CREEKWOOD RESIDENTIAL DEVELOPMENT
NOISE AND VIBRATION ASSESSMENT

270-280 Casa Grande Road
Petaluma, California

January 20, 2022

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INTRODUCTION AND SUMMARY

This report presents the results of an environmental noise assessment completed for the proposed 59-unit Creekwood residential condominium development located at 270-280 Casa Grande Road in the City of Petaluma (see Figure 1). The purpose for this noise assessment is to evaluate the compatibility of the development with respect to the environmental noise levels at the project site and evaluate noise impacts upon sensitive receptors in the area. The Setting Section of this report presents the fundamentals of environmental noise and vibration, describes regulatory criteria that are applicable in the project's assessment, and summarizes the results of a survey of the existing noise environment at the project site and vicinity.

Figure 1: Project Site, Vicinity and Measurement Locations

SETTING

FUNDAMENTALS OF ENVIRONMENTAL NOISE

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

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

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

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

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

Effects of Noise

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. To achieve an acceptable interior noise environment, bedrooms facing secondary roadways need to be able to have their windows closed, those facing major roadways and freeways typically need special glass windows.

Table 1: Definitions of Acoustical Terms Used in this Report

Term	Definitions
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.
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. The hourly Leq used for this report is denoted as dBA Leq[h].
Day-Night Level, L_{dn}	The equivalent noise level for a continuous 24-hour period with a 10-decibel penalty imposed during nighttime and morning hours (10:00 pm to 7:00 am).
Community Noise Exposure Level, CNEL	CNEL is the equivalent noise level for a continuous 24-hour period with a 5-decibel penalty imposed in the evening (7:00 pm to 10:00 pm) and a 10-decibel penalty imposed during nighttime and morning hours (10:00 pm to 7:00am)
L_1, 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.
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.

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 additional decibel increases the percentage of the population highly annoyed by about 3 percent. 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.

Table 2: Typical Noise Levels in the Environment

Common Outdoor Noise Source	Noise Level (dBA)	Common Indoor Noise Source
	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), Caltrans, November 2009.

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 is the Peak Particle Velocity (PPV), and another is the Root Mean Square (RMS) velocity. The PPV is defined as the maximum instantaneous positive or negative peak of the vibration wave. The RMS velocity is defined as the average of the squared amplitude of the signal. The PPV and RMS vibration velocity amplitudes are used to evaluate human response to vibration. In this section, a PPV descriptor with units of mm/sec or in/sec is used to evaluate construction generated vibration for building damage and human complaints. Table 3 displays the reactions of people and the effects on buildings that continuous vibration levels produce. The annoyance levels shown in Table 3 should be interpreted with care since vibration may be found to be annoying at much lower levels than those shown, depending on the level of activity or the sensitivity of the individual. To sensitive individuals, vibrations approaching the threshold of perception can be annoying.

Table 3: Reaction of People and Damage to Buildings for Continuous Vibration Levels

Vibration Level, PPV (in/sec)	Human Reaction	Effect on Buildings
0.006 to 0.019	Threshold of perception, Possibility of intrusion	Vibration unlikely to cause damage of any type
0.08	Vibrations readily perceptible	Recommended upper level of the vibration to which ruins and ancient monuments should be subjected
0.10	Level at which continuous vibrations begin to annoy people	Virtually no risk of "architectural" damage to normal buildings
0.20	Vibrations annoying to people in buildings	Threshold at which there is a risk of "architectural" damage to normal dwellings such as plastered walls or ceilings.
0.4 to 0.6	Vibrations considered unpleasant by people subjected to continuous vibrations	Vibration at this level would cause "architectural" damage and possibly minor structural damage.

Source: Transportation Related Earthborne Vibrations (Caltrans Experiences), Technical Advisory, Vibration TAV-02-01-R9601, California Department of Transportation, February 20, 2002.

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. In high noise environments, which are more prevalent where groundborne vibration approaches perceptible levels, this rattling phenomenon may also be produced by loud airborne environmental noise causing induced vibration in exterior doors and windows.

Construction activities can cause vibration that varies in intensity depending on several factors. The use of pile driving and vibratory compaction equipment typically generate the highest construction related ground-borne vibration levels. Because of the impulsive nature of such activities, the use of the peak particle velocity descriptor (PPV) has been routinely used to measure and assess ground-borne vibration and almost exclusively to assess the potential of vibration to induce structural damage and the degree of annoyance for humans.

The two primary concerns with construction-induced vibration, the potential to damage a structure and the potential to interfere with the enjoyment of life are evaluated against different vibration limits. Studies have shown that the threshold of perception for average persons is in the range of 0.008 to 0.012 in/sec PPV. Human perception to vibration varies with the individual and is a function of physical setting and the type of vibration. Persons exposed to elevated

ambient vibration levels such as people in an urban environment may tolerate a higher vibration level.

Structural damage can be classified as cosmetic only, such as minor cracking of building elements, or may threaten the integrity of the building. Safe vibration limits that can be applied to assess the potential for damaging a structure vary by researcher and there is no general consensus as to what amount of vibration may pose a threat for structural damage to the building. Construction-induced vibration that can be detrimental to the building is very rare and has only been observed in instances where the structure is at a high state of disrepair and the construction activity occurs immediately adjacent to the structure.

REGULATORY BACKGROUND

Noise

The State of California and the City of Petaluma have established regulatory criteria that are applicable in this assessment. The State of California Environmental Quality Act (CEQA) Guidelines, Appendix G, are used to assess the potential significance of impacts pursuant to local General Plan policies, Zoning Code standards, or the applicable standards of other agencies. A summary of the applicable regulatory criteria is provided below.

State CEQA Guidelines. 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.

