3111 & 3119 SANTA ROSA AVENUE APARTMENTS AND STORAGE PROJECT ENVIRONMENTAL NOISE AND VIBRATION ASSESSMENT

Santa Rosa, California

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INTRODUCTION

The project parcels, 3111 and 3119 Santa Rosa Avenue, located between Santa Rosa Avenue and Highway 101 just south of Bellevue Avenue, are proposed to be pre-zoned to the General Commercial zoning district and annexed into the City of Santa Rosa. The project site is currently used for automobile and recreational vehicle (RV) storage. The project proposes to develop 48 units of rental multifamily housing and a self-storage facility. The northerly and westerly portion of the site will be developed with an approximately 40,000 square foot single story self-storage facility with a large central parking area for RV storage. The southeasterly portion of the site along Santa Rosa Avenue will be developed with a three-story 48-unit apartment project.

This report evaluates the project's potential to result in significant 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 groundborne vibration, summarizes applicable regulatory criteria, and discusses the results of the ambient noise monitoring survey completed to document existing noise conditions; 2) the Plan Consistency Analysis section discusses noise and land use compatibility utilizing policies in the City's General Plan; 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 mitigate project impacts to a less-than-significant level.

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 DNL. Typically, the highest steady traffic noise level during the daytime is about equal to the DNL and nighttime levels are 10 dBA lower. The standard is designed for sleep and speech protection and most jurisdictions apply the same criterion for all residential uses. Typical structural attenuation is 12-17 dBA with open windows. With closed windows in good condition, the noise attenuation factor is around 20 dBA for an older structure and 25 dBA for a newer dwelling. Sleep and speech interference is therefore possible when exterior noise levels are about 57-62 dBA DNL with open windows and 65-70 dBA DNL if the windows are closed. Levels of 55-60 dBA are common along collector streets and secondary arterials, while 65-70 dBA is a typical value for a primary/major arterial. Levels of 75-80 dBA are normal noise levels at the first row of development outside a freeway right-of-way. In order to achieve an acceptable interior noise environment, bedrooms facing secondary roadways need to be able to have their windows closed, those facing major roadways and freeways typically need special glass windows.

Annoyance

Attitude surveys are used for measuring the annoyance felt in a community for noises intruding into homes or affecting outdoor activity areas. In these surveys, it was determined that the causes for annoyance include interference with speech, radio and television, house vibrations, and interference with sleep and rest. The DNL as a measure of noise has been found to provide a valid correlation of noise level and the percentage of people annoyed. People have been asked to judge the annoyance caused by aircraft noise and ground transportation noise. There continues to be disagreement about the relative annoyance of these different sources. When measuring the percentage of the population highly annoyed, the threshold for ground vehicle noise is about 50 dBA DNL. At a DNL of about 60 dBA, approximately 12 percent of the population is highly annoyed. When the DNL increases to 70 dBA, the percentage of the population highly annoyed increases to about 25-30 percent of the population. There is, therefore, an increase of about 2 percent per dBA between a DNL of 60-70 dBA. Between a DNL of 70-80 dBA, each decibel increase increases by about 3 percent the percentage of the population highly annoyed. People appear to respond more adversely to aircraft noise. When the DNL is 60 dBA, approximately 30-35 percent of the population is believed to be highly annoyed. Each decibel increase to 70 dBA adds about 3 percentage points to the number of people highly annoyed. Above 70 dBA, each decibel increase results in about a 4 percent increase in the percentage of the population highly annoyed.

TABLE 1 Definition of Acoustical Terms Used in this Report

Term	Definition
Decibel, dB	A unit describing, the amplitude of sound, equal to 20 times the logarithm to the base 10 of the ratio of the pressure of the sound measured to the reference pressure. The reference pressure for air is 20 micro Pascals.
Sound Pressure Level	Sound pressure is the sound force per unit area, usually expressed in micro Pascals (or 20 micro Newtons per square meter), where 1 Pascal is the pressure resulting from a force of 1 Newton exerted over an area of 1 square meter. The sound pressure level is expressed in decibels as 20 times the logarithm to the base 10 of the ratio between the pressures exerted by the sound to a reference sound pressure (e. g., 20 micro Pascals). Sound pressure level is the quantity that is directly measured by a sound level meter.
Frequency, Hz	The number of complete pressure fluctuations per second above and below atmospheric pressure. Normal human hearing is between 20 Hz and 20,000 Hz. Infrasonic sound are below 20 Hz and Ultrasonic sounds are above 20,000 Hz.
A-Weighted Sound Level, dBA	The sound pressure level in decibels as measured on a sound level meter using the A-weighting filter network. The A-weighting filter de-emphasizes the very low and very high frequency components of the sound in a manner similar to the frequency response of the human ear and correlates well with subjective reactions to noise.
Equivalent Noise Level, L_{eq}	The average A-weighted noise level during the measurement period.
L_{max}, L_{min}	The maximum and minimum A-weighted noise level during the measurement period.
L_{01}, L_{10}, L_{50}, L_{90}	The A-weighted noise levels that are exceeded 1%, 10%, 50%, and 90% of the time during the measurement period.
Day/Night Noise Level, L_{dn} or DNL	The average A-weighted noise level during a 24-hour day, obtained after addition of 10 decibels to levels measured in the night between 10:00 pm and 7:00 am.
Community Noise Equivalent Level, CNEL	The average A-weighted noise level during a 24-hour day, obtained after addition of 5 decibels in the evening from 7:00 pm to 10:00 pm and after addition of 10 decibels to sound levels measured in the night between 10:00 pm and 7:00 am.
Ambient Noise Level	The composite of noise from all sources near and far. The normal or existing level of environmental noise at a given location.
Intrusive	That noise which intrudes over and above the existing ambient noise at a given location. The relative intrusiveness of a sound depends upon its amplitude, duration, frequency, and time of occurrence and tonal or informational content as well as the prevailing ambient noise level.

Source: Handbook of Acoustical Measurements and Noise Control, Harris, 1998.

TABLE 2 Typical Noise Levels in the Environment

Common Outdoor Activities	Noise Level (dBA)	Common Indoor Activities
	110 dBA	Rock band
Jet fly-over at 1,000 feet		
	100 dBA	
Gas lawn mower at 3 feet		
	90 dBA	
Diesel truck at 50 feet at 50 mph		Food blender at 3 feet
	80 dBA	Garbage disposal at 3 feet
Noisy urban area, daytime		
Gas lawn mower, 100 feet	70 dBA	Vacuum cleaner at 10 feet
Commercial area		Normal speech at 3 feet
Heavy traffic at 300 feet	60 dBA	
		Large business office
Quiet urban daytime	50 dBA	Dishwasher in next room
Quiet urban nighttime	40 dBA	Theater, large conference room
Quiet suburban nighttime		
	30 dBA	Library
Quiet rural nighttime		Bedroom at night, concert hall (background)
	20 dBA	
		Broadcast/recording studio
	10 dBA	
	0 dBA	

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

Fundamentals of Groundborne Vibration

Ground vibration consists of rapidly fluctuating motions or waves with an average motion of zero. Several different methods are typically used to quantify vibration amplitude. One method is the Peak Particle Velocity (PPV). The PPV is defined as the maximum instantaneous positive or negative peak of the vibration wave. In this report, a PPV descriptor with units of mm/sec or in/sec is used to evaluate construction generated vibration for building damage and human complaints. Table 3 displays the reactions of people and the effects on buildings that continuous or frequent intermittent vibration levels produce. The guidelines in Table 3 represent syntheses of vibration criteria for human response and potential damage to buildings resulting from construction vibration.

Construction activities can cause vibration that varies in intensity depending on several factors. The use of pile driving and vibratory compaction equipment typically generates the highest construction related groundborne vibration levels. Because of the impulsive nature of such activities, the use of the PPV descriptor has been routinely used to measure and assess groundborne vibration and almost exclusively to assess the potential of vibration to cause damage and the degree of annoyance for humans.

