eq}. Nighttime noise levels during periods without train activity were as low as 51 dBA L_{eq}. The day-night average noise level at this location was calculated to be 73 to 74 dBA L_{dn}.

Measurement position LT-2 was situated on the southeast portion of the proposed site, about 60 feet from the center of Concar Drive, about 250 feet from SR92 and about 260 feet from the center of the nearest Caltrain track. The primary noise sources at this location were trains and vehicular traffic along Concar Drive and SR92. Maximum instantaneous noise levels from trains ranged from 80 to 100 dBA L_{max} at this location, with occasional trains generating maximum instantaneous noise levels as high as 103 dBA L_{max}. Hourly average daytime noise levels ranged from 64 to 74 dBA L_{eq}. Nighttime noise levels during periods without train activity were as low as 53 dBA L_{eq}. The day-night average noise level at this location was calculated to be 71 dBA L_{dn}.

Four short term noise measurements (ST-1 to ST-4) were conducted at the locations shown in Figure 1 to complete the noise survey at the project site. Table 6 summarizes the results of the short-term measurements.

FIGURE 1 Aerial Photo Showing Site and Noise Measurement Locations

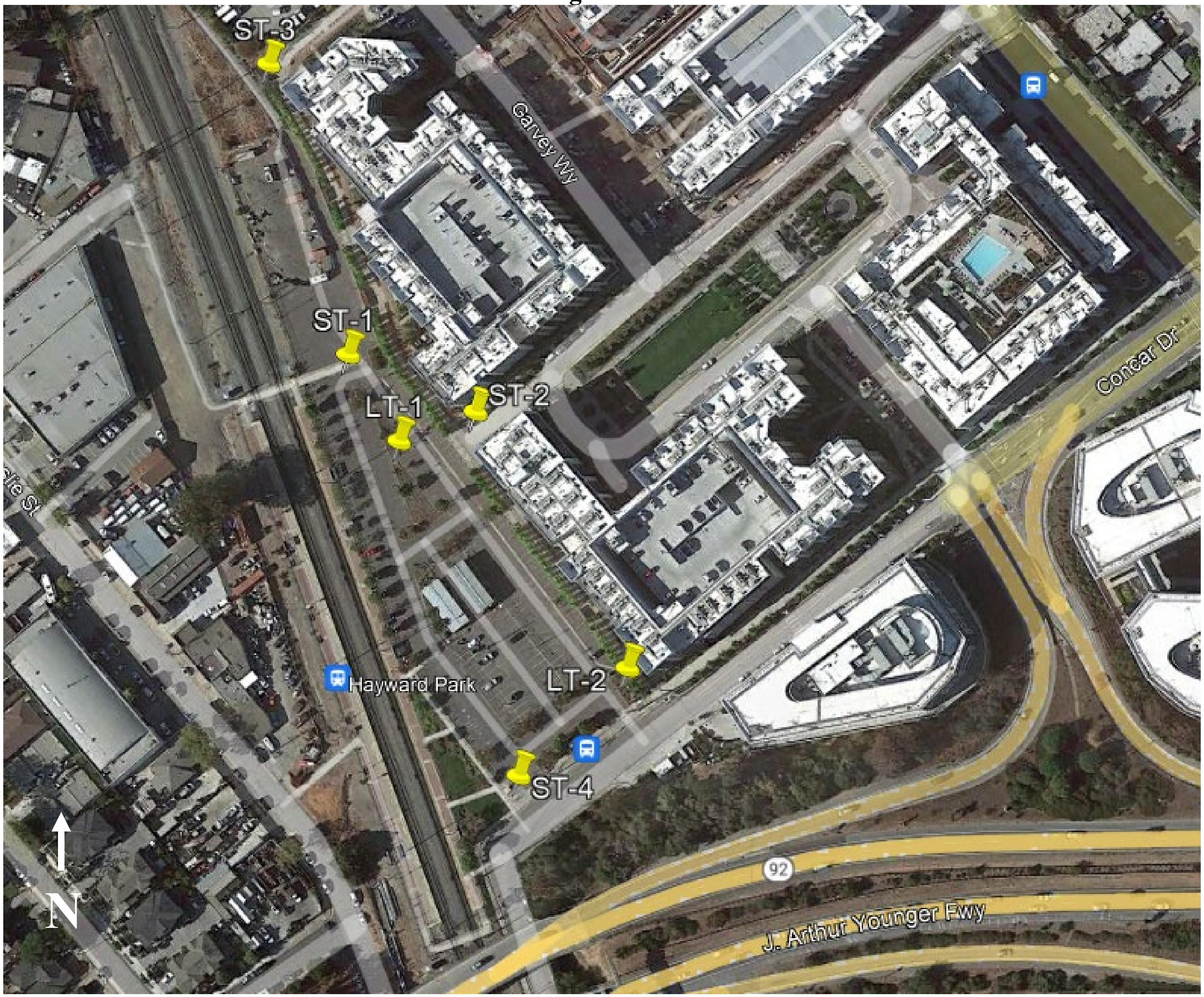


TABLE 6 Summary of Short-Term Noise Measurement Data, January 11, 2022

ID	Location (Date, Time)	Measured Noise Levels, dBA					Primary Noise Source
		L_1	L_{10}	L_{50}	L_{90}	L_{eq}	
ST-1	North of site, ~90 feet east of Caltrain railroad centerline (1/11/22, 10:40 a.m. to 10:50 a.m.)	82	60	53	50	69	Trains on Caltrain tracks
ST-2	East edge of site, ~200 feet east of Caltrain railroad centerline (1/11/22, 10:10 a.m. to 10:20 a.m.)	75	63	52	50	63	Trains and SR-92 traffic
ST-3	Northeast edge of site, ~115 feet east of Caltrain railroad centerline (1/11/22, 10:30 a.m. to 10:40 a.m.)	56	52	49	48	50	Ambient noise environment
ST-4	Southwest edge of site, ~170 feet away from SR-92	67	62	59	57	60	SR-92 traffic

Vibration Monitoring Survey

Observed and recorded vibration measurements of individual Caltrain passby's were conducted on January 11th, 2022 at a setback of 80 feet (V-1) from the center of the railroad track (Figure 2). The instrumentation used to conduct the measurements included a Roland R-05 solid state recorder and seismic grade, low noise accelerometers firmly fixed to the ground. This system is capable of accurately measuring very low vibration levels.

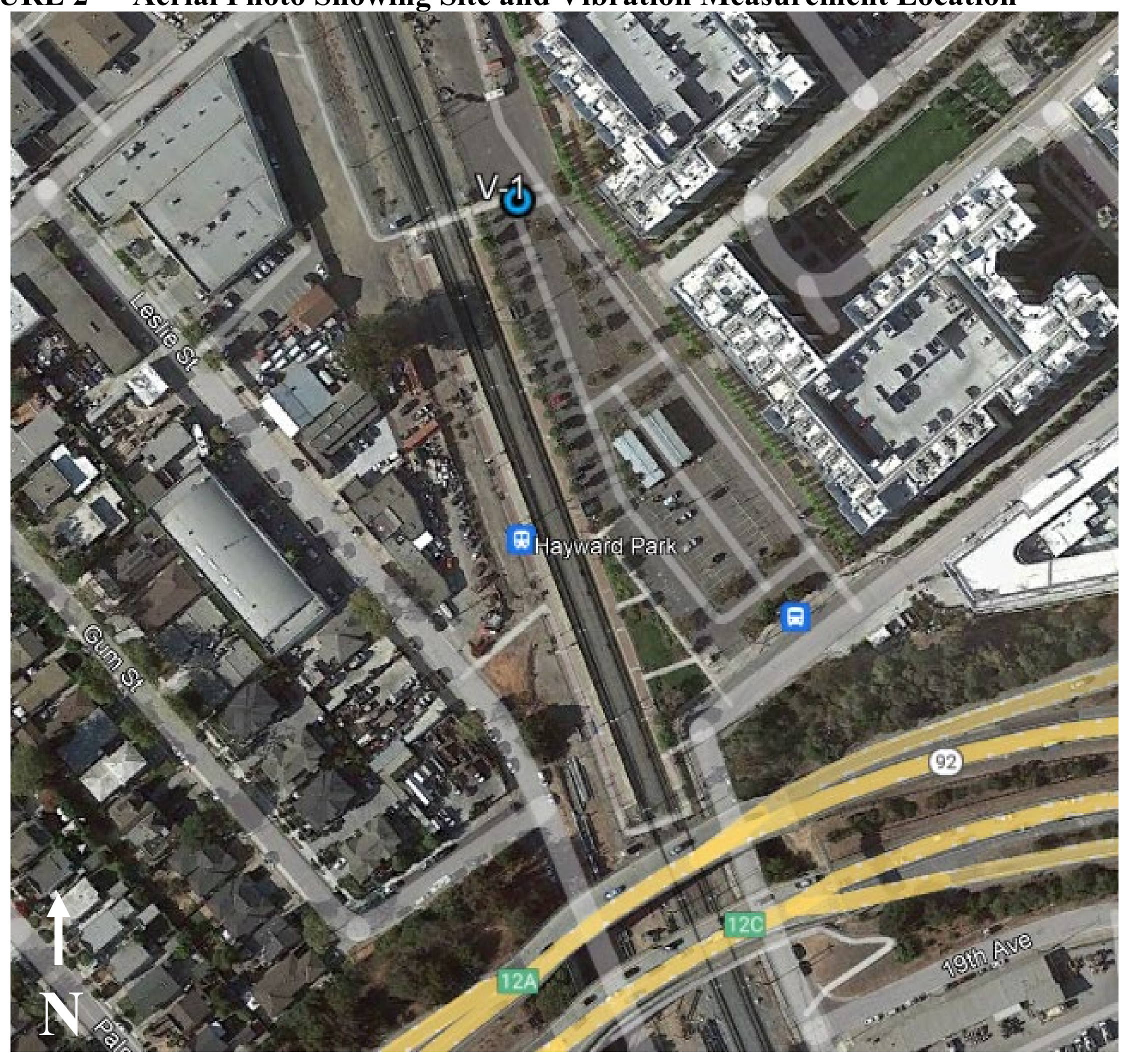
A total of ten (10) individual Caltrain passbys, including five (5) northbound (NB) and five (5) southbound (SB) passbys, were observed and recorded. Vibration levels were measured in the vertical axis because ground vibration is typically most dominant on this axis. Caltrain vibration levels ranged from approximately 57 to 73 VdB at a distance of 80 feet from the centerline of the tracks. Out of the 10 Caltrain passby measurements conducted, 5 were measured for trains that stopped at the adjacent train station while the remaining 5 measurements were conducted for trains that passed by the area without stopping (through-trains). The vibration levels for through-trains (trains 2,3,4,7,8) were observed to be higher than for trains that stopped at the station (trains 1,5,6,9,10). Overall vibration levels measured during train passby events are summarized in Table 7. Frequency spectra (1/3rd octave band) vibration levels for each passby event are provided in Appendix B.