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 Petaluma General Plan 2025

Section 10.2 of the City of Petaluma's Health and Safety Element includes objectives and policies applicable to the proposed residential project. The City's objective is to, "Protect public health and welfare by eliminating or minimizing the effects of existing noise problems, and by minimizing the increase of noise levels in the future." Single- and Multi-family residential land uses are respectively considered "normally acceptable" up to 60 dBA and 65 dBA L_{dn} or CNEL. Single- and Multi-family residential land uses are both considered "conditionally acceptable" up to 70 dBA L_{dn} or CNEL, "normally unacceptable" between 70 and 75 dBA L_{dn} or CNEL, and "clearly unacceptable" above 75 dBA L_{dn} or CNEL.

The following General Plan policies are applicable to the proposed residential project.

Policy A: Continue efforts to incorporate noise considerations into land use planning decisions and guide the locations and design of transportation facilities to minimize the effects of noise on adjacent land uses.

Policy B: Discourage location of new noise-sensitive uses, primarily homes, in areas with projected noise levels greater than 65 dBA CNEL. Where such uses are permitted, require incorporation of mitigation measures to ensure that interior noise levels do not exceed 45 dB CNEL.

Policy C: Ensure that the City's Noise Ordinance and other regulations:

- Require that applicants for new noise-sensitive development in areas subject to noise levels greater than 65 dB CNEL obtain the services of a professional acoustical engineer to provide a technical analysis and design of mitigation measures.
- Require placement of fixed equipment, such as air conditioning units and condensers, inside or in the walls of new buildings or on rooftops of central units to reduce noise impacts on any nearby sensitive receptors.

Policy D: Continue to require control of noise or mitigation measures for any noise-emitting construction equipment or activity. The City's Noise Ordinance establishes controls on construction-related noise.

Policy E: As part of development review, use Figure 10-2: Land Use Compatibility Standards to determine acceptable uses and installation requirements in noise-impacted areas.

Policy F: Discourage the use of sound walls anywhere except along Highway 101 and/or along the NWPRA corridor without findings that such walls will not be detrimental to community character. When sound walls are deemed necessary, integrate them into the streetscape.

Policy G: In making a determination of impact under the California Environmental Quality Act (CEQA) consider an increase of four or more dBA to be "significant" if the resulting noise level would exceed that described as normally acceptable for the affected use in Figure 10-3: Land Use Compatibility for Community Noise Environments.

City of Petaluma Implementing Zoning Ordinance. Section 21.040 A of the City of Petaluma Implementing Zoning Ordinance contains the following regulations which are generally applicable to operational (non-traffic) related noise in the City:

3. **Noise Regulations Generally.**

a. The following specific acts, subject to the exemptions provided in Section 21.040(A)(5), are declared to be public nuisances and are prohibited:

1) The operation or use of any of the following before 7:00 a.m. or after 10:00 p.m. daily (except Saturday, Sunday and State, Federal or Local Holidays, when the prohibited time shall be before 9:00 a.m. and after 10:00 p.m.):

2) A hammer or any other device or implement used to repeatedly pound or strike an object.

3) An impact wrench, or other tool or equipment powered by compressed air.

4) Any tool or piece of equipment powered by an internal-combustion engine such as, but not limited to, chain saw, backpack blower, and lawn mower. Except as specifically included in this Ordinance, motor vehicles, powered by an internal combustion engine and subject to the State of California vehicle code, are excluded from this prohibition.

5) Any electrically or battery powered tool or piece of equipment used for cutting, drilling, or shaping wood, plastic, metal, or other materials or objects, such as but not limited to a saw, drill, lathe or router.

6) Any of the following: the operation and/or loading or unloading of heavy equipment (such as but not limited to bulldozer, road grader, back hoe), ground drilling and boring equipment, hydraulic crane and boom equipment, portable power generator or pump, pavement equipment (such as but not limited to pneumatic hammer, pavement breaker,

tamper, compacting equipment), pile-driving equipment, vibrating roller, sand blaster, gunite machine, trencher, concrete truck, and hot kettle pump and the like.

7) Construction, demolition, excavation, erection, alteration or repair activity.

8) Operating or permitting the operation of powered model vehicles including but not limited to cars, aircraft and boats.

9) Using or operating for any purpose any loudspeaker, loudspeaker system or similar device in such a manner as to create a noise disturbance. Any permit issued pursuant to PMC Section 13.28.050 (amplified sound permit within a public park) is exempt from this section.

10) The use of truck/tractor trailer "Jake Brakes" on any public street under the jurisdiction of the City of Petaluma Police Department.

b. In the case of urgent necessity and in the interest of public health and safety, the Noise Control Officer may issue a permit for exemption from the requirements with subsection 21.040(A)(3). Such period shall not exceed ten (10) working days in length but may be renewed for successive periods of thirty (30) days or less, not to exceed a total of 90 days while the emergency continues. Requests for exemptions beyond 90 days shall require public hearing approval. The Noise Control Officer may limit such permit as to time of use and/or permitted action, depending upon the nature of the emergency and the type of action requested.

c. The operation of any licensed motor vehicle in violation of the State Vehicle Code or the operation of stereo, public address or other such amplified equipment on or within a motor vehicle in violation of the State Vehicle Code.

d. Continued or repeated operation of a Public Address System between the hours of 10:00 a.m. and 7:00 p.m. daily shall not exceed a decibel level of 5 dBA above the measured ambient of the area in which this activity is occurring. Unless specifically approved by the City of Petaluma (i.e., Use Permit, Parks Director, Exception or Exemption from this Code Sec.) no Public Address System shall be permitted during the hours of 7:00 p.m. to 10:00 a.m.