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

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

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

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

Velocity Level, PPV (in/sec)	Human Reaction	Effect on Buildings
0.01	Barely perceptible	No effect
0.04	Distinctly perceptible	Vibration unlikely to cause damage of any type to any structure
0.08	Distinctly perceptible to strongly perceptible	Recommended upper level of the vibration to which ruins and ancient monuments should be subjected
0.1	Strongly perceptible	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.

Regulatory Background – Noise

This section describes the relevant guidelines, policies, and standards established by State Agencies and the City of Santa Rosa. 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.

State of California

State CEQA Guidelines. The California Environmental Quality Act (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.

Checklist items (a) and (b) are applicable to the proposed project. In this case, the project is at least 8.4 miles from the nearest airport (Sonoma County Airport). As a result, the project would not expose people residing or working in the project area to excessive aircraft noise levels; therefore, item (c) is not carried further 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 Santa Rosa

City of Santa Rosa General Plan 2035. The City of Santa Rosa's General Plan1 includes the Noise and Safety Element, which provides guidelines to achieve the goal of maintaining an acceptable community noise level.

NS-B **Maintain an acceptable community noise level to protect the health and comfort of people living, working and/or visiting in Santa Rosa, while maintaining a visually appealing community.**

NS-B-1 Do not locate noise-sensitive uses in proximity to major noise sources, except residential is allowed near rail to promote future ridership.

NS-B-2 Encourage residential developers to provide buffers other than sound walls, where practical. Allow sound walls only when projected noise levels at a site exceed land use compatibility standards in Figure 12-1.

NS-B-3 Prevent new stationary and transportation noise sources form creating a nuisance in existing developed areas. Use a comprehensive program of noise prevention through planning and mitigation and consider noise impacts as a crucial factor in project approval. *The Land Use Compatibility Standards specify normally acceptable levels for community noise in various land use areas.*

NS-B-4 Require new projects in the following categories to submit an acoustical study, prepared by a qualified acoustical consultant:

- All new projects proposed for areas with existing (exterior) noise above 60 dBA DNL. Mitigation shall be sufficient to reduce noise levels below 45 dBA DNL in (interior) habitable rooms and 60 dBA DNL in (interior) private and shared recreational facilities. Additions to existing housing units are exempt.
- All new projects that could generate noise whose impacts on other existing uses would be greater than those normally acceptable (as specified in the Land Use Compatibility Standards)

1 *Santa Rosa General Plan 2035*, November 3, 2009.

NS-B-5 Pursue measures to reduce noise impacts primarily through site planning. Engineering solutions for noise mitigation, such as sound walls, are the least desirable alternative.

NS-B-6 Do not permit existing uses to generate new noises exceeding normally acceptable levels unless:

- Those noises are mitigated to acceptable levels; or
- The activities are specifically exempted by the City Council on the basis of community health, safety, and welfare.

NS-B-7 Allow reasonable latitude for noise generated by uses that are essential to community health, safety, and welfare. These include emergency medical helicopter and vehicle operations, and emergency vehicle sirens.

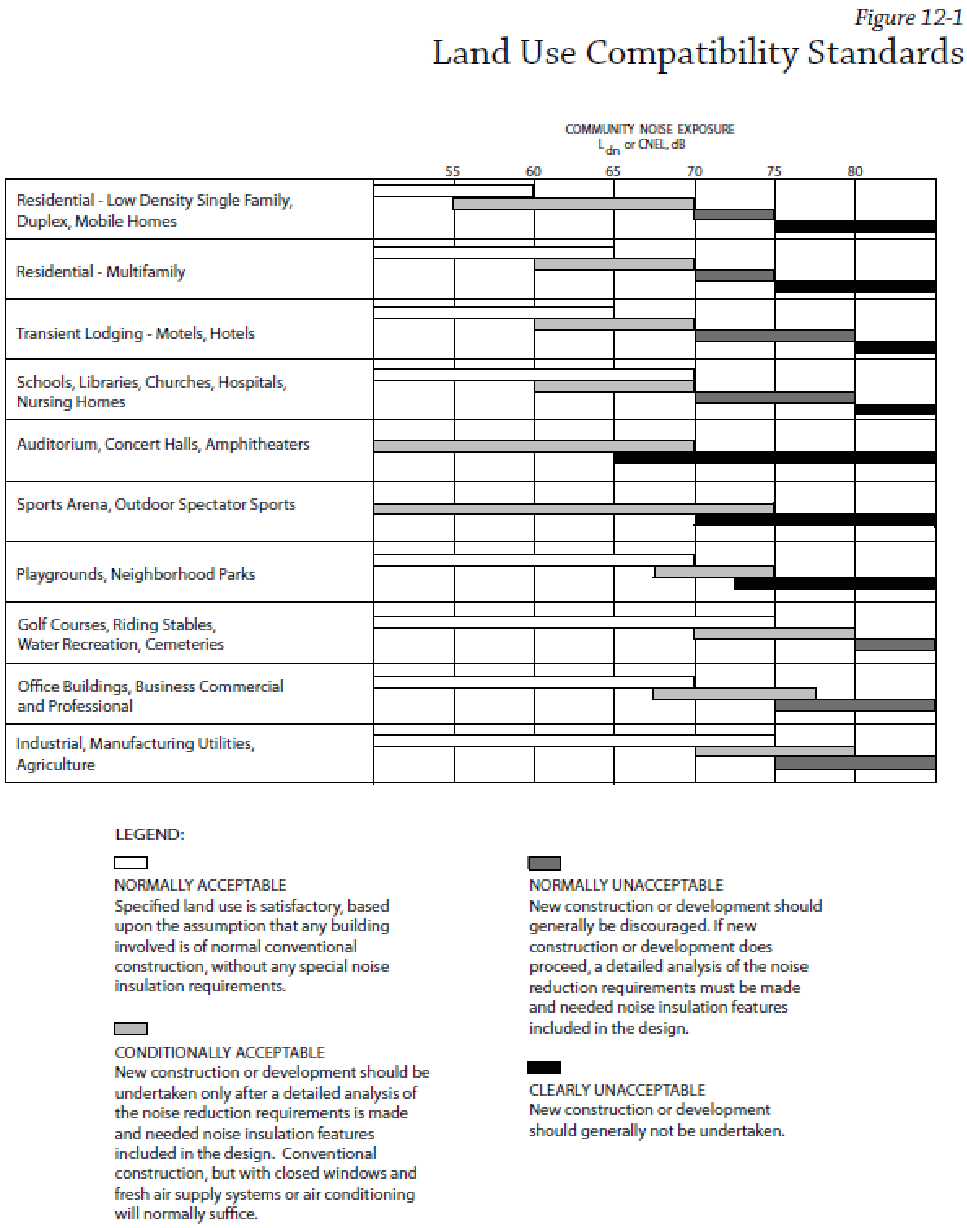
NS-B-8 Adopt mitigations, including reduced speed limits, improved paving texture, and traffic controls, to reduce noise to normally acceptable levels in areas where noise standards may be exceeded (e.g., where homes front regional/arterial streets and in areas of mixed-use development)

NS-B-9 Encourage developers to incorporate acoustical site planning into their projects. Recommended measures include:

- Incorporating buffers and/or landscaped earth berms;
- Orienting windows and outdoor living areas away from unacceptable noise exposure;
- Using reduced-noise pavement (rubberized-asphalt);
- Incorporating traffic calming measures, alternative intersection designs, and lower speed limits; and
- Incorporating state-of-the-art structural sound attenuation and setbacks.

NS-B-14 Discourage new projects that have potential to create ambient noise levels more than 5 dBA DNL above the existing background, within 250 feet of sensitive receptors.

Figure 12-1



Source: *Source: Santa Rosa General Plan 2035, 2009*

City of Santa Rosa Municipal Code. The City of Santa Rosa's Municipal Code provides provisions for allowable noise levels for stationary equipment. The portions of the code that are relevant for this project are as follows:

Section 17-16.030 Ambient Base Noise Level Criteria
The following criteria will be used as a base (ambient noise level) from which noise levels can be compared.