TABLE 7 Results of Caltrain Vibration Measurements

#	Event	Maximum Overall Vibration Level (VdB re 1µinch/sec, RMS)
		Position V-1
1	SB Caltrain*	60 VdB
2	NB Caltrain	72 VdB
3	NB Caltrain	73 VdB
4	SB Caltrain	65 VdB
5	NB Caltrain*	68 VdB
6	SB Caltrain*	59 VdB
7	NB Caltrain	64 VdB
8	SB Caltrain	65 VdB
9	NB Caltrain*	58 VdB
10	SB Caltrain*	57 VdB

Notes: V-1: 70 feet from the center of the northbound tracks and 100 feet from the center of the southbound tracks.
RMS – root-mean-square.
* Stopped at Hayward Park station. Remaining trains passed through without stopping.

FIGURE 2 Aerial Photo Showing Site and Vibration Measurement Location



CONSISTENCY ANALYSIS – COMPATIBILITY OF PROJECT WITH NOISE AND VIBRATION

The impacts of site constraints such as exposure of the proposed project to excessive levels of noise and vibration are not considered under CEQA. This section addresses noise and land use compatibility for consistency with the policies set forth in the City's General Plan, and railroad train vibration with respect to FTA guidelines.

Noise and Land Use Compatibility

The Noise Element of the City of San Mateo 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. The applicable General Plan policies were presented in detail in the Regulatory Background section and are summarized below for the proposed project:

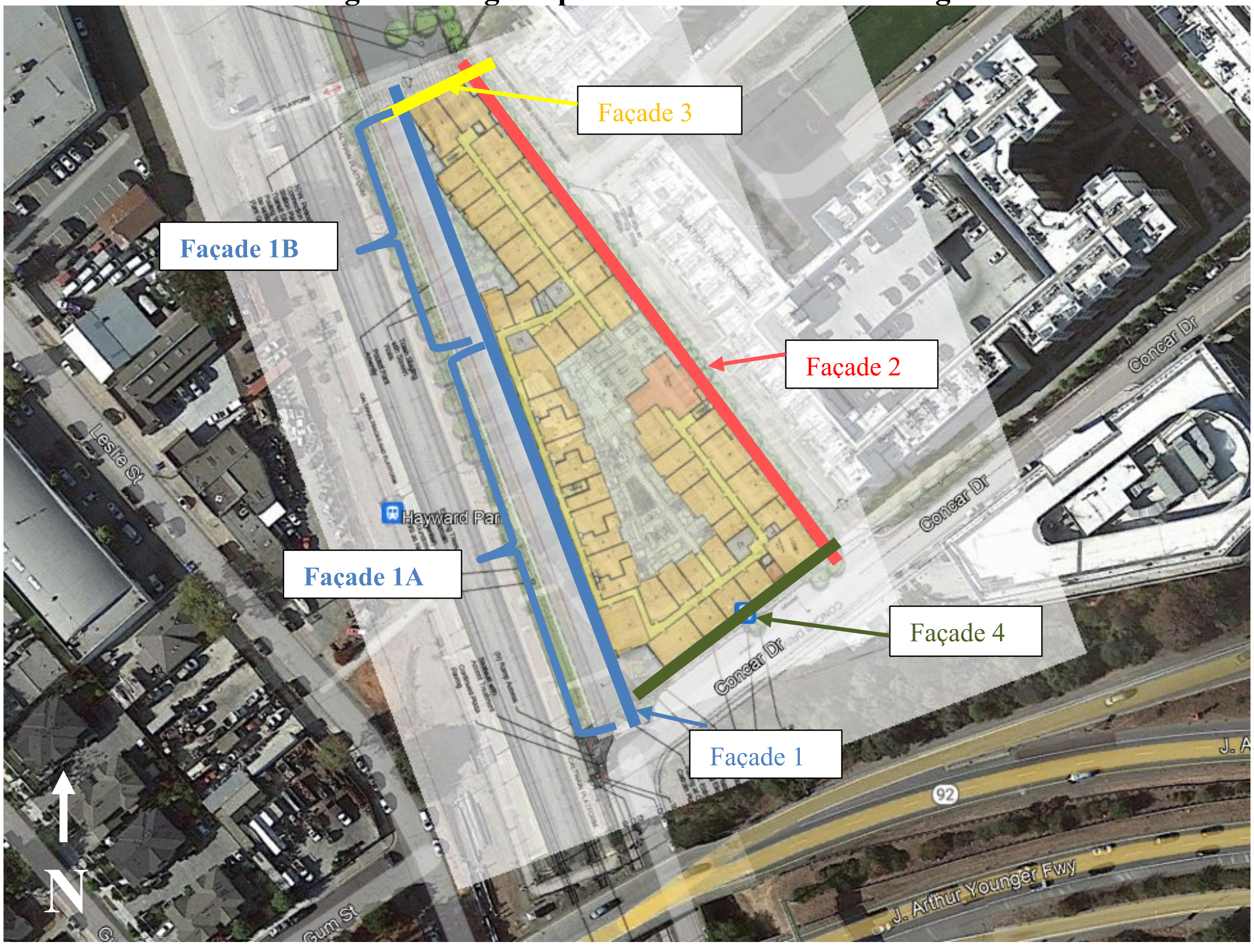
- The City's acceptable exterior noise level objective is 67 dBA L_{dn} or less for multi-family common open space intended for use and enjoyment of residents (N-1.2).

- The City's standard for interior noise levels in residences is 45 dBA L_{dn} (Policy N-1.1).

- ***Supplemental Annoyance and Sleep Disturbance:*** Though the City's policies are typically sufficient to achieve an acceptable interior noise environment with common environmental noise sources, when dealing with loud intermittent noise sources, such as the sounding of train horns near railroad tracks, the achievement of an L_{dn} of 45 dBA within homes may still result in maximum noise levels within interiors great enough to result in sleep disturbance and resident annoyance. Studies have been undertaken to determine the effect of short-term maximum noise levels on these issues. The conclusions of the studies related to the sleep disturbance and speech interference typically give a probability related to the maximum noise level of the event. A review of these data shows that **limiting typical maximum noise levels to 55 dBA** within bedrooms will minimize the probability of waking the future residents or interfering with conversation, tv, music etc.

Figure 3 shows an aerial view of the project site along with an overlay of the proposed project plans. Each façade of the proposed building is labelled and discussed in the sections below.

FIGURE 3 Aerial Image Showing Proposed Site Plan and Building Facades



Future Exterior Noise Environment

Existing average day-night noise levels at the site range from 71 to 74 dBA L_{dn}. Noise from trains travelling along the adjacent railroad tracks and traffic along SR92 are the main contributors to the noise environment as per the existing conditions and would continue to be the main contributors for the future noise environment in the area. The noise environment at the site would vary depending on the proximity and shielding of the receptor to the Caltrain tracks and the highway. An outdoor courtyard, a rooftop lounge and a pocket park are proposed as part of the project plans.

For the future exterior noise analysis in the sections below, it is assumed that the number of trains passing through the vicinity of the project site remains the same as existing since there is no trend or data suggesting an increase in frequency of trains passing through the area. Based on traffic volumes provided for the project[2], future traffic noise levels along local streets are anticipated to increase by approximately 1 dBA or less in the vicinity of the project site. Comparing existing and future noise contours[3] for SR92, the noise levels due to the highway are expected to increase by approximately 1 dBA at the project site.

[2] Kittelson & Associates – "San Mateo Hayward Park Station Traffic Impact Analysis – Traffic Volume Estimation Memorandum", January 20,2022.
[3] City of San Mateo General Plan – Noise Element: Existing and Future (2030) Noise Contours

Podium level outdoor courtyard (No façade exposure)
An outdoor courtyard would be located on the podium level. The courtyard is the primary outdoor use area associated with the project. The courtyard would be nearly completely enclosed by the building allowing the building itself to provide substantial acoustical shielding from train and traffic noise. The building would provide a minimum noise reduction of 15 dB resulting in a noise level of less than 60 dB Ldn for the outdoor courtyard, consistent with Policy N1.2 and falling with the City's "*normally acceptable*" noise and land use compatibility designation.

Rooftop lounge and roof deck (Facades 1B and 3)
The outdoor rooftop lounge and roof deck is shown on the north end of floor 5 (along Façade 3). This area would be exposed to a future day-night average noise level of 72 dBA L_{dn}. The building plans show a parapet wall with a glass barrier on top surrounding the roof deck (approximate height about 5 feet). The barrier is proposed to be high enough to provide about 5 dBA of noise reduction throughout most of the deck, resulting in a noise level of 67 dBA L_{dn}, consistent with Policy N1.2 and falling within the City's "*normally acceptable*" noise and land use designation .

Pocket Park (Along Façade 1B)
The Pocket Park is proposed adjacent to the Caltrain right-of-way. Measurements conducted for the existing conditions, adjusted for the distance of the Pocket Park from the train tracks, indicates a future day-night average noise level of 73 to 74 dBA L_{dn}, above the level established in Policy N1.2 and falling within the City's "*normally unacceptable*" noise and land use designation. It is not acoustically feasible to reduce exterior noise levels in the Pocket Park to meet the City's 67 dBA L_{dn} objective for multi-family common open space. The Pocket Park is a small percentage of the total outdoor common use areas and would likely be a place to meet or stay for short periods where elevated noise levels during train passbys would not be a significant detriment to the use of the area.

Private residential balconies (Façade 2)
Private residential balconies are only proposed on Façade 2, the side of the building oriented away from the railroad tracks and perpendicular to SR92. This orientation affords substantial acoustical shielding from train and traffic noise. The expected future day-night average noise level would range from 60 to 65 dBA Ldn, within the City's "*conditionally acceptable*" threshold of 60 to 70 dBA L_{dn}.

Future Interior Noise Environment

Interior noise levels within new multi-family residential units are required to be maintained at or below 45 dBA L_{dn} by City and State Standards; additionally, to minimize the potential for activity interference and sleep disturbance (as recommended above) typical maximum instantaneous noise levels from railroad operations should also be controlled to 55 dBA or less inside bedrooms and other living spaces within the proposed residences. A reasonable metric to apply the 55 dBA sleep disturbance criteria is to calculate the 70th percentile of all the L_{max} levels measured during railroad operations such as train horns. For this project, the 70th percentile of L_{max} noise levels recorded for train passby's is calculated to be 90 dBA.

The ground floor of the building would contain the enclosed parking garage, leasing office, a lounge area, and the gym while floors 2 to 5 would include residential uses. The future exterior noise exposure at residential façades throughout the site are shown in Table 8. Exterior to interior noise reduction would vary depending on the relative window to wall areas per room in the final design of the buildings and construction materials and methods. Standard residential construction provides approximately 15 dBA of exterior to interior noise reduction assuming the windows are partially open for ventilation. Standard construction with the windows closed provides approximately 20 to 25 dBA of noise reduction in interior spaces. The façade elements which contribute to the composite sound isolation of the assembly are the exterior wall assemblies themselves, along with significant openings/penetrations to the wall assembly, such as windows or exterior doors.