4. **Noise Measurement**: Utilizing the "A" weighting scale of a sound level meter and the "slow" meter response (use "fast" response for impulsive type sounds), the ambient noise level shall first be measured at a position or positions at any point on the receptor's property which can include private and public property. In general, the microphone shall be located four to five feet above the ground; ten feet or more from the nearest reflective surface where possible. If possible, the ambient noise shall be measured with the alleged offending noise source inoperative. If for any reason the alleged offending noise source cannot be shut down, the ambient noise must be estimated by performing a measurement in the same general area of the source but at a sufficient distance such that the noise from the source is at least 10dB below the ambient in order that only the ambient level will be measured.

a. If the measured ambient level is greater than 60dB, the Maximum Noise Exposure standard shall be adjusted in 5dB increments for each time period as appropriate to encompass or reflect the measured ambient noise level. In no case shall the maximum allowed threshold exceed 75dB after adjustments are made.

b. In the event the measured ambient noise level is 70dB or greater, the maximum allowable noise level shall be increased to reflect the maximum ambient noise level. In this case, adjustments for loudness and time as contained in Table 21.1 shall not be permitted.

c. No person shall cause or allow to cause, any source of sound at any location within the incorporated City or allow the creation of any noise on property owned, leased, occupied or

otherwise controlled by such person, which when measured on the property where the noise disturbance is being experienced within public or private open/outdoor spaces, exceeds the noise level of Table 21.1.

TABLE 21.1: Maximum Exterior Noise Exposure (dBA)

Category Description	Noise Metric[1]	Nighttime Hours (10:00 pm to 7:00 am M-F, 10:00 pm to 8:00 am S, S and Holidays)	Daytime Hours (7:00 am to 10:00 pm M-F, 8:00 am to 10:00 pm S, S and Holidays)
General Plan Ambient	L_{eq}	60 dBA	60 dBA
Cumulative period of 15 min. or more in one hour	L_{25}	65 dBA	70 dBA
Cumulative period of 5 min. or more in one hour	L_{08}	70 dBA	75 dBA
Cumulative period of 1 min. or more in one hour	L_{02}	75 dBA	80 dBA

Note 1: The noise metric column was added by Illingworth& Rodkin, Inc. to provide a measurable hourly noise level to compare with the Table 21.1 noise categories. These levels equate to the sound level exceeded n% of the time in any hour. For example, the L_{25} is the value exceeded 25% of the time or 15 minutes in any hour. These levels, which are used to evaluate noise events which occur during a given daytime or nighttime hour, differ from the CNEL metric used for the General Plan Noise and Land Use Compatibility standards, which is used to evaluate noise events over a 24-hour period.

EXISTING NOISE ENVIRONMENT

The proposed project is located 270-280 Casa Grande Road on the opposite side of this roadway from Casa Grande High School. The project site is bordered by a Senior Housing Facility to the north, Casa Grande creek and single-family residences beyond to the east, existing and future single-family residences to the south, and Casa Grande Road with Casa Grande High School beyond to the west. Other area uses are also residential or educational. The existing noise environment at the project site results primarily from vehicular traffic on Casa Grande Road. Other sources of noise in the area include residential and educational uses, seasonal sounds from water flows in Casa Grande Creek and the associated riparian habitat, and overhead noise from general aviation aircraft using the Petaluma Airport.

Noise monitoring surveys were conducted on the site and surrounding areas between 10 am on Tuesday January 4th, 2022, and 10 am on Friday January 7th, 2022, to quantify the existing noise environment on the project site. The noise monitoring survey included two long-term noise measurements as indicated as LT-1 and LT-2 in Figure 1 and three short term measurements indicated as ST-1, ST-2, and ST-3 in Figure 1. The noise measurements were conducted with Larson Davis Laboratories (LDL) Type I Model LXT Sound Level Meters. All meters were equipped with ½-inch pre-polarized condenser microphones and windscreens and were calibrated with a Larson Davis Model CA250 precision acoustic calibrator prior to and following the measurement survey.

Long-term noise measurement, LT-1, was located on the northern property line on the trunk of a tree at a height of 12 feet above grade and approximately 65 feet from the centerline of Casa Grande Road (see Figure 1). The measured noise levels at this location, including the energy equivalent noise level (L_{eq}), maximum (L_{max}), minimum (L_{min}), and the noise levels exceeded 10, 50 and 90 percent of the time (indicated as L_{10}, L_{50} and L_{90}) are shown on Chart 1, following.

A review of Chart 1 indicates that the noise levels at site LT-1 followed a diurnal pattern characteristic of traffic noise, with the average daytime noise levels ranging from 62 to 78 dBA L_{eq} and the average hourly nighttime noise levels ranging from 51 to 66 dBA L_{eq}. The overall Community Noise Equivalent Level (CNEL) for the 72-hour monitoring period at position LT-1 was 69 dBA, with the full day (Wednesday 1/5/22 and Thursday 1/6/22) CNELs at 68 dBA and 69 dBA, respectively.

Long-term noise measurement LT-2 was in the single-family neighborhood west of the project site on the light pole at a height of 12 feet above grade across the street from the residence at 1702 Silverado Circle (see Figure 1). The measured noise levels at this location, including the energy equivalent noise level (L_{eq}), maximum (L_{max}), minimum (L_{min}), and the noise levels exceeded 10, 50 and 90 percent of the time (indicated as L_{10}, L_{50} and L_{90}) are shown on Chart 2, following.