Zone	Time	Sound Level A (decibels) Community Environment Classification
R1 and R2	10 p.m. to 7 a.m.	45
R1 and R2	7 p.m. to 10 p.m.	50
R1 and R2	7 a.m. to 7 p.m.	55
Multi-family	10 p.m. to 7 a.m.	50
Multi-family	7 a.m. to 10 p.m.	55
Office & Commercial	10 p.m. to 7 a.m.	55
Office & Commercial	7 a.m. to 10 p.m.	60
Intensive Commercial*	10 p.m. to 7 a.m.	55
Intensive Commercial	7 a.m. to 10 p.m.	65
Industrial	Anytime	70

Section 17-16.040 Standards for Determining Violations
Notwithstanding any other provision of this chapter, and in addition thereto, it is unlawful for any person to willfully make or continue, or cause to be made or continued, any loud, unnecessary, or unusual noise which disturbs the peace or quiet of any neighborhood or which causes discomfort or annoyance to any reasonable person of normal sensitiveness residing in the area.

The standards which shall be considered in determining whether a violation of the provisions of this section exists shall include, but not be limited to the following:

(A) The level of noise;

(B) The intensity of the noise;

(C) Whether the nature of the noise is usual or unusual;

(D) Whether the origin of the noise is natural or unnatural;

(E) The level and intensity of the background noise, if any;

(F) The proximity of the noise to residential sleeping facilities;

(G) The nature and zoning of the area within which the noise emanates;

(H) The density of the inhabitation of the area within which the noise emanates;

(I) The time of the day or night the noise occurs;

(J) The duration of the noise;

(K) Whether the noise is recurrent, intermittent or constant;

(L) Whether the noise is produced by a commercial or noncommercial activity. (Prior code Ch. 27, Art. I, Div. 5)

Section 17-16.120 Machinery and Equipment
It is unlawful for any person to operate any machinery, equipment, pump, fan, air-conditioning apparatus or similar mechanical device in any manner so as to create any noise which would cause the noise level at the property line of any property to exceed the ambient base noise level by more than five decibels.

Existing Noise Environment

The project site is located at 3111 and 3119 Santa Rosa Avenue in the City of Santa Rosa, California. The site is bound to the west by Highway 101 (US-101), to the east by Santa Rosa Avenue, to the south by an existing motel, mobile home park, and rental car business, and to the north by existing truck rental business and self-storage facility. East of Santa Rosa Avenue are automotive businesses and multifamily residential land uses.

A noise monitoring survey was performed to quantify and characterize ambient noise levels at the site between Thursday July 15, 2021 and Tuesday July 20, 2021. The monitoring survey included two long-term noise measurements (LT-1 and LT-2) and one short-term noise measurements (ST-1) as shown in Figure 1. Figure 2 shows the proposed project overlaid on a satellite image. The noise environment at the site results primarily from traffic along US-101 and Santa Rose Avenue. Secondary noise sources include overhead aircraft and neighboring commercial land uses.

Long-term measurement LT-1 was located on the west side of the site, approximately 145 feet east of the US-101 center line. This location serves to characterize the background noise environment of the site along the western property line, originating primarily from vehicular traffic on US-101. As shown in Table 4, average noise levels at this location typically ranged from 69 to 75 dBA L_{eq} during the day and from 64 to 74 dBA L_{eq} at night. The day-night average noise level was 77 dBA DNL. Figure 3 shows the daily trends for LT-1.

Long-term measurement LT-2 was located near the northeast corner of the site, approximately 95 feet west of the Santa Rosa Avenue center line. This location serves to characterize the background noise environment originating primarily from vehicular traffic on Santa Rosa Avenue. As shown in Table 4, average noise levels at this location typically ranged from 63 to 71 dBA L_{eq} during the day and from 53 to 66 dBA L_{eq} at night. The day-night average noise level was 69 dBA DNL. Figure 4 shows the daily trends for LT-2.

TABLE 4 Summary of Long-Term Measurement Data (dBA)

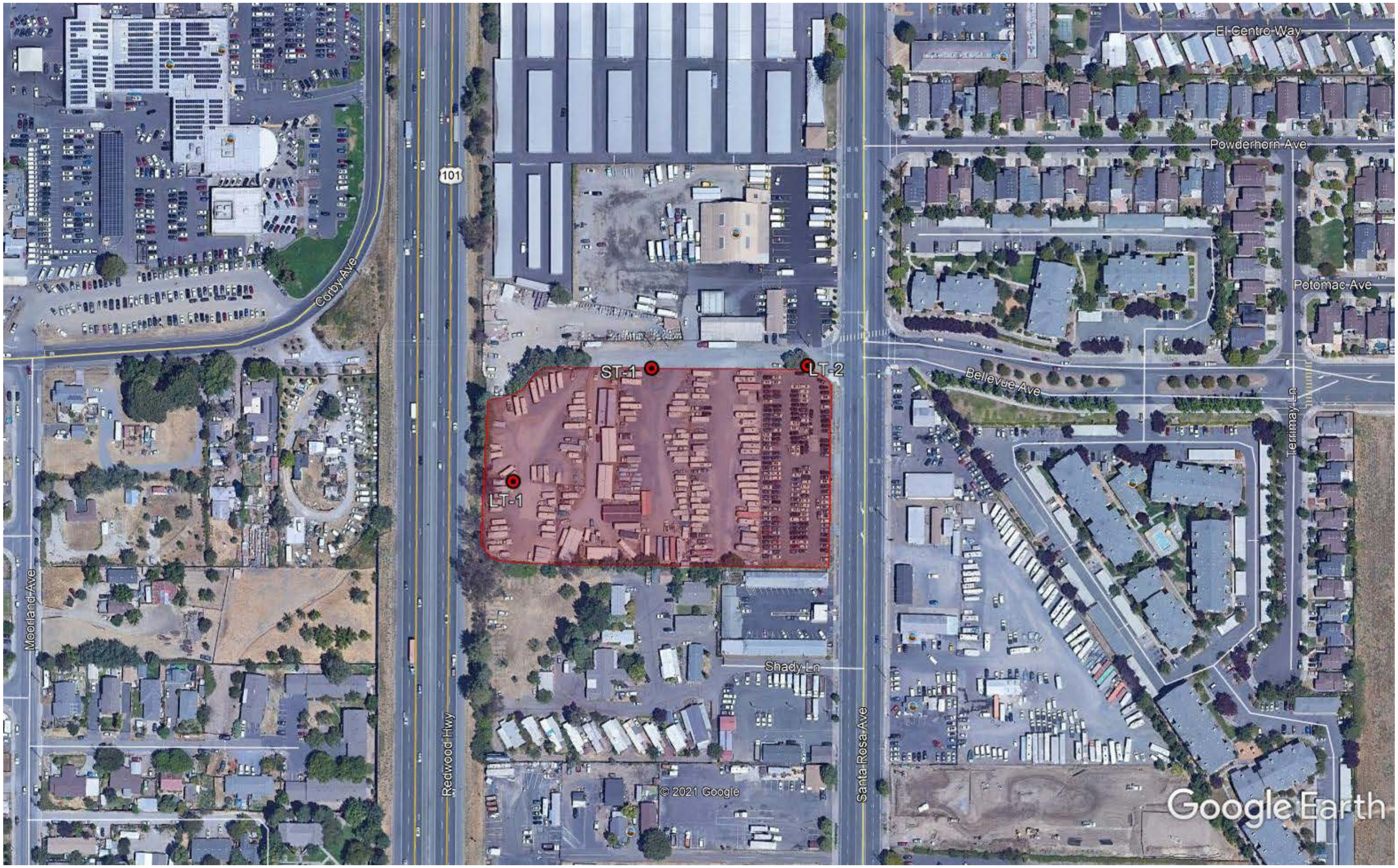
Location	Date	Hourly-Average Noise Level, L_{eq}		DNL
		Daytime	Nighttime	
LT-1, ~145 ft. East of US-101 Center Line	Thursday, 7/15/2021 to Tuesday, 7/20/2021	69 – 75	64 – 74	77
LT-2, ~95 ft. West of Santa Rosa Avenue Center Line	Thursday, 7/15/2021 to Tuesday, 7/20/2021	63 – 71	53 – 66	69

Short-term measurement ST-1 was made on Thursday July 15, 2021, beginning at 12:20 p.m. and concluding at 12:40 p.m. Measurement ST-1 was located near the center of the northern property line of the site, approximately 375 feet west of the center line of Santa Rosa Avenue and 390 feet east of the center line of US-101, at the proposed residential building setback. Primary noise sources at ST-1 were vehicular traffic from US-101 and Santa Rosa Avenue. As shown in Table 5, the maximum noise level measured at ST-1 was 78 dBA L_{max}, and the average noise level was 59 dBA L_{eq}.