Considering these average façade noise losses, the following general observations can be made relative to exterior to interior noise control:

1. In noise environments with exterior façade noise exposures of 60 to 70 dBA L_{dn} and typical maximum noise levels from trains ranging from 70 to 80 dBA L_{max}, interior noise levels in residences would be considered acceptable with the incorporation of an adequate forced air mechanical ventilation system in each residential unit to allow occupants the option of keeping windows closed for noise control. (Highlighted in Blue in Table 8)

2. In noise environments of 70 to 80 dBA L_{dn} or greater and/or typical maximum noise levels from trains of 80 to 90 dBA L_{max} or greater, a combination of forced-air mechanical ventilation and sound-rated construction methods (typically windows with STC 30 to 40) would be required to meet the interior residential noise level limit. (Highlighted in Yellow in Table 8)

3. In noise environments exceeding 80 dBA L_{dn} and/or typical maximum noise levels exceeding 90 dBA L_{max}, the construction materials and techniques necessary to reduce interior noise levels to acceptable levels become more expensive and difficult to implement. Noise insulation features such as stucco-sided staggered-stud walls and high STC-rated windows and doors (STC 36 to 42) would likely be required in residential units and office uses. Units would also need to be equipped with a full heating and air-conditioning system because it is unlikely residents would open their windows for ventilation. (Highlighted in Red in Table 8)

As indicated in Table 8, interior facing residences and residences facing Station Park Green would meet the 45 dBA L_{dn} and 55 dBA L_{max} interior thresholds with forced air mechanical ventilation, allowing residences the option of keeping windows closed. Residences with façades facing SR92 and Concar Drive would meet the 45 dBA L_{dn} and 50 dBA L_{eq} thresholds with forced air mechanical ventilation and sound rated windows. However, to meet the 55 dBA L_{max} criteria for an individual train passby, high STC-rated windows and doors (STC 36 to 42) along with sound rated exterior walls will be needed. Residences with facades facing the adjacent railroad tracks (Façade 1, Figure 3) would require significant exterior to interior sound isolation and high STC rated windows and doors (STC 36 to 42) to meet the 45 dBA L_{dn}, and 55 dBA L_{max} thresholds. The high rated STC windows and doors would only be required for residences on Façade 1B since the residences on Façade 1A would benefit from shielding provided by a corridor between the exterior building wall and the units, as per the proposed building plans.

TABLE 8 Calculated Noise Levels at Proposed Exterior Façades

Receptor	Calculated Exterior Façade Exposure, dBA	
	L_{dn}/L_{eq}	L_{max}
Façade facing railroad (Façade 1)	74	82 to 105
Façade facing SR92 & Concar Drive (Façade 4, floors 4 & 5)	74	81 to 101
Façade facing SR92 & Concar Drive (Façade 4, floors 2 & 3)	72	81 to 101
Façade facing Station Park Green (Façade 2)	60-65	70 to 80
Façade facing Site Interior	<60	70 to 80

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

- Project-specific acoustical analyses are required by the state building code to confirm that interior noise levels in residences will be reduced to 45 dBA L_{dn} or lower. The specific determination of what treatments are necessary will be conducted on a unit-by-unit basis. Results of the analysis, including the description of the necessary noise control treatments, will be submitted to the City along with the building plans and approved prior to issuance of a building permit. Additional treatments should be considered to reduce the maximum noise level during a train passby to 55 dBA L_{max}.

- Building sound insulation requirements would need to include the provision of forced-air mechanical ventilation for units throughout the site so that windows could be kept closed at the occupant's discretion to control noise.

- Special building techniques (e.g., sound-rated windows and building facade treatments) may be required to maintain interior noise levels at or below acceptable levels. These treatments would include, but are not limited to, sound rated windows and doors, sound rated wall constructions, acoustical caulking, protected ventilation openings, etc. Preliminary calculations indicate that residential units would require sound rated windows and doors with ratings ranging from STC 28-42 to assure that the 45 dBA L_{dn} indoor standards are met.

Vibration and Land Use Compatibility

The FTA has developed vibration impact assessment criteria for evaluating vibration impacts associated with transit projects (see Table 5). About 104 Caltrain passenger trains travel along the rail line per weekday between 5:25 a.m. and 12:42 a.m. There are also a few unscheduled freight trains that utilize the rail line. Given the total number of trains the residential Category 2 'frequent event' impact level of 72 VdB would be appropriate for the proposed project. However, based on the results of the vibration survey and pursuant to FTA guidelines, it is appropriate to consider separating the trains into two groups, trains that stop at the station and through-trains that would include about half of the passenger trains and the freight trains. Under this assumption there would be between 50 and 60 trains in each group. Given this assumption, the residential Category 2 'occasional event' impact level of 75 VdB would be appropriate for the proposed project for both train groups.

As described in the Setting Section of this report, Caltrain vibration levels ranged from 57 to 73 VdB at the building setback (V-1). Of the ten trains measured, one train exceeded the 72 VdB threshold for a Category 2 and "frequent events" and none of the trains in either group exceeded the 75 VdB threshold for Category 2 land uses and "occasional events". A more detailed analysis of this vibration measurement was completed using the 1/3 octave band frequency spectra presented in Appendix B. The analysis shows that the 72 VdB threshold was not exceeded in any frequency band. Railroad train vibration at the proposed building location is therefore projected to be compatible with the residential use pursuant to the FTA guidelines.

NOISE IMPACTS AND MITIGATION MEASURES

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

Significance Criteria

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

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

    - Operational Noise in Excess of Standards. A significant noise impact would be identified if the project operations would generate noise levels that would exceed applicable noise standards presented in the San Mateo General Plan, Municipal Code and the Rail Corridor Plan FEIR[4].

    - Permanent Noise Increase. A significant permanent noise increase would be identified if traffic generated by the project or project improvements/operations would substantially increase noise levels at sensitive receivers in the vicinity. The City of San Mateo defines a substantial increase to occur if the noise level increase is 3 dBA L_{dn} or greater. (Policy N-2.2)

    - Temporary Noise Increases from Project Construction. A significant noise impact would be identified if temporary construction activities noise would cause a substantial increase in ambient noise levels at sensitive receptors. Large or complex projects involving substantial on-going noise-generating construction activities are considered significant when noise levels would exceed 80 dBA L_{eq} at residential land uses near the site or 90 dBA L_{eq} at

[4] San Mateo Rail Corridor Plan Environmental Impact Report dated February 17, 2004, State Clearing House Number: 2003042170

commercial land uses near the site for more than 12 months within the allowable workdays and work hours[5].

2. **<u>Generation of Excessive Groundborne Vibration.</u>** A significant impact would be identified if the construction of the project would expose persons to excessive vibration levels. Groundborne vibration levels exceeding 0.3 in/sec PPV would have the potential to result in cosmetic damage to normal buildings (see Table 3).

Impact 1: Temporary or Permanent Noise Increases in Excess of Established Standards. Project operations and traffic would not exceed the applicable noise thresholds or result in a substantial permanent noise level increase at existing noise-sensitive land uses in the project vicinity. However, existing noise-sensitive land uses would be exposed to construction noise levels in excess of the temporary increase significance thresholds for a period of more than one year. **This is a potentially significant impact.**

Operational Noise

Operational noise is limited to the levels specified in Table 7.30.040 of the City's Municipal Code, adjusted for ambient conditions. As described in the Setting Section, ambient daytime noise levels at adjacent properties are in the range of 64 to 80 dBA L_{eq}, with nighttime levels as low as 51 to 53 dBA L_{eq}. The adjusted operational noise limits based on the ambient levels measured would be 65 dBA L_{eq} during the daytime hours and 55 dBA L_{eq} during the nighttime hours.

The average day-night level at the project site ranges from 71 to 74 dBA L_{dn}.

<u>Operational Noise – Mechanical Equipment</u>

Multi-family dwelling buildings typically include various mechanical equipment such as air conditioners, exhaust fans, chillers, pumps, and air handling equipment. As per the client provided Updated Preliminary Concept Design (April 30, 2021), there are numerous HVAC condensers shown in the roof plan for the proposed building. No other mechanical equipment is detailed in this concept design plan. There are 40 HVAC condensers grouped near the closest residential receptor to the east (Station Park Green). The project design plan also indicates that the rooftop is about the same height as the roof of the adjacent Station Park Green building. The edge of the roof of the project building would provide a minimum 5 dBA reduction in noise levels between the noise generating HVAC units and the receptors.

Each unit generally produces a noise level ranging from 55 to 65 dBA at 5 feet. Assuming a credible worst-case scenario where all 40 units would be running simultaneously during daytime hours and 10 units running during the night, noise levels from HVAC units would range from 50 to 60 dBA during the daytime and 44 to 54 dBA during the nighttime hours at the Station Park

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

Green residences. The day night average noise level from mechanical equipment is calculated to be 62 dBA DNL.

Mechanical equipment noise would be lower than the range of existing noise levels measured during the daytime. During the night, ambient noise levels could be exceeded by up to 1 to 3 dBA. Noise from mechanical equipment would be below the adjusted operational noise limits of 65 dBA L_{eq} during the daytime hours and 55 dBA L_{eq} during the nighttime hours from the Municipal Code.

The proposed project would be subject to the Rail Corridor Plan FEIR mitigation measure Noise-CP2, which requires:

- All proposed developments, as feasible, shall specify equipment that meets the City's noise standard of 60 dB DNL at the nearest receptor without special enclosures or mufflers.
- Mechanical equipment shall be located as far away from nearby residential land uses as feasible.
- As necessary, a separate noise barrier or enclosure shall be constructed around mechanical equipment to block line-of-sight between the equipment and nearby residences.

Based on the calculated noise level of 62 dBA DNL for mechanical equipment, the noise level established by the Rail Corridor Plan FEIR would be exceeded by 2 dBA. This noise level is about 8 to 11 dBA lower than the existing measured ambient levels of 71 to 74 dBA L . The project proposes rooftop screens or perimeter parapet walls, noise control baffles, sound attenuators or enclosures as required for all rooftop mounted mechanical equipment that would provide additional shielding of about 5 to 10 dBA. These noise control treatments included in the proposed project result in a less-than-significant impact due to mechanical equipment.

<u>Operational Noise – Parking</u>

Most of the parking and all deliveries are expected to occur in the parking garage from the project driveway, located on the ground floor of the planned project building. Noise from the parking garage is not anticipated to be discernable from ambient noise levels at adjacent land uses. In addition to the parking garage, a surface parking lot located towards the rear (north) of the project frontage, is part of the proposed project. Noise from parking lots involving vehicle circulation, engines starting, car alarms, door slams and human voices usually range from 50 to 60 dBA L_{max} at a distance of 50 ft. The ambient noise levels in the area along with noise propagating from Caltrain trains in the vicinity results in a **less-than-significant** level corresponding to parking lot noise.

Operational noise due to mechanical equipment and parking is **less-than-significant**.

Permanent Noise Increases from Project Traffic

A significant impact would occur if the permanent noise level increase due to project-generated traffic would be 3 dBA L_{dn} or greater at noise-sensitive receptors. For reference, a 3 dBA L_{dn} noise increase would be expected if the project would double existing traffic volumes along a roadway.

Comparing the existing Average Daily Traffic (ADT) volumes with the Existing plus Project ADT volumes provided in the project's Traffic Impact Analysis document[6], the project would not result in a substantial traffic noise increase along roadway segments and intersections in the vicinity (increases would be 1 dBA or less). This is a **less-than-significant** impact.