A review of Chart 2 indicates that the noise levels at site LT-1 followed a less distinct, but still diurnal pattern characteristic of traffic noise, with the average daytime noise levels ranging from 44 to 65 dBA L_{eq} and the average hourly nighttime noise levels ranging from 35 to 47 dBA L_{eq}. The overall Community Noise Equivalent Level (CNEL) for the 72-hour monitoring period at position LT-1 was 54 dBA, with the full day (Wednesday 1/5/22 and Thursday 1/6/22) CNELs at 53 dBA and 54 dBA, respectively.

Two short-term (10-minute duration) noise measurements (ST-1 and ST-2) were made on the site at a height of 5 feet above grade simultaneously the long-term noise monitors between 10:00 and 10:30 a.m. on Tuesday, January 4th, 2022, and one short-term (10-minute duration) noise measurements (ST-3) was made on the site at a height of 5 feet above grade simultaneously the long-term noise monitors between 9:30 and 9:40 a.m. on Friday, January 7th, 2022. These measurements were used to determine the relative attenuation of Casa Grande Road traffic noise across the site and document other area noise sources.

The first short term measurement on the project site (see ST-1 on Figure 1) was made on the bike path adjacent to Casa Grande Creek and the home at 1702 Silverado Circle. Sound levels measured at this location included water flow sounds in the creek, barking dogs, birds in the surrounding trees and distant traffic.

The second short term (see ST-2 on Figure 1) was made at the end of Del Rancho Way in the existing residential neighborhood south of the project site. Sound levels measured at this location included distant leaf blower noise, birds in the surrounding trees and distant traffic.

The third short term (see ST-3 on Figure 1) was made at the rear of the parking lot of the senior apartments north of the project site. Sound levels measured at this location included primarily included noise from distant traffic, with occasional sound from birds and distant airplanes.

The results of the measurements at the short-term positions are shown in Table 6. The CNEL levels assigned to these measurement locations are approximated by correlating the measured Leq levels at the short-term positions with those measured simultaneously at the long-term positions.

Table 6: Summary of Short-Term Noise Measurement Data, dBA

Noise Measurement Location	**L_{max}**	**$L_{(1)}$**	**$L_{(10)}$**	**$L_{(50)}$**	**$L_{(90)}$**	**L_{eq}**	**CNEL**
ST-1: Bike path adjacent to Casa Grande Creek	58	52	49	48	47	48	**47**[1]
ST-2: End of Del Rancho Way	59	52	47	44	42	45	**45**[1]
LT-2: Senior Apartment Parking Lot	57	56	53	50	46	50	**50**[1]

[1] The CNEL at ST-1, ST-2 and ST-3 are estimated by correlation to the corresponding measurements at LT-1& LT-2