TABLE 5 Summary of Short-Term Noise Measurement Data (dBA)

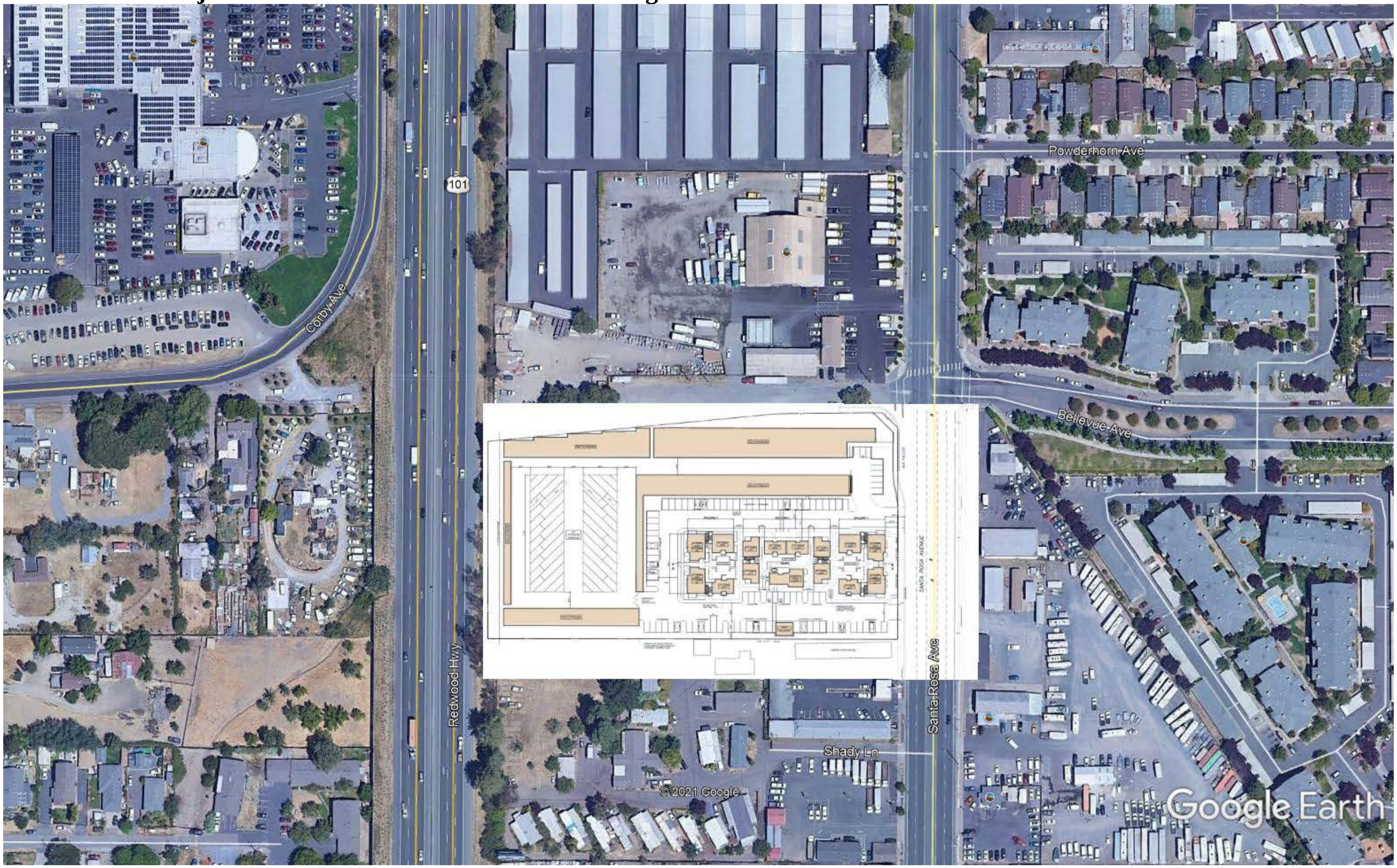
Noise Measurement Location	Date	L_{max}	$L_{(2)}$	$L_{(8)}$	$L_{(25)}$	$L_{(50)}$	$L_{eq(10\text{-}min)}$	L_{eq}
LT-2, ~95 ft. West of Santa Rosa Avenue Center Line	Thursday 7/15/2021 12:20 p.m. to 12:40 p.m.	78	62	60	59	54	52	59

FIGURE 1 Site Aerial and Noise Measurement Locations



Source: Google Earth, 2021.

FIGURE 2 Project Site Plan Overlaid on a Satellite Image



Source: Google Earth, 2021.

FIGURE 3 Daily Trend in Noise Levels for LT-1 from July 15, 2021 through July 20, 2021