Temporary Noise Increases from Project Construction

A significant noise impact would be identified if the project would generate a substantial temporary or permanent noise level increase over ambient noise levels at existing noise-sensitive receptors surrounding the project site and that would exceed applicable noise standards presented in the General Plan at existing noise-sensitive receptors surrounding the project site.

Section 7.30.060 of the City of San Mateo's Municipal Code limits construction to weekdays between 7:00 a.m. and 7:00 p.m., Saturdays between 9:00 a.m. and 5:00 p.m., and Sundays and Holidays between 12:00 p.m. and 4:00 p.m. Additionally, the City specifies that no individual piece of equipment shall produce a noise level exceeding 90 dBA at a distance of 25 feet and that the noise level outside of any point outside the property plane of the project shall not exceed 90 dBA. Noise limits identified by the Federal Transit Administration (FTA) are used to identify the potential for impacts due to substantial temporary construction noise. A significant noise impact would be identified if temporary construction activities noise would cause a substantial increase in ambient noise levels at sensitive receptors. Large or complex projects involving substantial on-going noise-generating construction activities are considered significant when noise levels would exceed 80 dBA L_{eq} at residential land uses near the site or 90 dBA L_{eq} at commercial land uses near the site for more than 12 months within the allowable workdays and work hours.

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

Project construction is anticipated to occur over a period of about 14 months and would include demolition, site preparation, grading and excavation, wet utilities underground, dry utilities joint trench, building erection, and paving. The hauling of excavated materials and construction materials would generate truck trips on local roadways as well. Pile driving is not anticipated in any phase of construction of the project.

Construction activities would be 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 9 and 10. Table 9 shows the average noise level ranges, by construction phase and Table 10 shows the maximum noise level ranges for different construction equipment. Most demolition

[6] Kittelson & Associates – "San Mateo Hayward Park Station Traffic Impact Analysis – Traffic Volume Estimation Memorandum", January 20,2022.

and construction noise falls in the range of 80 to 90 dBA at 50 feet from the source. Construction-generated noise levels drop off/increase at a rate of about 6 dBA per doubling/halving 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 9 Typical Ranges of Construction Noise Levels at 50 Feet, L_{eq} (dBA)

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

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

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

TABLE 10 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.

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

The Federal Highway Administration's (FHWA's) Roadway Construction Noise Model (RCNM) was used to calculate the hourly average noise levels anticipated for the worst-case scenario for each construction phase, based on the equipment list provided by the applicant at the time of this study. RCNM includes representative sound levels for the most common types of construction equipment and the approximate usage factors of such equipment that were developed based on an extensive database of information gathered during the construction of the Central Artery/Tunnel Project in Boston, Massachusetts (CA/T Project or "Big Dig"). The usage factors represent the percentage of time that the equipment would be operating at full power. To estimate the worst-case scenario for each phase of the proposed project, it was assumed that all equipment provided for each phase would operate simultaneously. Additionally, all mobile equipment will be fitted with backup alarms per OSHA requirements. The noise level of backup alarms can vary depending on the type and directivity of the sound, but maximum noise levels are typically in the range of 65 to 75 dBA L_{max} at a distance of 50 feet.

Table 11 summarizes all equipment and quantities expected to be used for each construction phase, the duration of each phase, and the estimated worst-case scenario noise levels expected at the property lines of the nearest surrounding noise-sensitive land use. During construction at both areas, construction equipment would likely be spread throughout the sites, but for purposes of modeling the worst-case scenario, all equipment was assumed to be operating in relatively the same area, with the geometrical center of construction equipment being the center of the construction sites. Therefore, the propagation distances were estimated from the center of the active construction site to the property lines of the surrounding receptors. No shielding effects were assumed for the estimated noise levels shown in Table 11.

TABLE 11 Estimated Construction Noise Levels at the Nearby Land Uses

Phase	Time Duration	Construction Equipment (Quantity)	Calculated Hourly Average L_{eq}, dBA[c]	
			East Residential (*85 ft*)	Southeast Commercial (*300 ft*)
Demolition	10/2/2023-10/27/2023	Concrete/Industrial Saw (1) Excavator (1) Tractor/Loader/Backhoe (1)	81	70
Site Preparation	10/28/2023-11/10/2023	Grader (1) Rubber-Tired Dozer (1) Water Truck (1)	78	67
Grading/ Excavation	11/11/2023-12/8/2023	Excavator (1) Grader (1) Compactor (1) Scraper (2) Water Truck (1)	82	70
Wet Underground Utilities	11/11/2023-12/1/2023	Tractor/Loader/Backhoe (1) Excavator (2) Water Truck (1)	79 to 83 [a]	68 to 72 [a]
Dry Utilities Joint Trench	12/2/2023-12/8/2023	Tractor/Loader/Backhoe (1) Excavator (2) Water Truck (1)	77 to 83 [b]	66 to 72 [b]
Building – Exterior	12/9/2023-10/25/2024	Crane (1) Forklift (3) Generator set (1) Tractor/Loader/Backhoe (3) Welder (1)	82	71
Building – Interior/Architectural coating	10/26/2024-11/22/2024	Air Compressor (1)	69	58
Paving	11/23/2024-12/20/2024	Cement and Mortar Mixers (2) Paver (1) Roller (2) Tractor/Loader/Backhoe (3) Grader (1) Water Truck (1)	83	72

[a] The range of construction noise levels represents the levels during the 'Wet Underground Utilities' phase only and combined with the 'Grading/Excavation' phase. [b] The range of construction noise levels represents the levels during the 'Dry Utilities Joint Trench' phase only and combined with the 'Grading/Excavation' phase. [c] East Residential refers to Station Park Green residences at 410 Station Park Circle and Southeast commercial refers to 'WeWork Office Space & Coworking' at 400 Concar Drive.

It is assumed that construction would occur during the allowable hours established in the Municipal Code and construction equipment would comply with the 90 dBA limit for individual pieces of equipment as measured at a distance of 25 feet. Noise levels due to construction activities are calculated to intermittently exceed the 80 dBA L_{eq} threshold intermittently during several construction phases at nearby residential uses, assuming worst case scenario involving no shielding. The following best management practices[7] would reduce construction noise levels emanating from the site below the established thresholds, limit construction hours and minimize disruption and annoyance:

- Construction activities shall be limited to the hours between 7:00 am and 7:00 pm, Monday through Friday, Saturdays between 9:00 am and 5:00 pm, and Sundays and Holidays between 12:00 pm and 4:00 pm in accordance with the City's Municipal Code, unless permission is granted with development permit or other planning approval, and construction equipment shall comply with the noise limit set forth in the City's Municipal Code.
- Equip all internal combustion engine-driven equipment with intake and exhaust mufflers that are in good condition and appropriate for the equipment.
- Unnecessary idling of internal combustion engines should be strictly prohibited.
- Locate stationary noise-generating equipment, such as air compressors or portable power generators, as far as possible from sensitive receptors. If they must be located near receptors, adequate muffling (with enclosures where feasible and appropriate) shall be used reduce noise levels at the adjacent sensitive receptors. Any enclosure openings or venting shall face away from sensitive receptors.
- Construct solid plywood fences around construction sites adjacent to operational business, residences, or other noise-sensitive land uses. A temporary 8-foot noise barrier shall be constructed along the east property line of the project site to shield adjacent residential 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 5 dBA noise reduction.
- 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.
- Locate material stockpiles, as well as maintenance/equipment staging and parking areas, as far as feasible from residential receptors.
- Construction Noise Logistics Plan: Prior to the issuance of any grading or demolition permits, the project proponent shall submit and implement a construction noise logistics

[7] Based on Mitigation Measure CP1 in the San Mateo Rail Corridor Plan Environmental Impact Report dated February 17, 2004, State Clearing House Number: 2003042170

plan that specifies hours of construction, noise and vibration minimization measures, posting and notification of construction schedules, equipment to be used, and designation of a noise disturbance coordinator. The noise disturbance coordinator shall respond to neighborhood complaints and shall be in place prior to the start of construction and implemented during construction to reduce noise impacts on neighboring residents and other uses. The noise logistic plan shall be submitted to the Director of Planning or Director's designee of the Department of Planning, Building and Code Enforcement prior to the issuance of any grading or demolition permits. In order to minimize negative effects of construction noise on the surrounding neighborhoods near the project site, the following measures will be utilized to identify, mitigate, respond to and track any complaints that may arise pertaining to construction noise:

- Notify property owners and occupants located within 500 feet of construction activities at least 14 calendar days prior to commencement of construction;
- Post a large on-site sign near the public right-of-way containing permitted construction days/hours, complaint procedures and phone numbers for the complaint manager and City Code Enforcement unit;
- Maintain a complaint log that records received complaints and how complaints were addressed, which shall be submitted to the City for review upon the City's request;
- If reliable noise complaints are received during demolition, excavation, and/or construction activities, noise levels should be monitored at the location from which the noise complaints originated by a qualified acoustical professional. Integrated average (L_{eq}) noise level measurements on an hourly basis should be made of activities representative of those that generated the complaint. If the measured noise levels during this test are found to exceed 80 dBA L_{eq} at residential property lines or 90 dBA L_{eq} at commercial property lines, an acoustical professional should be retained to specify additional noise attenuation measures to reduce noise levels to City Standards. These measures may include operational considerations, the use of additional ground level noise barriers or noise control blanketing of the building structure.

Implementation of the above best management practices would reduce construction noise levels emanating from the site, limit construction hours, and minimize disruption and annoyance. With the implementation of these measures and recognizing that noise generated by construction activities would occur over a temporary period, the impact would be **less-than-significant**.

Impact 2: **Exposure to Excessive Groundborne Vibration due to Construction.** Construction related vibration levels would exceed 0.3 in/sec PPV at existing off-site residences but is not expected to cause threshold, minor or major damage. **This is a less-than-significant impact.**

The City of San Mateo does not specify a construction vibration limit. For structural damage, the California Department of Transportation 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 0.08 in/sec PPV for ancient buildings or buildings that are documented to be structurally weakened (see Table 3). The 0.3 in/sec PPV vibration limit would be applicable to properties in the vicinity of the project.
The construction of the project may generate perceptible vibration when heavy equipment or impact tools (e.g., jackhammers, hoe rams) are used. Construction activities would include demolition, site preparation, grading and excavation, wet utilities underground, dry utilities joint trench, building (exterior), interior/ architectural coating and paving. Pile driving is not anticipated for construction of the building foundation.

Vibration levels would vary depending on soil conditions, construction methods, and equipment used. Jackhammers typically generate vibration levels of 0.035 in/sec PPV and drilling typically generates vibration levels of 0.09 in/sec PPV at a distance of 25 feet. 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 12 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 25 feet away. Vibration levels at distances greater than 25 feet from the project site would not exceed the 0.3 in/sec PPV threshold for buildings of normal conventional construction, especially since there is no pile driving activity involved in any phase of the construction.