Chart 1: Measured Noise Levels at LT-1

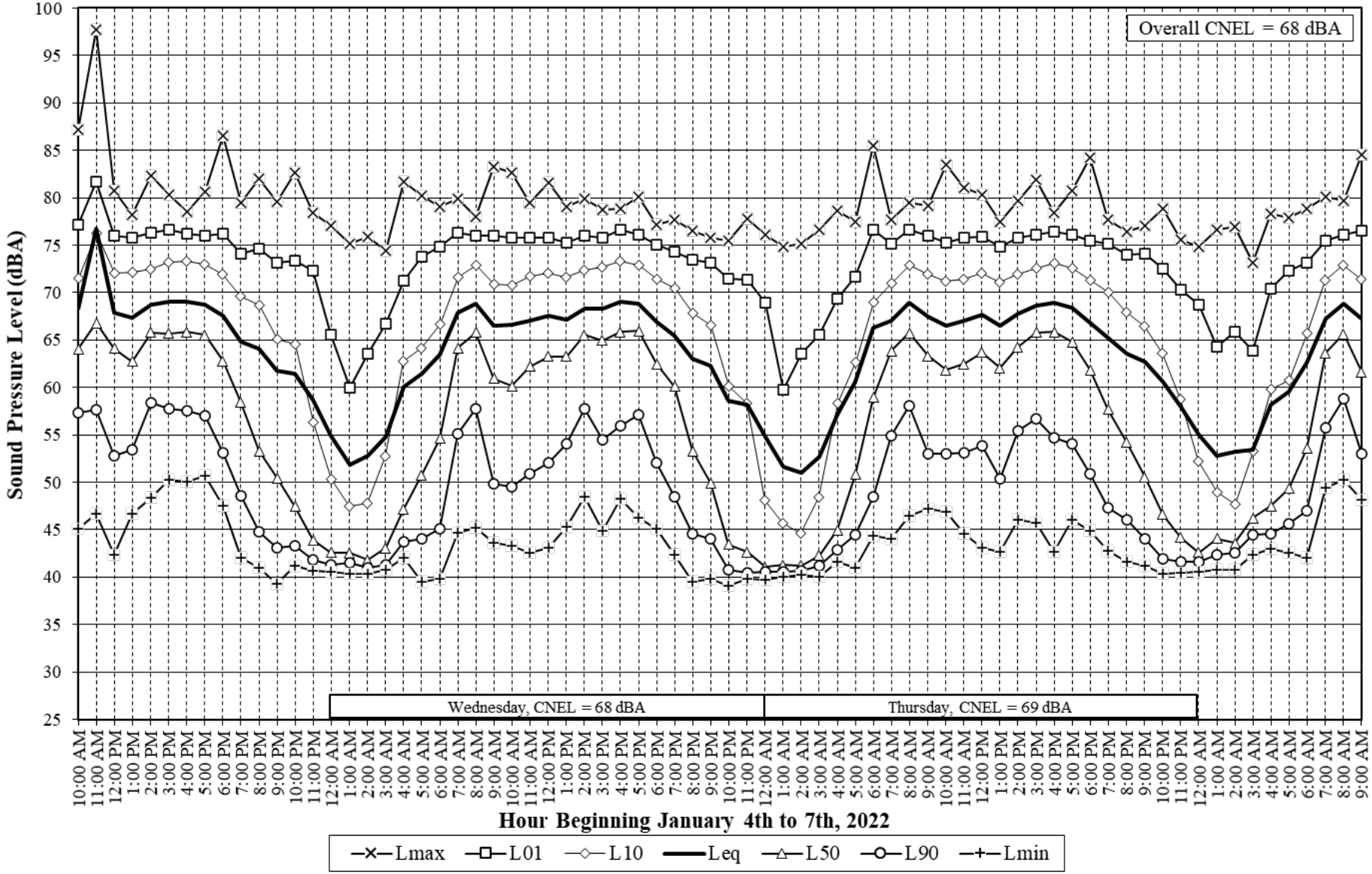
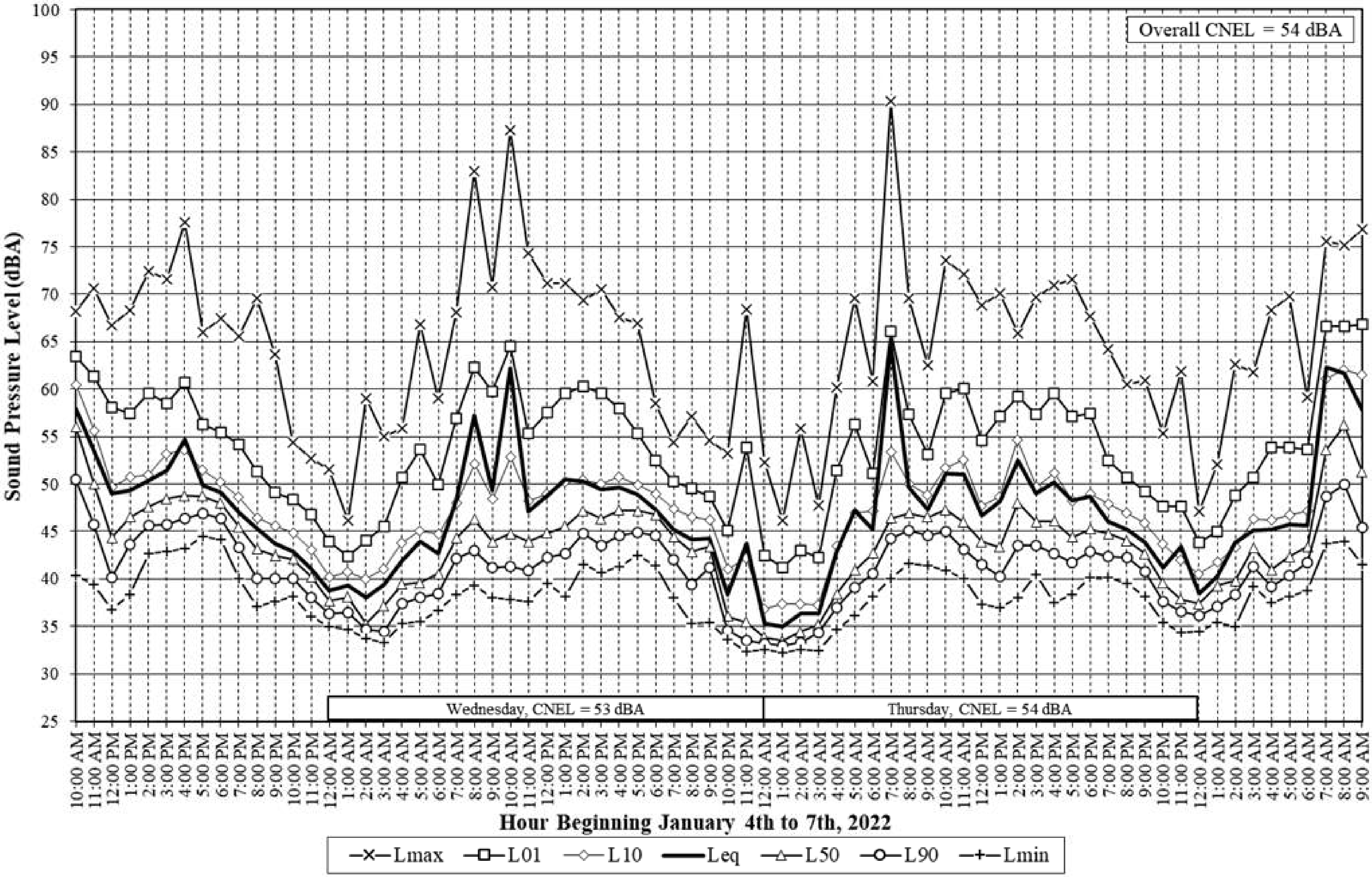


Chart : Measured Noise Levels at LT-2



FUTURE NOISE ENVIRONMENT

The future noise environment on the roadway frontages would continue to result from traffic along the adjacent roadways. To assess the future noise environment, we have assumed that future traffic volumes on Casa Grande Road. would increase by about 1-2% per year as a result of general growth throughout the city. Based on this traffic volume estimate, the future noise environment would be approximately 1 decibel higher than existing noise levels. Thus, exterior noise levels due to roadway traffic under future conditions would be 69 dBA CNEL at the residential facades closest to Casa Grande Road.