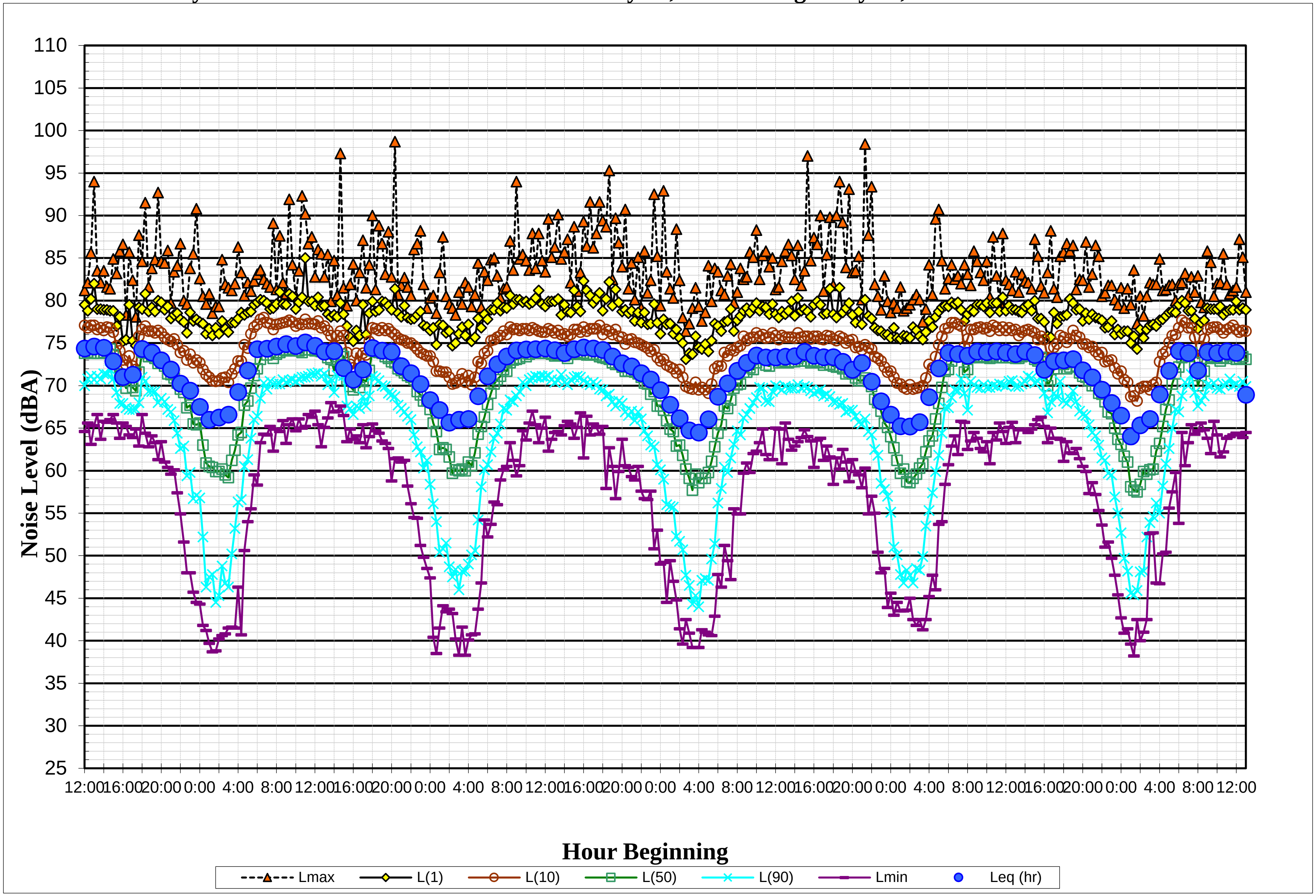
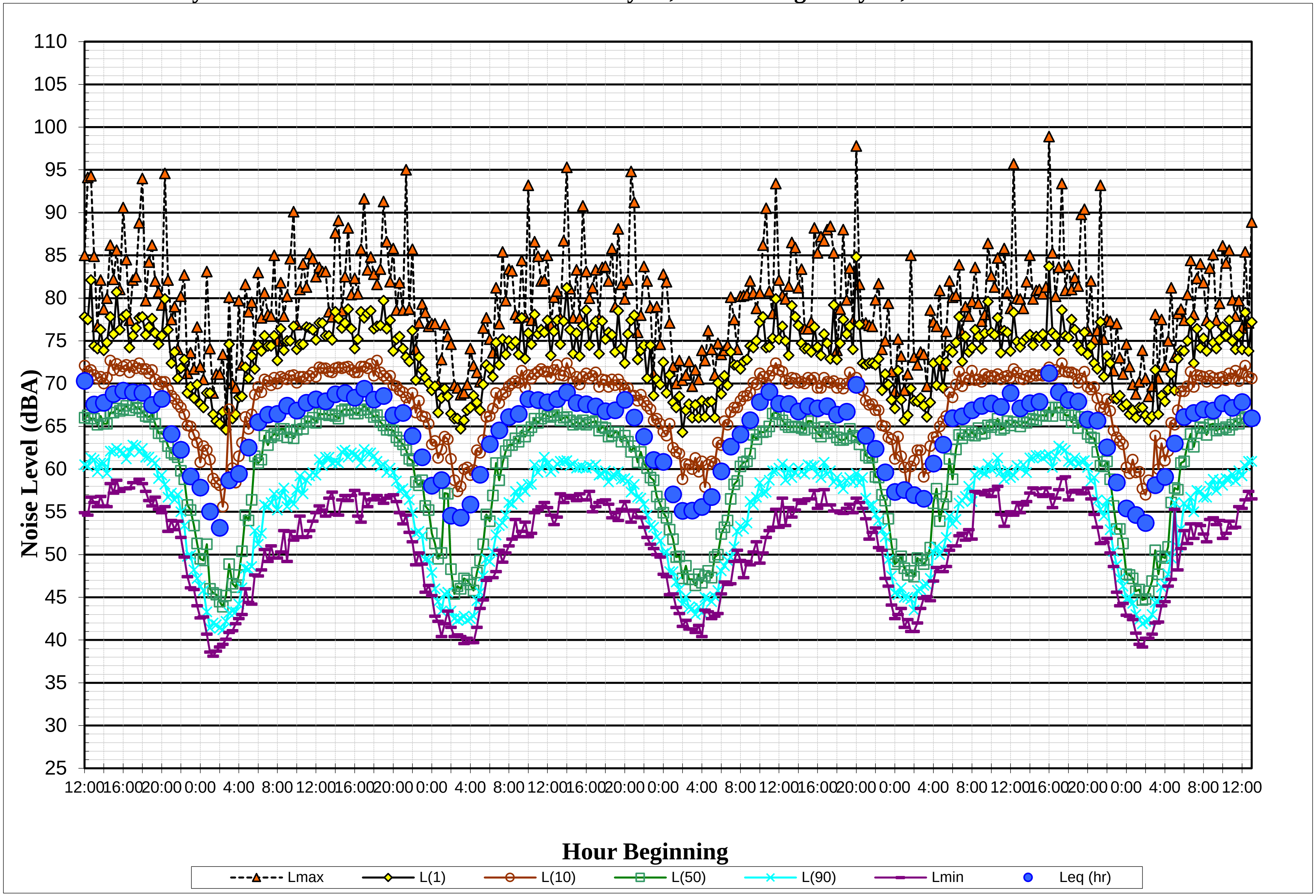


FIGURE 4 Daily Trend in Noise Levels for LT-2 from July 15, 2021 through July 20, 2021



PLAN CONSISTENCY ANALYSIS

Noise and Land Use Compatibility

The applicable Santa Rosa General Plan policies were presented in detail in the Regulatory Background section and are summarized below:

- The City's "normally acceptable" exterior noise level threshold for multi-family residences is 65 dBA DNL.

- City's standard for interior noise levels in residences is 45 dBA DNL in habitable rooms.

- The Cal Green Code standards specify an interior noise environment attributable to exterior sources not to exceed an hourly equivalent noise level ($L_{eq\ (1\text{-}hr)}$) of 50 dBA in occupied areas of nonresidential uses during any hour of operation.

Future Exterior Noise Environment

The proposed project includes ground-level interior courtyards shielded from roadway noise by the proposed project buildings (Courtyard 1, Courtyard 2, and Courtyard 3). The future day-night average noise levels at Courtyard 1, Courtyard 2, and Courtyard 3 would be up to 57 dBA DNL, 61 dBA DNL, and 64 dBA DNL, respectively. The future noise levels at Courtyard 1, Courtyard 2, and Courtyard 3 are below the City's normally acceptable level of 65 dBA DNL.

The project plans show balconies and small patios on levels 1 through 3 of Buildings 1, 2, and 3. The 1st through 3rd floor future noise levels at the private patios and balconies of Building 1 would be up to 69 dBA DNL, 68 dBA DNL, and 69 dBA DNL, respectively. The 1st through 3rd floor future noise levels at the private patios and balconies of Building 2 would be up to 68 dBA DNL. The 1st through 3rd floor future noise levels at the private patios and balconies of Building 3 would be up to 70 dBA DNL, 70 dBA DNL, and 69 dBA DNL, respectively. Common industry practice, with regard to the exterior noise assessment of multi-family land uses is to apply the exterior noise threshold to common outdoor use areas and not to small private outdoor use areas (e.g., balconies, patios, etc.). This common practice is due to the following considerations:

1. Frequency of use – small balconies and patios associated with multi-family residential land uses are not frequently used by residents for outdoor enjoyment, particularly when adjacent to transportation-related noise sources and when other outdoor amenity areas are provided as a part of a project. It is anticipated that residents of this project that desire a quiet outdoor use area would use the shared open space area for outdoor enjoyment.

2. Feasibility of mitigation – it is not possible to mitigate high noise exposures to meet the exterior noise thresholds without completely enclosing the space. The necessary mitigation to meet the exterior noise threshold eliminates the outdoor space altogether.