TABLE 12 Vibration Levels for Construction Equipment at Various Distances

Equipment		PPV at 25 ft. (in/sec)
Clam shovel drop		0.202
Hydromill (slurry wall)	in soil	0.003
	in rock	0.006
Vibratory Roller		0.210
Hoe Ram		0.089
Large bulldozer		0.089
Caisson drilling		0.089
Loaded trucks		0.076
Jackhammer		0.035
Small bulldozer		0.003

Source: Transit Noise and Vibration Impact Assessment, United States Department of Transportation, Office of Planning and Environment, Federal Transit Administration, October 2018 as modified by Illingworth & Rodkin, Inc., March 2022.

The closest structures to the project site include residential buildings to the east. The US Bureau of Mines has analyzed the effects of blast-induced vibration on buildings in USBM RI 8507[8], and these findings have been applied to vibrations emanating from construction equipment on

[8] 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.

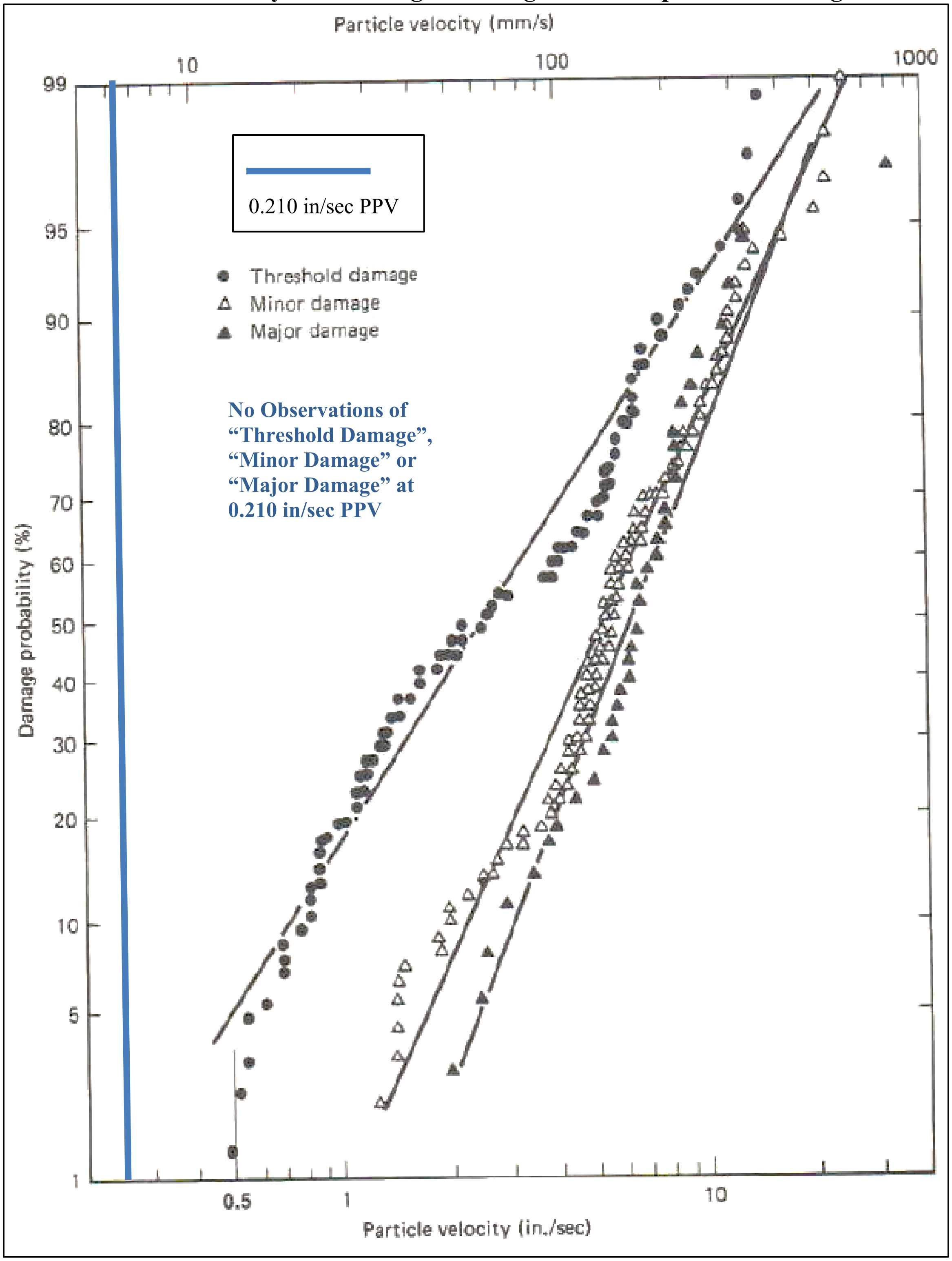
buildings[9]. Figure 4 presents the damage probability, as reported in USBM RI 8507 and reproduced by Dowding, assuming a maximum vibration level of 0.210 in/sec PPV. Based on the data summarized in Figure 4, there would be no observations of "threshold damage," "minor damage," or "major damage" at buildings of normal conventional construction when vibration levels were 0.210 in/sec PPV or less.

Project-generated vibration levels are below the 0.3 in/sec PPV structural damage threshold, which implies that neither cosmetic, minor, or major damage would occur beyond 25 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, perceptible vibration can be kept to a minimum.

While construction activity may be perceptible, the proposed project is not expected to result in "architectural" damage to any surrounding structure. This is a **less-than-significant impact.**

[9] 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

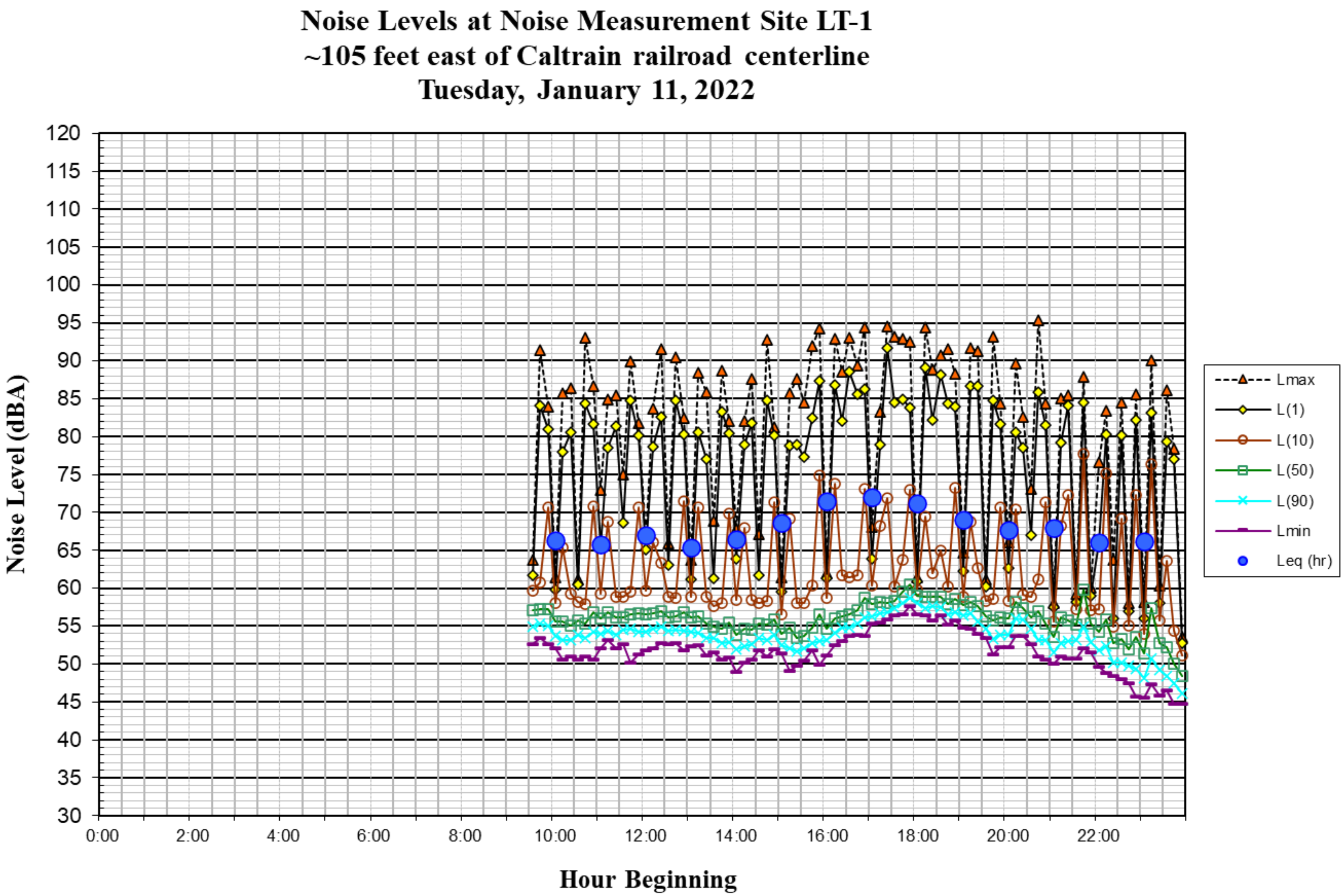
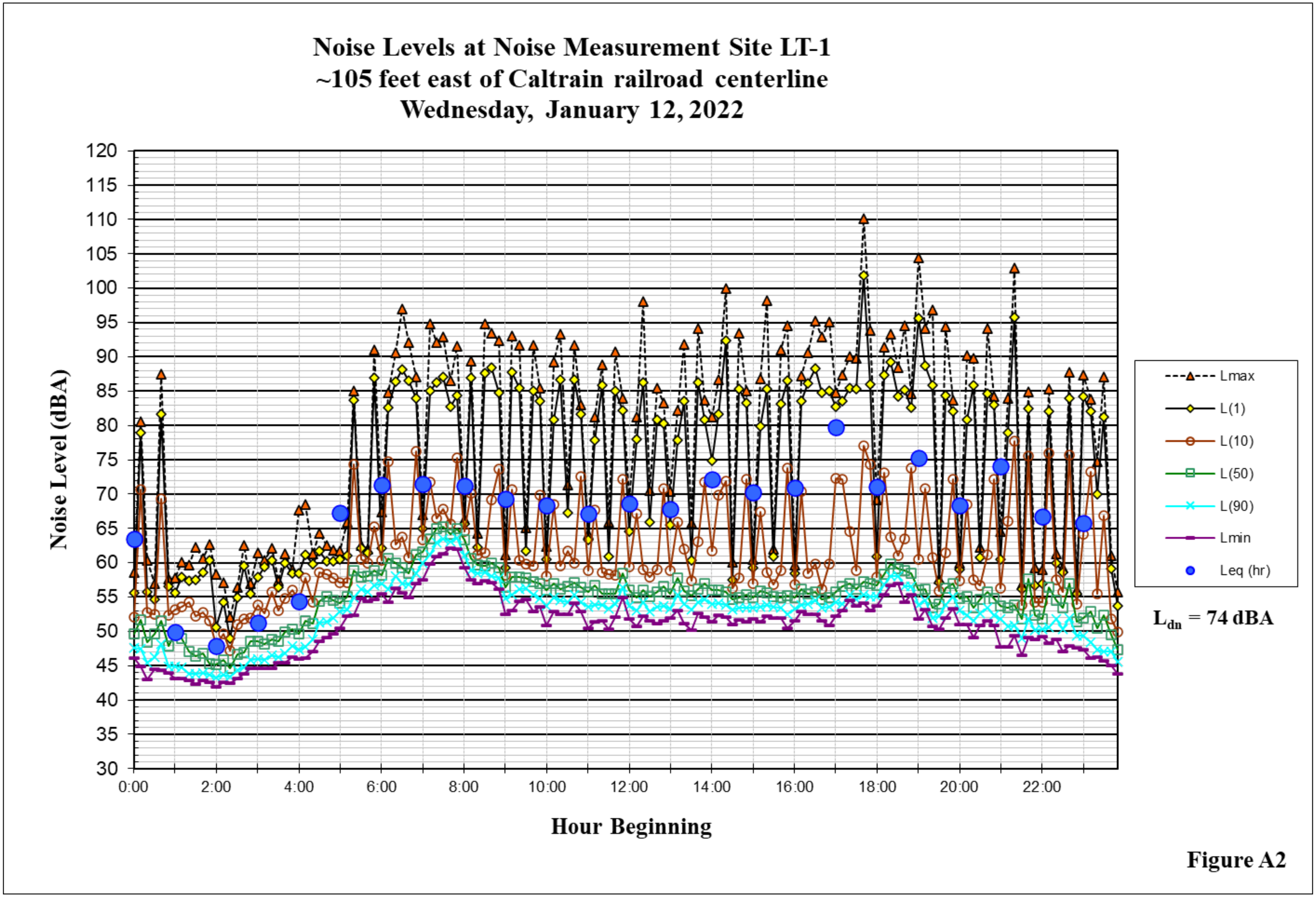