SIGNIFICANCE CRITERIA

Appendix G of the CEQA Guidelines states that a project would normally be considered to result in significant noise impacts if noise levels conflict with adopted environmental standards or plans or if noise generated by the project would substantially increase existing noise levels at sensitive receivers over a permanent or temporary basis. A significant impact would be identified for a proposed land use if it would be exposed to noise levels exceeding established guidelines or standards for noise and land use compatibility. A substantial permanent noise increase would occur if the noise level increase resulting from the project is 4 dBA CNEL as established by the Petaluma General Plan. A substantial temporary noise level increase would occur where noise from construction activities exceeds 60 dBA L_{eq} and the ambient noise environment by at least 5 dBA L_{eq} at adjacent land uses in the project vicinity for a period of one year or more. Vibration levels generated during demolition or construction activities would be significant if they cause cosmetic or structural damage to adjacent buildings.

NOISE IMPACTS AND MITIGATION MEASURES

Impact 1a: Exterior Residential Noise and Land Use Compatibility. Residential uses developed at portions of the project site would be exposed to normally and conditionally acceptable noise levels. **This is a potentially significant impact.**

The proposed project is a 59-unit condominium development will include 3 detached, 16 duets and 8 triplex residential units. A review of the project site plan and project description indicates that each of the residences will have fenced private outdoor open spaces to the rear and side of the residences and no project-wide common outdoor use areas.

A review of the project site plan indicates that the front side and rear yard areas of the residences directly adjacent to and/or perpendicular to Casa Grande Road will be exposed to CNEL levels of up to 69 dBA under future conditions, with these areas being considered “conditionally acceptable” for residential use by the City’s General Plan noise standards.

Though the private outdoor use areas of these residences are not considered unacceptable by City standards, to reduce noise levels in these private outdoor use areas we recommend the following mitigation measure be incorporated in the project design:

Mitigation Measure 1a: Exterior Noise Reduction at Private Yards

To reduce noise levels noise levels in the yards of the homes adjacent to Casa Grande Road to a CNEL of 60 dBA, noise barriers with a minimum top of wall elevation of seven (7) feet above grade level of the single-family home yards along Casa Grande Road should be built on property lines adjacent to the roadway as shown in Figure 2. Additionally, though the private outdoor use areas for the triplex multifamily homes adjacent to Casa Grande Road are not shown in the current drawings, where at grade private outdoor use areas occur adjacent to Casa Grande Road,

they should also be enclosed by a barrier with a minimum top of wall elevation of seven (7) feet above grade. Example locations of these barriers are also shown in Figure 2.

To be effective as a barrier to noise, the noise barrier walls should be built without cracks or gaps in the face or large or continuous gaps at the base or where they adjoin the homes or each other. The walls should also have a minimum surface weight of 3.0 lbs. per sq. ft. Small, dispersed, gaps in the base of the walls for landscape irrigation or drainage which do not compose more than 0.5% of the wall area are acceptable.