Future Interior Noise Environment

<u>Residential</u>

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. Where exterior noise levels range from 60 to 65 dBA DNL, the inclusion of adequate forced-air mechanical ventilation is often the method selected to reduce interior noise levels to acceptable levels by closing the windows to control noise. Where noise levels exceed 65 dBA DNL, forced-air mechanical ventilation systems and sound-rated construction methods are normally required. Such methods or materials may include a combination of smaller window and door sizes as a percentage of the total building façade facing the noise source, sound-rated windows and doors, sound rated exterior wall assemblies, and mechanical ventilation so windows may be kept closed at the occupant's discretion.

Building 1

Residential units are located on floors one through three of the proposed Building 1. Units located along the western façade nearest US-101 would be set back from the centerline of the roadway by approximately 330 feet. The project's proposed Self-Storage buildings shield Building 1 from US-101. The units facing US-101 would be exposed to future exterior noise levels up to 69 dBA DNL. Assuming windows to be partially open, future interior noise levels would be 54 dBA DN. Table 6 below lists noise levels at Building 1 façades at different elevations. As indicated in Table 6, the exterior noise exposure would range from 44 to 69 dBA DNL.

To meet the interior noise requirements set forth by the City of Santa Rosa of 45 dBA DNL, implementation of noise insulation features would be required. Preliminary calculations indicate that residential units along the 1^{st}-3^{rd} floor southern and western building façades would require windows and doors with a rating of 28 STC – 34 STC with adequate forced-air mechanical ventilation to meet the interior noise threshold of 45 dBA DNL. Residential units along the 3^{rd} floor norther building façade would require windows and doors with a rating of 28 STC – 32 STC with adequate forced-air mechanical ventilation to meet the interior noise threshold of 45 dBA DNL

TABLE 6 Future Noise Exposure at Building 1 Façades

Floor	Future Noise Exposure at Facades (dBA DNL)			
	North	East	South	West
1	54	44	67	64
2	57	45	68	65
3	66	50	69	69

Building 2

Residential units are located on floors one through three of the proposed Building 2. Building 2 is shielded from US-101 by the project's proposed Self-Storage buildings and Building 1 and shielded from Santa Rosa Avenue by the project's proposed Building 3. The units would be exposed to future exterior noise levels up to 68 dBA DNL. Assuming windows to be partially open, future interior noise levels would be 53 dBA DNL. Table 7 below lists noise levels at Building 2 façades at different elevations. As indicated in Table 7, the exterior noise exposure would range from 62 to 68 dBA DNL.

To meet the interior noise requirements set forth by the City of Santa Rosa of 45 dBA DNL, implementation of noise insulation features would be required. Preliminary calculations indicate that residential units along the 1st-3rd floors would require windows and doors with a rating of 28 STC – 34 STC with adequate forced-air mechanical ventilation to meet the interior noise threshold of 45 dBA DNL.

TABLE 7 Future Noise Exposure at Building 2 Façades

Floor	Future Noise Exposure at Facades (dBA DNL)			
	North	East	South	West
1	62	65	68	65
2	62	65	68	65
3	65	65	68	65

Building 3

Residential units are located on floors one through three of the proposed Building 3. Units located along the eastern façade nearest Santa Rosa Avenue would be set back from the centerline of the roadway by approximately 90 feet. The units facing Santa Rosa Avenue would be exposed to future exterior noise levels up to 70 dBA DNL. Assuming windows to be partially open, future interior noise levels would be 55 dBA DNL. Table 8 below lists noise levels at Building 3 façades at different elevations. As indicated in Table 8, the exterior noise exposure would range from 66 to 70 dBA DNL.

To meet the interior noise requirements set forth by the City of Santa Rosa of 45 dBA DNL, implementation of noise insulation features would be required. Preliminary calculations indicate that residential units along the 1st-3rd floors would require windows and doors with a rating of 28 STC – 34 STC with adequate forced-air mechanical ventilation to meet the interior noise threshold of 45 dBA DNL.

TABLE 8 Future Noise Exposure at Building 3 Façades

Floor	Future Noise Exposure at Facades (dBA DNL)			
	North	East	South	West
1	68	69	70	66
2	68	69	70	67
3	68	69	70	67

Nonresidential

The performance method enforced in the Cal Green Code requires that interior noise levels be maintained at 50 dBA $L_{eq(1\text{-}hr)}$ or less during hours of operation at the proposed buildings. Standard construction materials for commercial uses would provide about 25 dBA of noise reduction in interior spaces. The inclusion of adequate forced-air mechanical ventilation systems is normally required so windows may be kept closed at the occupant's discretion and would provide an additional 5 dBA reduction.

Nonresidential uses would include the self-storage manager's office located at the northeastern corner of the project site. The eastern facade would be setback approximately 85 feet from the centerline of Santa Rosa Avenue. At this distance, future hourly average noise levels during daytime hours would be up to 71 dBA $L_{eq(1\text{-}hr)}$ at the building exterior. With standard construction and assuming windows to be partially open, future interior noise levels would be 46 dBA $L_{eq(1\text{-}hr)}$. The future interior noise level will meet the daytime threshold of 50 dBA $L_{eq(1\text{-}hr)}$.

Nonresidential uses would include the community room and office located south of Building 2. The eastern facade would be setback approximately 190 feet from the centerline of Santa Rosa Avenue and would be shielded by Buildings 2 and 3. At this distance future hourly average noise levels during daytime hours would be up to 68 dBA $L_{eq(1\text{-}hr)}$ at the building exterior. With standard construction and assuming windows to be partially open, future interior noise levels would be 43 $L_{eq(1\text{-}hr)}$. The future interior noise level will meet the daytime threshold of 50 dBA $L_{eq(1\text{-}hr)}$.

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 reduce project impacts to less-than-significant levels.

Significance Criteria

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

- 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 or Municipal Code at existing noise-sensitive receptors surrounding the project site.
    - Temporary Noise Increase. A significant temporary noise impact would be identified if construction would occur outside of the hours specified in the Municipal Code of if construction-related noise would temporarily increase ambient noise levels at sensitive receptors.

- Permanent Noise Increase. A significant permanent noise level increase would occur if the project would result in a noise level increase of 5 dBA DNL or greater.

- 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 City of Santa Rosa’s General Plan or Municipal Code. They City of Santa Rosa limits stationary noise sources to 5 dBA above the ambient noise levels.

- **Generation of Excessive Groundborne Vibration.** 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 buildings (see Table 3).

Impact 1a: **Temporary Construction Noise.** Existing noise-sensitive land uses would be exposed to a temporary increase in ambient noise levels due to project construction activities. The incorporation of construction best management practices as project conditions of approval would result in a **less-than significant impact.**

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.

While noise thresholds for temporary construction are not provided in the City's General Plan or Municipal Code, the Fundamentals section of this report provides a threshold of 45 dBA for speech interference indoors. Assuming a 15 dBA exterior-to-interior reduction for standard residential construction and a 25 dBA exterior-to-interior reduction for standard commercial construction, this would correlate to an exterior threshold of 60 dBA L_{eq} at residential land uses and 70 dBA L_{eq} at commercial land uses.

The construction methods and timing for the project are undefined at this time, however based on the project type and scope of the site improvements needed we would expect that on-site construction activities would be completed within 15 months. It is assumed that construction for the proposed project will occur during daytime hours only.

However, the actual noise levels from construction will depend on the noise generated by various pieces of construction equipment, the timing and duration of noise-generating activities, the distance between construction noise sources and noise-sensitive receptors, any shielding provided by intervening structures or terrain, and ambient noise levels. Construction noise impacts primarily result when construction activities occur during noise-sensitive times of the day (early morning, evening, or nighttime hours), when construction occurs in areas immediately adjoining noise-sensitive land uses, or when construction durations last over extended periods of time.