Noise Levels at Noise Measurement Site LT-1
~105 feet east of Caltrain railroad centerline
Tuesday, January 11, 2022
Noise Level (dBA)
Hour Beginning
Lmax
L(1)
L(10)
L(50)
L(90)
Lmin
Leq (hr)

Figure A1



Noise Levels at Noise Measurement Site LT-1
~105 feet east of Caltrain railroad centerline
Wednesday, January 12, 2022
Noise Level (dBA)
120
115
110
105
100
95
90
85
80
75
70
65
60
55
50
45
40
35
30
0:00
2:00
4:00
6:00
8:00
10:00
12:00
14:00
16:00
18:00
20:00
22:00
Hour Beginning
Lmax
L(1)
L(10)
L(50)
L(90)
Lmin
Leq (hr)
L_{dn} = 74 dBA

Figure A2

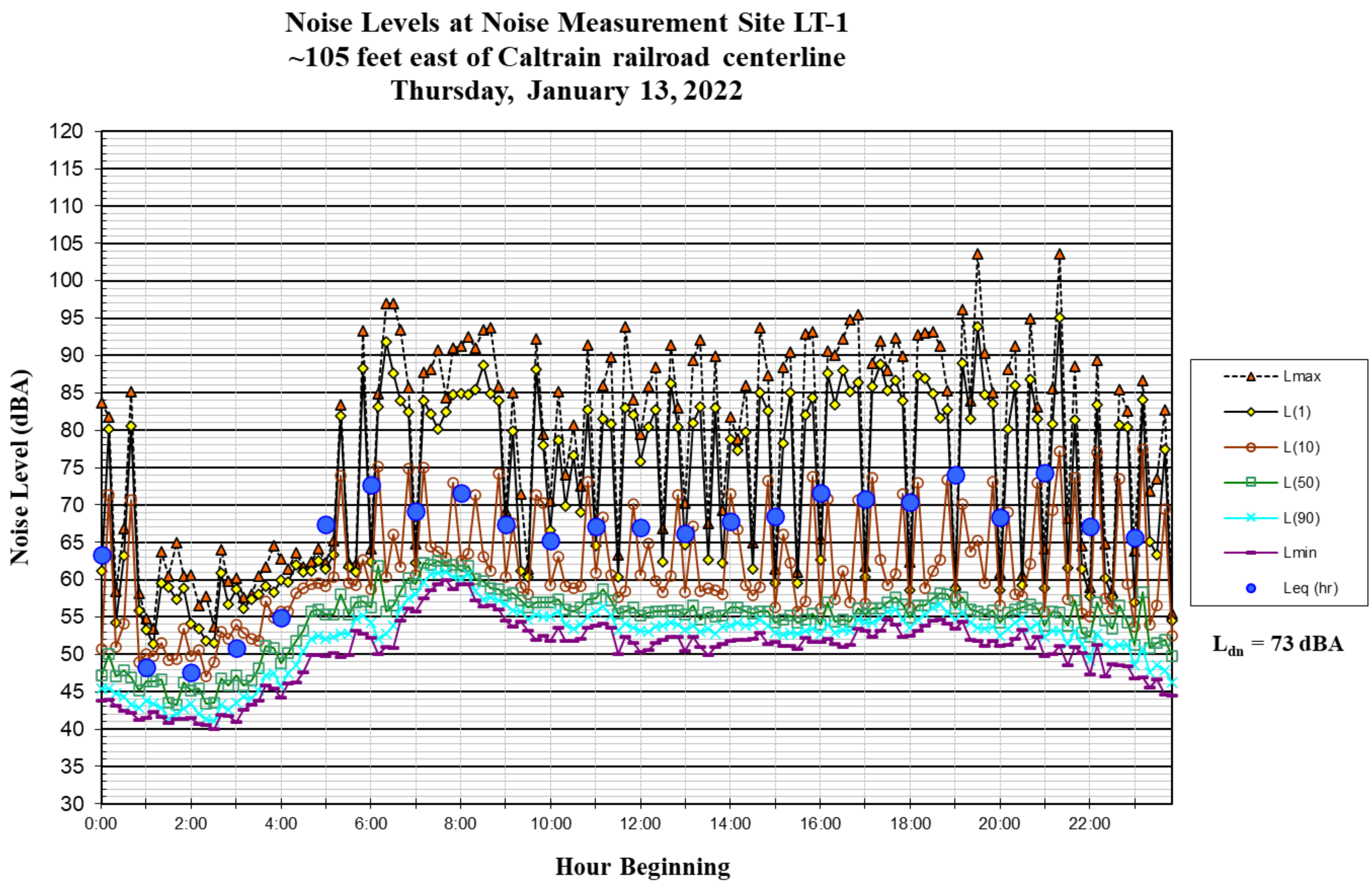

Noise Levels at Noise Measurement Site LT-1
~105 feet east of Caltrain railroad centerline
Thursday, January 13, 2022
Noise Level (dBA)
120
115
110
105
100
95
90
85
80
75
70
65
60
55
50
45
40
35
30
0:00
2:00
4:00
6:00
8:00
10:00
12:00
14:00
16:00
18:00
20:00
22:00
Hour Beginning
Lmax
L(1)
L(10)
L(50)
L(90)
Lmin
Leq (hr)
L_{dn} = 73 dBA

Figure A3

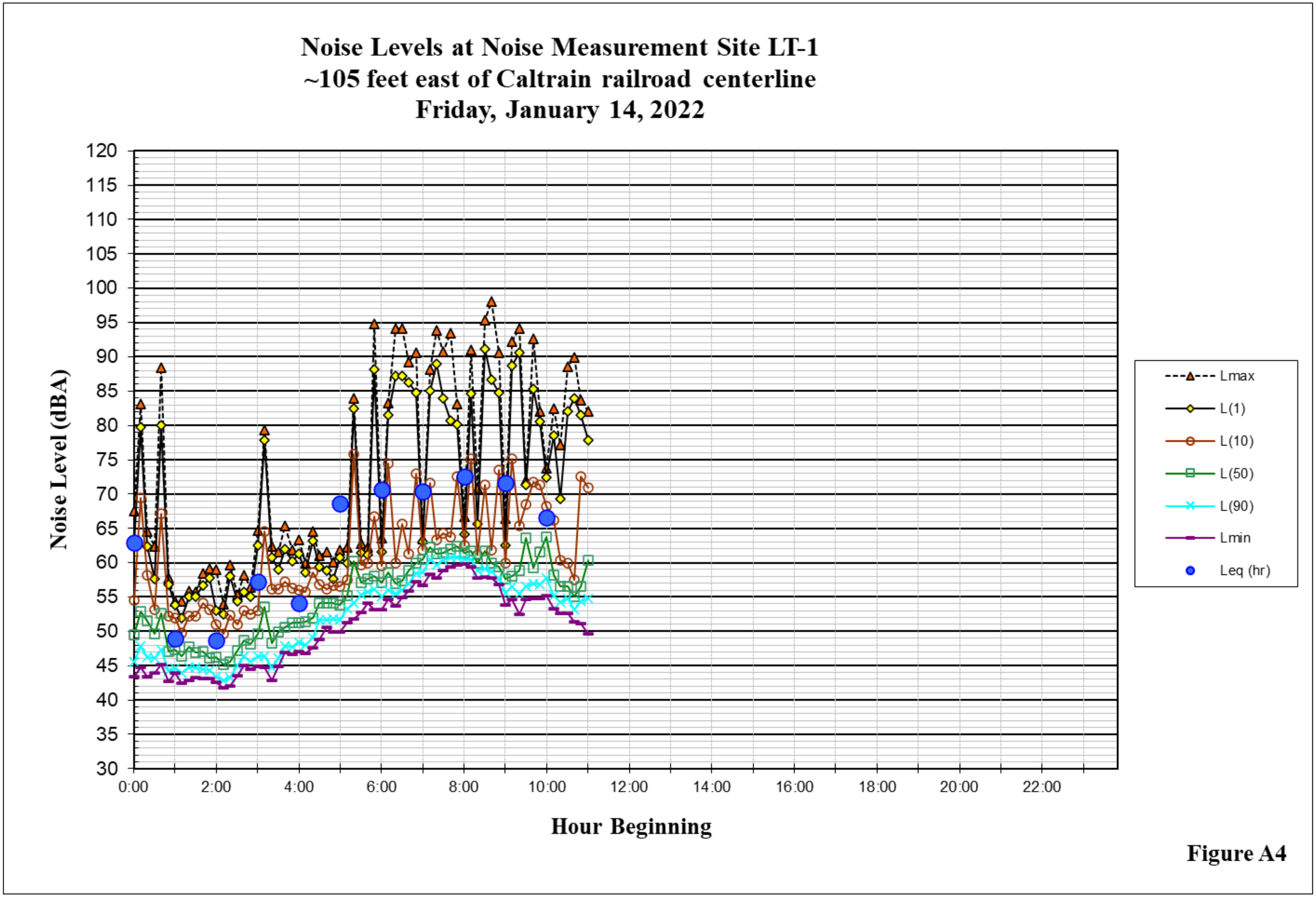
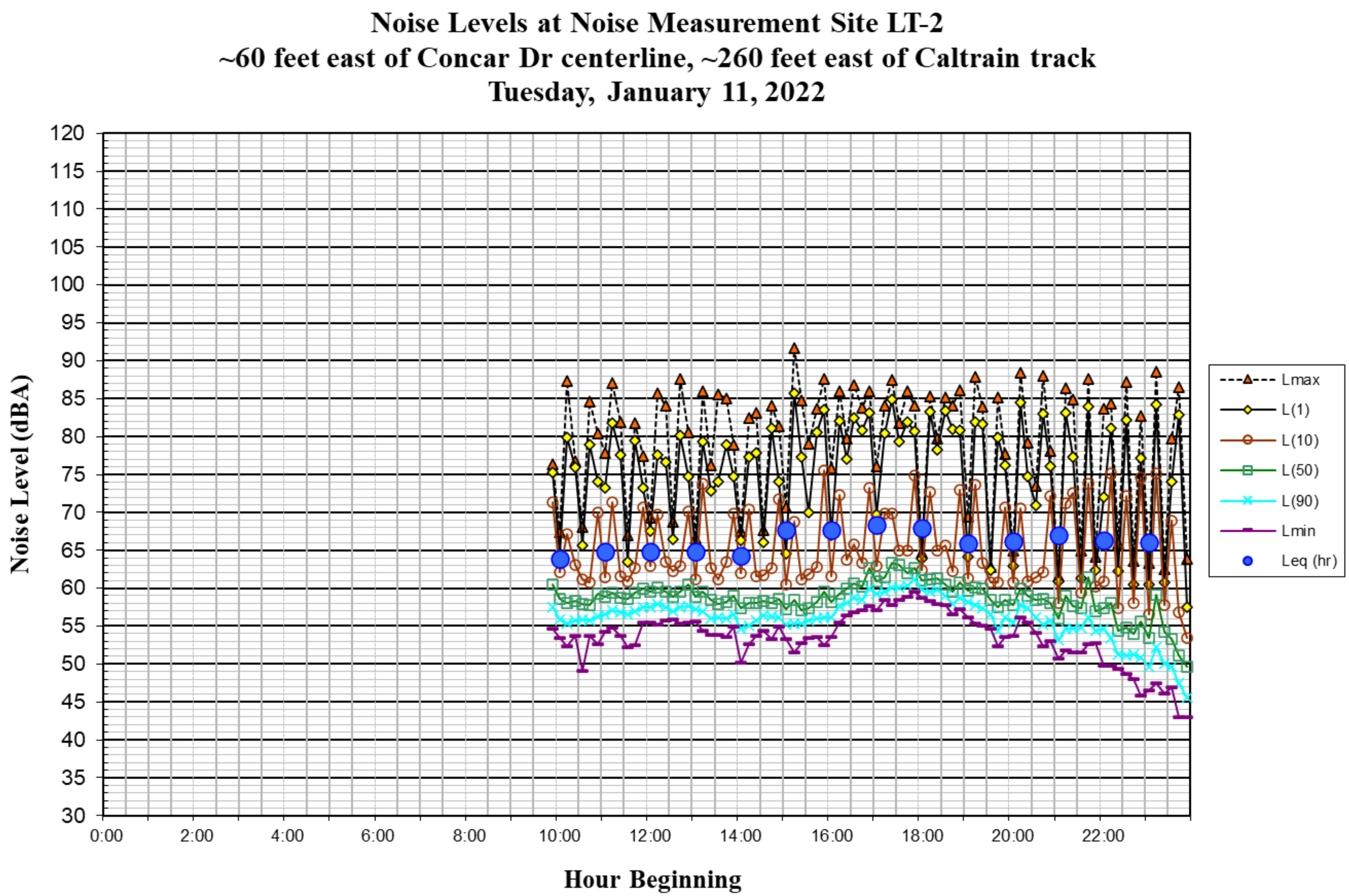