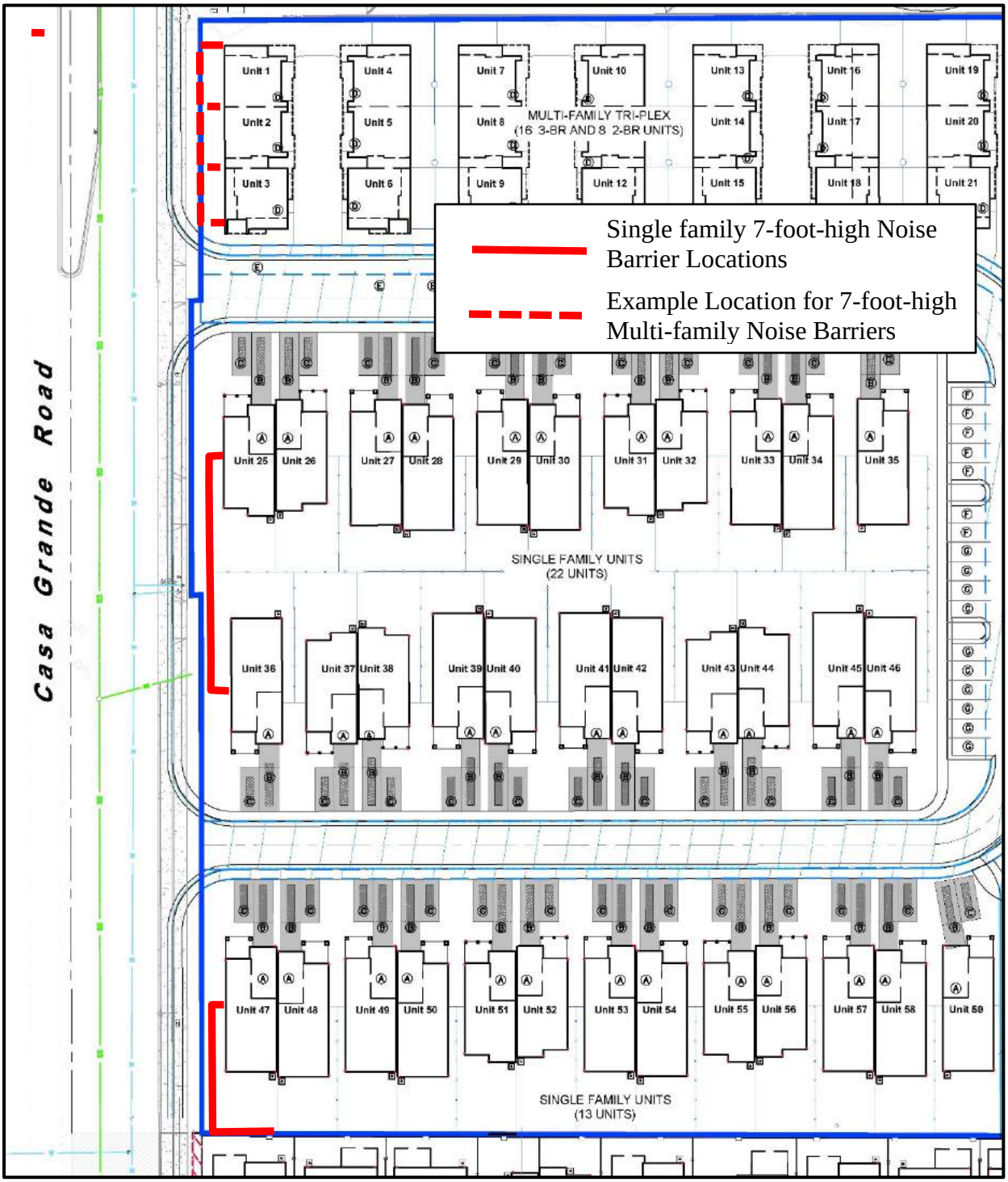


Figure 2: Site Plan with Noise Barrier Locations

Impact 1b: **Interior Residential Noise and Land Use Compatibility.** The interiors of residences adjacent to Casa Grande Road would be exposed to "conditionally acceptable" noise levels may be exposed to interior noise levels exceeding the City required 45 dBA CNEL. **This is a potentially significant impact.**

Residential units on the project site adjacent to or with a clear view of Casa Grande Road will be exposed to exterior noise levels of up to 69 dBA CNEL under future conditions. The City of Petaluma requires that interior noise levels within new residential units not exceed 45 dBA CNEL. In buildings of typical construction, with the windows partially open, interior noise levels are approximately 15 dBA lower than exterior noise levels. With the windows closed, standard residential construction typically provides 20 to 25 decibels of exterior to interior noise reduction. Considering this, where exterior day-night average noise levels are 65 dBA CNEL or less, interior noise levels can typically be maintained below City standards (45 dBA CNEL) with the incorporation of forced air mechanical ventilation systems in residential units. These systems allow the occupant the option of controlling noise by maintaining the windows shut. Where noise levels exceed 65 dBA CNEL, forced-air mechanical ventilation systems and sound-rated building elements are normally required.

Mitigation 1b.1: Average (CNEL) Interior Noise

a. To achieve the necessary noise reduction required to meet the requirements of the City General Plan standards, some form of forced air mechanical ventilation, satisfactory to the local building official, would be required in all residences with partial or full line of sight to Casa Grande Road traffic.
b. Given the anticipated exterior noise levels along Casa Grande Road, it may also be necessary to provide sound-rated windows and doors at upper floor residences facing or perpendicular to Casa Grande Road to maintain interior noise levels at or below 45 dBA CNEL. The degree of sound mitigation needed to achieve an interior CNEL of 45 dBA or less would vary depending on the final design of the building (relative window area to wall area) and the design of the exterior wall assemblies. However, based on the future exterior noise levels and typical residential construction, we would expect that windows and doors facing or with a view of Casa Grande Road may require STC ratings of between 28 and 30.
c. The specific determination of exterior wall assemblies and window/door STC ratings should be conducted on a unit-by-unit basis during the project design. The results of the analysis, including the description of the necessary noise control treatments, shall be submitted to the City along with the building plans and approved prior to issuance of a building permit.

Impact 2: **Project Operational Noise Generation** Noise due to the use and occupation of the project residences on adjacent noise sensitive uses is not expected to significantly increase or alter the existing noise environment at these uses. **This is a less-than-significant impact.**

The proposed project would place new residential uses adjacent to the existing senior housing development to the north and the future residential development to the south, and approximately 240 feet from the existing residential uses to the south, and over 300 feet from the classroom buildings across Casa Grande Road. The occupation and use of the proposed homes is expected to result in the typical noises associated with residential development, including voices of the new residents, home maintenance activities, barking dogs and children. The Heating Ventilation and Air Conditioning (HVAC) and other mechanical equipment associated with multifamily residential developments will also add noise the existing environment. However, though noise resulting from occupation of the new residences may noticeably change the noise environment in some areas, these sources are not expected to increase noise levels in any surrounding areas by

four or more dBA and the noise associated with the proposed residences is not incompatible with the surrounding land uses. Therefore, project operation is not judged to result in a noise impact.
Mitigation 2: None Needed

Impact 3: **Project-Generated Traffic Noise.** The proposed project would not substantially increase noise levels on a permanent basis at noise sensitive uses in the vicinity. **This is a less-than-significant impact.**

A significant impact would be identified if traffic generated by the project would substantially increase noise levels at sensitive receivers in the vicinity. A substantial increase would occur if the project traffic on area roadways where to result in a noise level increase of 4 dBA CNEL or greater. The traffic report for the development indicated that the project would generate an average of 494 trips per day, including 36 trips during the a.m. peak hour and 46 during the p.m. peak hour. Though the existing traffic volumes on Casa Grande Road were not given in this report, to cause a 4 dBA increase in noise along area roadway, the project would have to generate enough traffic to more than double current roadway volumes. Based on traffic volumes observed during the site noise surveys it is not considered possible for the number of traffic trips generated by the project to double current roadway volumes.
Mitigation 3: None Required.

Impact 4a: **Exposure to Construction Generated Groundborne Vibration.** Residences in the vicinity of the project site are not expected to be exposed to perceptible vibration levels from construction activities. **This is a less-than-significant impact.**

Construction activities would include site preparation work such as grading and the installation of utilities, foundation work, and new building framing. Construction techniques that generate the highest vibration levels, such as impact or vibratory pile driving, are not expected at this project. Construction activities would generally occur at distances of 200 feet or more from the nearest residential units, but activities near the northern project perimeter could occur at distances of as close as 60 feet from existing senior residential units and activities near the southern project perimeter could occur at distances of as close as 40 feet from the single-family homes currently under construction to the south.