Each standard construction phase includes a different mix of equipment operating. The highest noise levels are typically generated when impact tools are used (e.g., jackhammers, hoe rams). Site grading and excavation activities would also generate high noise levels as these phases often require the simultaneous use of multiple pieces of heavy equipment, such as dozers, excavators, scrapers, and loaders. Lower noise levels result from construction activities when less heavy equipment is required to complete the tasks. Pile driving is not anticipated for project construction.

Typical construction noise levels at a distance of 50 feet are shown in Tables 9 and 10. Table 9 illustrates the average noise level range by typical construction phase type and Table 10 shows the maximum noise level range for different construction equipment. The typical range of maximum instantaneous noise levels would range from 71 to 88 dBA L_{max} at a distance of 50 feet (see Table 10) from the equipment.

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

Equipment Category	L_{max} Level (dBA)[1,2]	Impact/Continuous
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.

The equipment expected to be used during each phase of project construction are undefined at this time, however based on the project type and scope of the site improvements default inputs were used and summarized in Table 11. Federal Highway Administration's (FHWA's) Roadway Construction Noise Model (RCNM) was used to calculate the hourly average noise levels for each phase of construction, assuming every piece of equipment would operate simultaneously, which would represent the worst-case scenario. This construction noise model 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.

For each phase, the worst-case hourly average noise level, as estimated at the property line of each surrounding land use, is also shown in Table 11. For overall construction noise levels, multiple pieces of equipment used simultaneously would add together creating a collective noise source. While every piece of equipment per phase would likely be scattered throughout the site, the noise-sensitive receptors surrounding the site would be subject to the collective noise source generated by all equipment operating at once. Therefore, to assess construction noise impacts at the receiving property lines of noise-sensitive receptors, the collective worst-case hourly average noise level for each phase was positioned at the geometrical center of the site and propagated to the nearest property line of the surrounding land uses. These noise level estimates are also shown in Table 11. Noise levels in the table do not assume reductions due to intervening buildings or existing barriers.

TABLE 11 Estimated Construction Noise Levels at Nearby Land Uses

Phase of Construction	Time Duration	Construction Equipment (Quantity)	Calculated Hourly Average Noise Levels, L_{eq} (dBA)				
			South Hotel (180 ft)	North Commercial (230 ft)	East Commercial (260ft)	NE Residential (400 ft)	East Residential (550ft)
Demolition	1/3/2022-1/28/2022	Concrete/Ind. Saw (1) Excavator (1) Rubber-Tired Dozer (2)	74	71	70	67	64
Site Preparation	1/29/2022-2/4/2022	Rubber-Tired Dozer (3) Tractor/Loader/Backhoe (4)	71	69	68	64	61
Grading/ Excavation	2/5/2022-2/16/2022	Excavator (1) Grader (1) Tractor/Loader/Backhoe (3)	76	74	73	69	66
Trenching/ Foundation	2/17/2022-3/2/2022	Tractor/Loader/Backhoe (1) Excavator (1)	71-76[a]	68-74[a]	67-73[a]	64-69[a]	61-67[a]
Building –Exterior	2/17/2022-1/4/2023	Crane (1) Forklift (3) Generator Set (1) Welder (1) Tractor/Loader/Backhoe (3)	75-76[b]	73-74[b]	72-73[b]	68-69[b]	65-67[b]
Building – Interior/ Architectural Coating	1/31/2023-2/23/2023	Air Compressor (1) Aerial Lift (1)	64	61	60	57	54
Paving	1/5/2023-1/30/2023	Cement Mixer Truck (2) Paver (1) Paving Equipment (2) Roller (2) Tractor/Loader/Backhoe (3)	83	81	80	76	74

[a] Range of hourly average noise levels reflects the trenching/foundation phase only and in combination with the building-exterior phase.
[b] Range of hourly average noise levels reflects the building-exterior phase only and in combination with the trenching/foundation phase.

As shown in Table 11, noise levels at times would exceed 60 dBA L_{eq} at existing residences during typical construction and at times exceed 70 dBA L_{eq} at existing commercial land uses. This is a potentially significant temporary impact.

Construction Best Management Practices

Reasonable regulation of the hours of construction, as well as regulation of the arrival and operation of heavy equipment and the delivery of construction material, are necessary to protect the health and safety of persons, promote the general welfare of the community, and maintain the quality of life. The City shall require the construction crew to adhere to the following construction best management practices to reduce construction noise levels emanating from the site and minimize disruption and annoyance at existing noise-sensitive receptors in the project vicinity.

- Construct temporary noise barriers, where feasible, to screen mobile and stationary construction equipment. Temporary noise barrier fences would provide noise reduction if the noise barrier interrupted the line-of-sight between the noise source and receiver and if the barrier is constructed in a manner that eliminates any cracks or gaps.
- All gasoline-powered construction equipment shall be equipped with an operating muffler or baffling system as originally provided by the manufacturer, and no modification to these systems is permitted.
- 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 as feasible. If they must be located near receptors, adequate muffling (with enclosures where feasible and appropriate) shall be used to reduce noise levels at the adjacent sensitive receptors. Any enclosure openings or venting shall face away from sensitive receptors.
- Utilize “quiet” air compressors and other stationary noise sources where technology exists.
- Construction staging areas shall be established at locations that will create the greatest distance between the construction-related noise sources and noise-sensitive receptors nearest the project site during all project construction.
- A temporary noise control blanket barrier could be erected, if necessary, along building facades facing construction sites. This mitigation would only be necessary if conflicts occurred which were irresolvable by proper scheduling. Noise control blanket barriers can be rented and quickly erected.
- Locate material stockpiles, as well as maintenance/equipment staging and parking areas, as far as feasible from residential receptors.
- Control noise from construction workers’ radios to a point where they are not audible at existing residences bordering the project site.
- The contractor shall prepare a detailed construction schedule for major noise-generating construction activities. The construction plan shall identify a procedure for coordination
- with adjacent residential land uses so that construction activities can be scheduled to minimize noise disturbance.
- Designate a "disturbance coordinator" who would be responsible for responding to any complaints about construction noise. The disturbance coordinator will determine the cause of the noise complaint (e.g., bad muffler, etc.) and will require that reasonable measures be implemented to correct the problem. Conspicuously post a telephone number for the

disturbance coordinator at the construction site and include in it the notice sent to neighbors regarding the construction schedule.

The implementation of the reasonable and feasible controls outlined above would reduce construction noise levels emanating from the project site by 5 to 10 dBA in order to minimize disruption and annoyance. With the implementation of these controls, as well as limiting the construction hours to daytime only, and considering that construction is temporary, the impact would be reduced to a less-than-significant level.

Mitigation Measure 1a: No further mitigation required.

Impact 1b: Permanent Noise Level Increase. The proposed project is not expected to cause a substantial permanent traffic noise level increase at the existing residential land uses in the project vicinity. **This is a less-than-significant impact.**

A significant increase would be identified if project generated traffic were to result in a permanent noise level increase of 5 dBA DNL or greater in a residential area. For reference, a 5 dBA DNL noise increase would be expected if the project would triple existing traffic volumes along a roadway.

The project's traffic study[2] included peak hour trip generation estimates. By comparing the net generation of 28 peak hour project trips to existing peak hour traffic volumes along roadways serving the site, which range from 2,379 trips along Santa Rosa Avenue[3] to 10,000 along US-101[4], it was determined that the net peak hour generation of trips would result in a future noise increase of less than 1 dBA DNL. This is a less-than-significant impact.

Mitigation Measure 1b: None required.

Impact 1c: Noise Levels in Excess of Standards. The proposed project is not expected to generate noise in excess of standards established in the City's General Plan at the nearby residential receptors. This is a **less-than-significant impact**.