Noise Levels at Noise Measurement Site LT-1
~105 feet east of Caltrain railroad centerline
Friday, January 14, 2022
Noise Level (dBA)
120
115
110
105
100
95
90
85
80
75
70
65
60
55
50
45
40
35
30
0:00
2:00
4:00
6:00
8:00
10:00
12:00
14:00
16:00
18:00
20:00
22:00
Hour Beginning
Lmax
L(1)
L(10)
L(50)
L(90)
Lmin
Leq (hr)

Figure A4



Noise Levels at Noise Measurement Site LT-2
~60 feet east of Concar Dr centerline, ~260 feet east of Caltrain track
Tuesday, January 11, 2022
Noise Level (dBA)
120
115
110
105
100
95
90
85
80
75
70
65
60
55
50
45
40
35
30
0:00
2:00
4:00
6:00
8:00
10:00
12:00
14:00
16:00
18:00
20:00
22:00
Hour Beginning
Lmax
L(1)
L(10)
L(50)
L(90)
Lmin
Leq (hr)

Figure A5

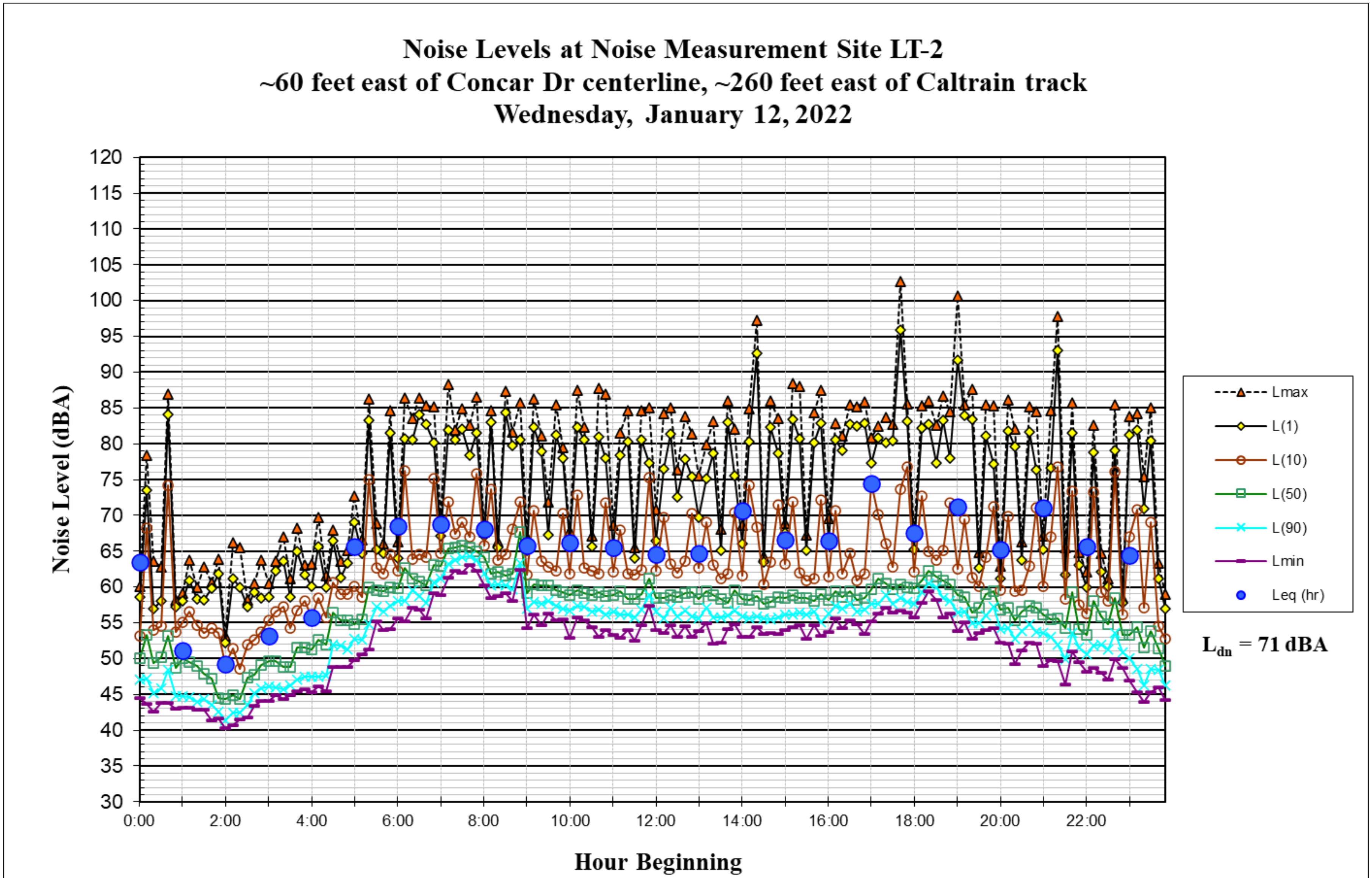

Noise Levels at Noise Measurement Site LT-2
~60 feet east of Concar Dr centerline, ~260 feet east of Caltrain track
Wednesday, January 12, 2022
Noise Level (dBA)
Hour Beginning
Lmax
L(1)
L(10)
L(50)
L(90)
Lmin
Leq (hr)
L_{dn} = 71 dBA