For structural damage, the California Department of Transportation uses a vibration limit of 0.5 in/sec, PPV for buildings structurally sound and designed to modern engineering standards and 0.2 in/sec, PPV for buildings that are found to be structurally sound but where structural damage is a major concern.

Project construction activities such as drilling, the use of jackhammers, rock drills and other high-power or vibratory tools, and rolling stock equipment (tracked vehicles, compactors, etc.) may generate substantial vibration in the immediate vicinity. Building framing, exterior and interior finishing, and landscaping activities are not anticipated to be sources of substantial vibration. Construction activities may extend over several construction seasons, but construction vibration would not be substantial for most of this time except during vibration generating activities (as discussed above).

Table 7 presents vibration source levels for typical construction equipment at distances of 40 and 60 feet. Jackhammers typically generate vibration levels of 0.017 to 0.009 in/sec PPV, drilling typically generates vibration levels of 0.044 to 0.024 in/sec PPV, and vibratory rollers generate vibration levels of 0.104 to 0.056 in/sec PPV at distances of 40 to 60 feet. Based on this,

construction vibration levels would be well below the 0.50 in/sec PPV damage criteria at the closest residential structures.

In 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 (jackhammers and vibratory rollers). By use of administrative controls such as notifying adjacent land uses of scheduled construction activities and scheduling construction activities with the highest potential to produce perceptible vibration to hours with least potential to affect nearby residences, perceptible vibration can be kept to a minimum and as such would not result in a significant impact with respect to perception.

TABLE 7 Vibration Source Levels for Construction Equipment[1]

Equipment		PPV at 40 ft. (in/sec)	PPV at 60 ft. (in/sec)
Clam shovel drop		0.100	0.054
Hydromill (slurry wall)	in soil	0.004	0.008
	in rock	0.008	0.017
Vibratory Roller		0.104	0.056
Hoe Ram		0.044	0.024
Large bulldozer		0.044	0.024
Caisson drilling		0.044	0.024
Loaded trucks		0.038	0.020
Jackhammer		0.017	0.009
Small bulldozer		0.004	0.004

Mitigation 4a: None Required

Impact 5: **Construction Noise.** Noise levels generated by project construction activities would temporarily elevate ambient noise levels at sensitive land uses in the vicinity. Major noise generating construction activities would be limited to less than one construction season or less. **This is a less-than-significant impact.**

The construction of the project would generate noise and would temporarily increase noise levels at adjacent residential receivers. Noise impacts resulting from construction depend on the noise generated by various pieces of construction equipment operating on site, the timing and duration of noise generating activities, and the distance between construction noise sources and noise sensitive receptors. Construction of the project would involve site improvements, such as the establishment of utilities, excavation of foundations, building erection, paving, and landscaping. The hauling of excavated material and construction materials would also generate truck trips on local roadways. Construction activities are typically carried out in stages. During each stage of construction, there would be a different mix of equipment operating. Construction noise levels would vary by stage and vary within stages based on the amount of equipment in operation and location where the equipment is operating. Typical construction noise levels at a distance of 50 feet are shown in Table 6, which gives the average noise level ranges by construction phase. Most demolition and construction noise is in the range of 80 to 90 dBA at a distance of 50 feet from the source.

[1] Transit Noise and Vibration Impact Assessment, United States Department of Transportation, Office of Planning and Environment, Federal Transit Administration, May 2006.

TABLE 6: Typical Ranges of L_{eq} Construction Noise Levels at 50 Feet, dBA

Construction Stage	Domestic Housing		Office Building, Hotel, Hospital, School, Public Works		Public Works Roads & Highways, Sewers, and Trenches	
	I	II	I	II	I	II
Ground Clearing	83	83	84	84	84	84
Excavation	88	75	89	79	88	78
Foundations	81	81	78	78	88	88
Erection	81	65	87	75	79	78
Finishing	88	72	89	75	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.

The nearest noise sensitive uses will be 40 to 60 feet from the home construction activities. Average noise levels at this distance of typical construction activity at this site would reach 86 to 90 dBA during busy construction periods. These noise levels drop off at a rate of about 6 dBA per doubling of distance between the noise source and receptor. The adjacent, existing, residences would, therefore, be intermittently exposed to high levels of noise during periods of nearby construction. Typically, significant noise impacts do not result when standard construction noise control measures are enforced at the project site and when the duration of the noise generating construction period is limited to one construction season (typically one year) or less. Noise generated by major construction activities is not expected to result in noise levels exceeding 60 dBA L_{eq} and the ambient noise environment by 5 dBA L_{eq} for a period of greater than one year.

The following standard controls are assumed to be included in the project:

- Pursuant to the Municipal Code, restrict noise-generating activities at the construction site or in areas adjacent to the construction site to the hours between 7:00 a.m. and 10:00 p.m., Monday through Friday and 9:00 a.m. to 10:00 p.m. on Saturday, Sunday and State, Federal or Local Holidays.
- Equip all internal combustion engine driven equipment with intake and exhaust mufflers that are in good condition and appropriate for the equipment.
- Locate stationary noise generating equipment (e.g., compressors) as far as possible from adjacent residential receivers.
- Acoustically shield stationary equipment located near residential receivers with temporary noise barriers.
- Utilize "quiet" air compressors and other stationary noise sources where technology exists.
- Designate a "disturbance coordinator" responsible for responding to any complaints about construction noise. The disturbance coordinator will determine the cause of the noise complaint (e.g., bad muffler, etc.) and will require that reasonable measures be implemented to correct the problem.

With the implementation of these controls, and the limited duration of the noise generating construction period, the substantial temporary increase in ambient noise levels associated with construction activities would be less-than-significant.

Mitigation Measure 5: No additional measures required