Figure A6

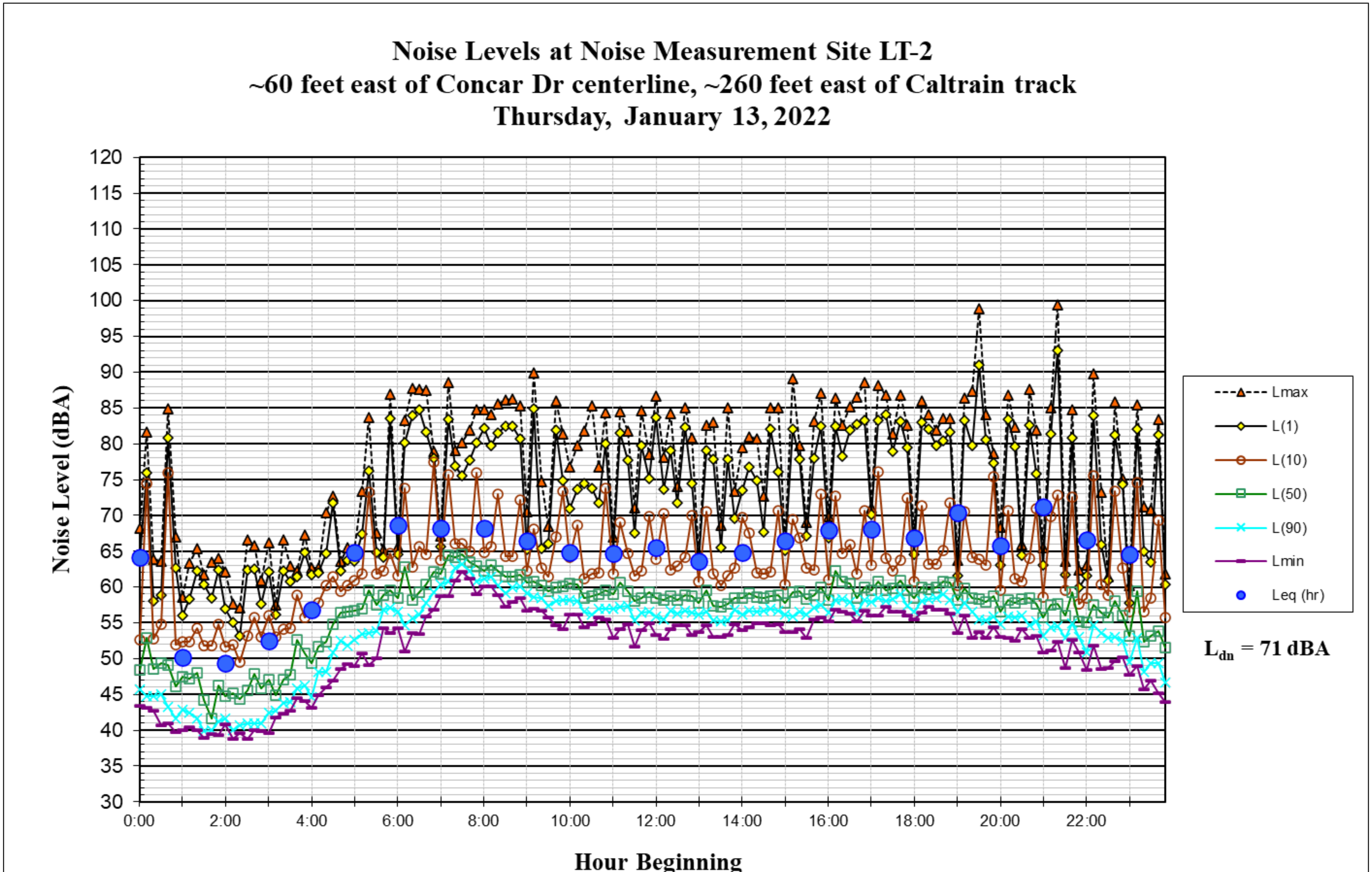

Noise Levels at Noise Measurement Site LT-2
~60 feet east of Concar Dr centerline, ~260 feet east of Caltrain track
Thursday, January 13, 2022
Noise Level (dBA)
120
115
110
105
100
95
90
85
80
75
70
65
60
55
50
45
40
35
30
0:00
2:00
4:00
6:00
8:00
10:00
12:00
14:00
16:00
18:00
20:00
22:00
Hour Beginning
Lmax
L(1)
L(10)
L(50)
L(90)
Lmin
Leq (hr)
L_{dn} = 71 dBA

Figure A7

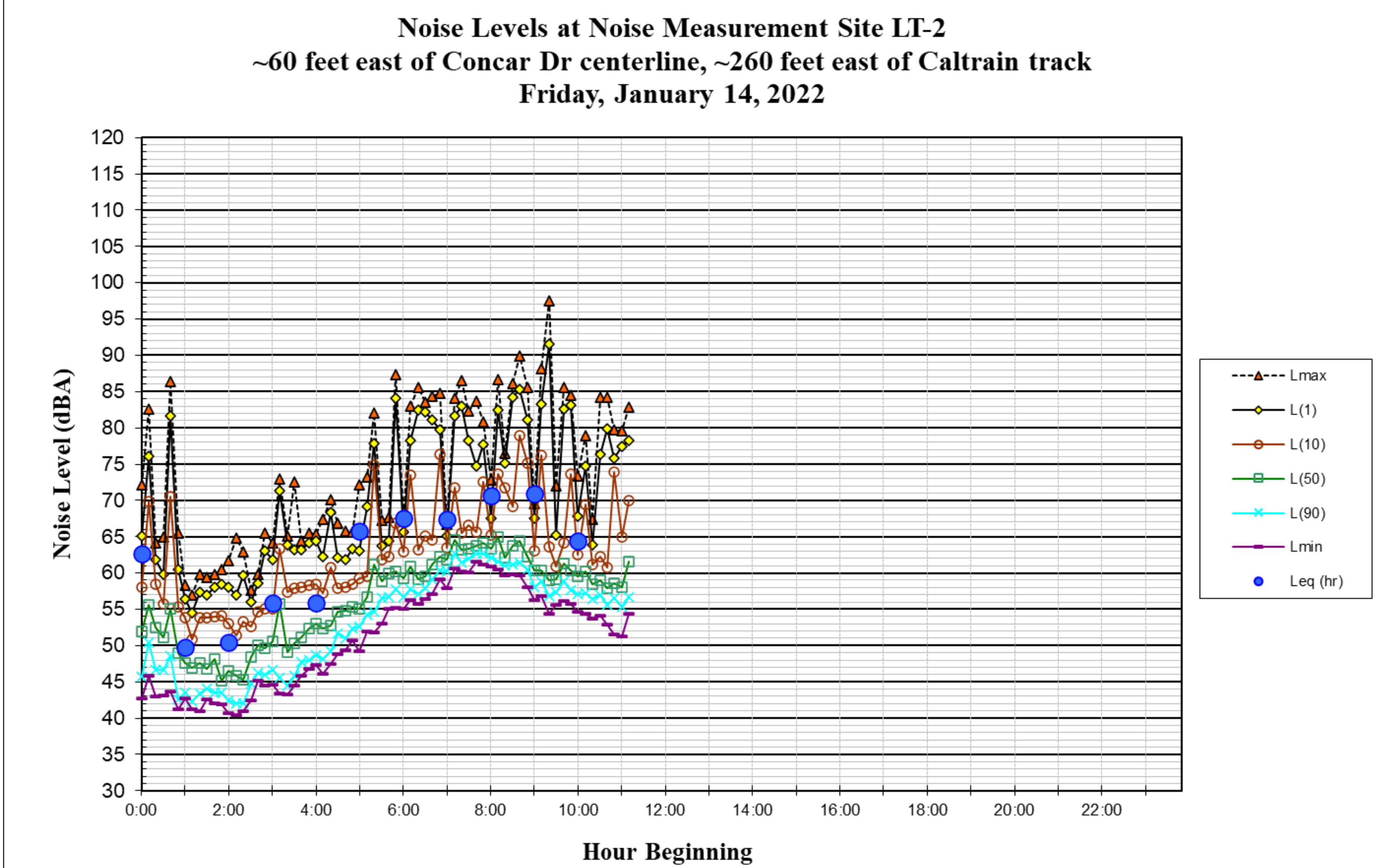
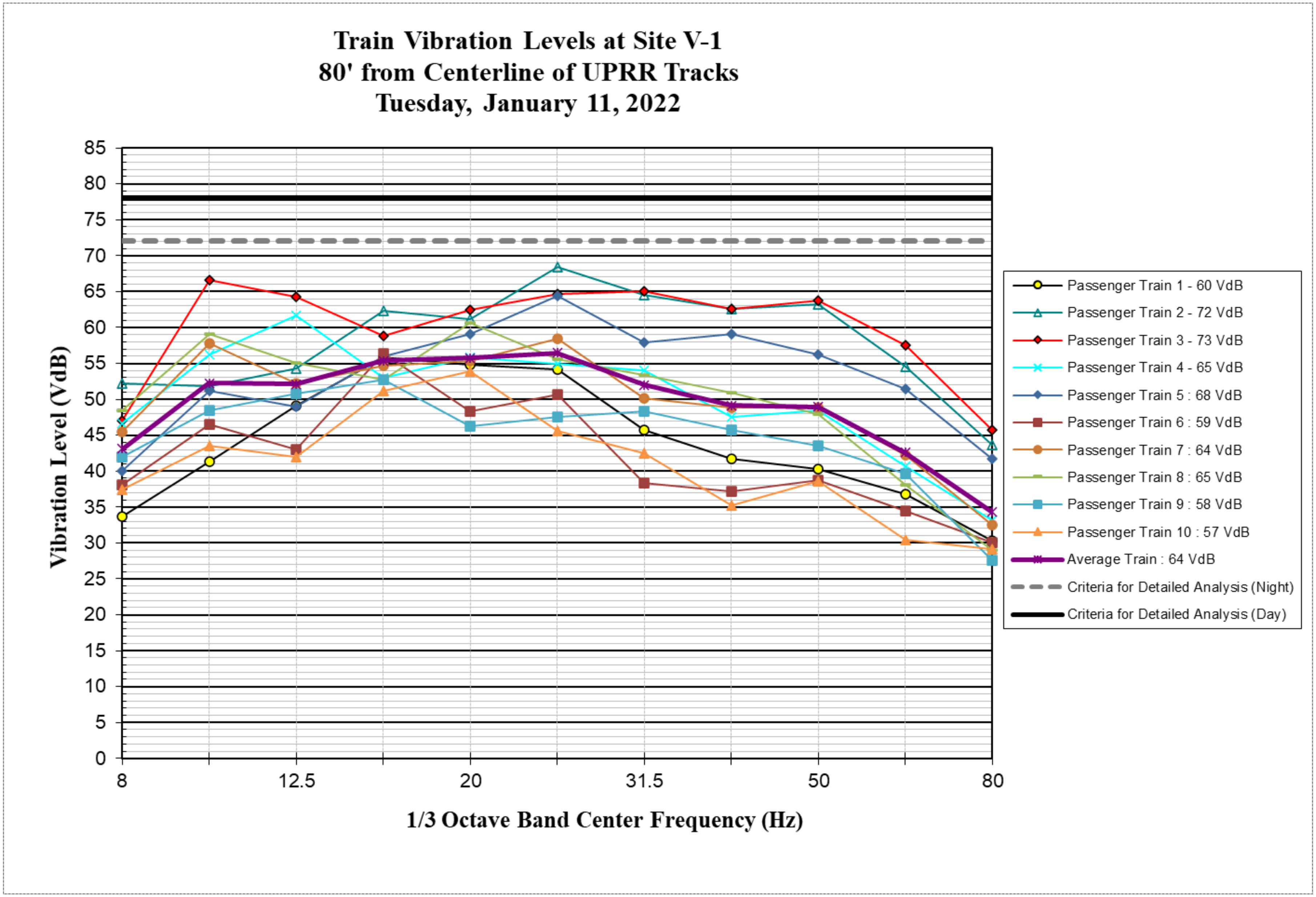

Noise Levels at Noise Measurement Site LT-2
~60 feet east of Concar Dr centerline, ~260 feet east of Caltrain track
Friday, January 14, 2022
Noise Level (dBA)
120
115
110
105
100
95
90
85
80
75
70
65
60
55
50
45
40
35
30
0:00
2:00
4:00
6:00
8:00
10:00
12:00
14:00
16:00
18:00
20:00
22:00
Hour Beginning
Lmax
L(1)
L(10)
L(50)
L(90)
Lmin
Leq (hr)

Figure A8

Appendix B – 1/3rd Octave Band Data for Train Passby Measurements


Train Vibration Levels at Site V-1
80' from Centerline of UPRR Tracks
Tuesday, January 11, 2022
Vibration Level (VdB)
85
80
75
70
65
60
55
50
45
40
35
30
25
20
15
10
5
0
8
12.5
20
31.5
50
80
1/3 Octave Band Center Frequency (Hz)
Passenger Train 1 - 60 VdB
Passenger Train 2 - 72 VdB
Passenger Train 3 - 73 VdB
Passenger Train 4 - 65 VdB
Passenger Train 5 : 68 VdB
Passenger Train 6 : 59 VdB
Passenger Train 7 : 64 VdB
Passenger Train 8 : 65 VdB
Passenger Train 9 : 58 VdB
Passenger Train 10 : 57 VdB
Average Train : 64 VdB
Criteria for Detailed Analysis (Night)
Criteria for Detailed Analysis (Day)