Mechanical Equipment
The proposed project would include mechanical equipment, such as heating, ventilation, and air conditioning systems. Although not indicated on the plans, rooftop mechanical equipment is often used in similar buildings. Due to the number of variables inherent in the mechanical equipment needs of the project (number and types of units, size, housing, specs, location, etc.), the impacts of mechanical equipment noise on nearby noise-sensitive uses should be assessed during the final project design stage. Design planning should consider the noise criteria associated with such equipment and utilize site planning to locate equipment in less noise-sensitive areas. Other controls could include, but shall not be limited to, fan silencers, enclosures, and screen walls.
The nearest noise-sensitive uses to the project site include a hotel directly to the south of the project site, commercial directly to the north and across Santa Rosa Avenue from the project site, and residential northeast and east across Satna Rosa Avenue from the project site. The City's municipal

2 W-Trans, "Focused Traffic Analysis for the 3111 Santa Rosa Avenue Project" Santa Rosa, California, June 10, 2021.

3 W-Trans Traffic Counts, Obtained February 19, 2019.

4 Caltrans, Traffic Census Program, Traffic Volumes: Annual Average Daily Traffic 2019, Accessed August 2, 2021.

code states mechanical noise should not exceed the ambient noise level by more than 5 dB at the property line. Due to the possibility of stationary mechanical equipment running all day and night, noise levels at off-site receptors would be limited to 67 dBA L_{eq}.

The final design plans should be reviewed by a qualified acoustical consultant to address any potential conflicts with the General Plan or Municipal Code.

Truck Loading and Unloading

The site plan shows truck loading and unloading activities occurring within the self-storage facility. All loading activities could occur at any spot of the self-storage buildings and would be shielded from all surrounding noise-sensitive uses by the project buildings.

Assuming the hours of operation of the self-storage all truck loading and unloading would occur during daytime hours between 7:00 a.m. and 9:00 p.m., a noise increase above existing conditions is not expected. Further, existing truck traffic occurs along the surrounding local roadways, and the existing noise environment ranges from 69 to 71 dBA DNL. Truck operations occurring at the proposed project site are not expected to generate levels exceeding 55 dBA DNL or existing ambient conditions at the nearby noise-sensitive land uses. This would be a less-than-significant impact.

Mechanical Storage Doors

The ground floor storage will be equipped with roll-up doors. The nearest sensitive receptors (commercial office) would be located 95 feet north of the roll-up doors. With a conservative assumption that a motorized roll-up door generates noise level of 70 dBA at 3 feet, the closest commercial offices would be exposed to up to 35 dBA L_{max}. It is anticipated that use of the door mechanisms would be infrequent, resulting in substantially lower levels on an hourly or daily average basis. Noise levels would be significantly below the exterior threshold of 60 dBA for commercial use areas. This is a less-than-significant impact.

Mitigation Measure 1c: No further mitigation required.

Impact 2: Exposure to Excessive Groundborne Vibration. Construction-related vibration levels are not expected to exceed applicable vibration thresholds at nearby sensitive land uses. **This is a less-than-significant impact.**

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 work, foundation work, and new building framing and finishing. Pile driving equipment, which can cause excessive vibration, is not expected to be required for the proposed project.

The City's Historic Preservation[5] list was reviewed to identify historical structures in the project vicinity. There are no buildings identified as historical in the City's inventory near the project site. There were also no documented buildings to be structurally weakened adjoining to the project site.

For the purposes of this study, groundborne vibration levels exceeding the conservative 0.3 in/sec PPV limit would have the potential to result in a significant vibration impact.

Table 13 presents typical vibration levels that could be expected from construction equipment at a distance of 25 feet. Project construction activities, such as drilling, the use of jackhammers, rock drills and other high-power or vibratory tools, and rolling stock equipment (tracked vehicles, compactors, etc.), may generate substantial vibration in the immediate vicinity. Jackhammers typically generate vibration levels of 0.035 in/sec PPV, and drilling typically generates vibration levels of 0.09 in/sec PPV at a distance of 25 feet. Vibration levels would vary depending on soil conditions, construction methods, and equipment used. Table 13 also summarizes the distances to the 0.3 in/sec PPV threshold for all non-historic buildings.

TABLE 13 Vibration Source Levels for Construction Equipment

Equipment		PPV at 25 ft. (in/sec)	Minimum Distance to Meet 0.3 in/sec PPV (feet)
Clam shovel drop		0.202	18
Hydromill (slurry wall)	in soil	0.008	1
	in rock	0.017	2
Vibratory Roller		0.210	19
Hoe Ram		0.089	9
Large bulldozer		0.089	9
Caisson drilling		0.089	9
Loaded trucks		0.076	8
Jackhammer		0.035	4
Small bulldozer		0.003	<1

Source: Transit Noise and Vibration Impact Assessment Manual, Federal Transit Administration, Office of Planning and Environment, U.S. Department of Transportation, September 2018, as modified by Illingworth & Rodkin, Inc., February 2021.

The nearest building of normal conventional construction would be the hotel south of the project site (approximately 7 feet from the southern boundary of the project site). This building would be exposed to vibration levels exceeding 0.3 in/sec PPV.

Table 14 summarizes the vibration levels at each of the surrounding buildings in the project vicinity. Vibration levels are highest close to the source and then attenuate with increasing distance at the rate $\left({D_{ref}}/{D}\right)^{1.1}$, where D is the distance from the source in feet and D_{ref} is the reference distance of 25 feet. While construction noise levels increase based on the cumulative equipment in use simultaneously, construction vibration levels would be dependent on the location of individual pieces of equipment. That is, equipment scattered throughout the site would not generate a collective vibration level, but a vibratory roller, for instance, operating near the project site boundary would generate the worst-case vibration levels for the receptor sharing that property line.

[5] https://srcity.org/398/Historic-Preservation

Further, construction vibration impacts are assessed based on damage to buildings on receiving land uses, not receptors at the nearest property lines. Therefore, the distances used to propagate construction vibration levels (as shown in Table 13), which are different than the distances used to propagate construction noise levels (as shown in Table 10), were estimated under the assumption that each piece of equipment from Table 13 was operating along the nearest boundary of the project site, which would represent the worst-case scenario.

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 of the conventional buildings adjoining the project site. As shown in Table 13, the 0.3 in/sec PPV threshold for non-historic buildings would potentially be exceeded within about 20 feet. Due to the close proximity of the adjacent buildings to the south of the project site (about 7 feet), the use of most construction equipment along the shared property line would potentially exceed the threshold, as shown in Table 14.

All other non-historic buildings in the vicinity would be more than 45 feet from the project site and would not be subject to vibration levels exceeding 0.3 in/sec PPV.

A study completed by the US Bureau of Mines analyzed the effects of blast-induced vibration on buildings in USBM RI 8507.[6] The findings of this study have been applied to buildings affected by construction-generated vibrations.[7] As reported in USBM RI 8507[3] and reproduced by Dowding,[4] Figure 4 presents the damage probability, in terms of "threshold damage," "minor damage," and "major damage," at varying vibration levels. Threshold damage, which is described as cosmetic damage in this report, would entail hairline cracking in plaster, the opening of old cracks, the loosening of paint or the dislodging of loose objects. Minor damage would include hairline cracking in masonry or the loosening of plaster, and major structural damage would include wide cracking or shifting of foundation or bearing walls.

As shown in Figure 5, maximum vibration levels of 0.9 in/sec PPV would result in about 13% chance of threshold or cosmetic damage. No minor or major damage would be expected at the non-historic buildings immediately adjoining the project site.

Heavy vibration-generating construction equipment would have the potential to produce vibration levels of 0.3 in/sec PPV or more at non-historical buildings within 20 feet of the project site.

Neither cosmetic, minor, or major damage would occur at conventional buildings located 45 feet or more from the project site. At these locations, and in other surrounding areas where vibration would not be expected to cause cosmetic 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 (use of jackhammers and other high-power tools). By use of administrative controls, such as notifying neighbors of scheduled construction activities and scheduling

[6] 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.

[7] Dowding, C.H., Construction Vibrations, Prentice Hall, Upper Saddle River, 1996.

construction activities with the highest potential to produce perceptible vibration during hours with the least potential to affect nearby businesses, perceptible vibration can be kept to a minimum.

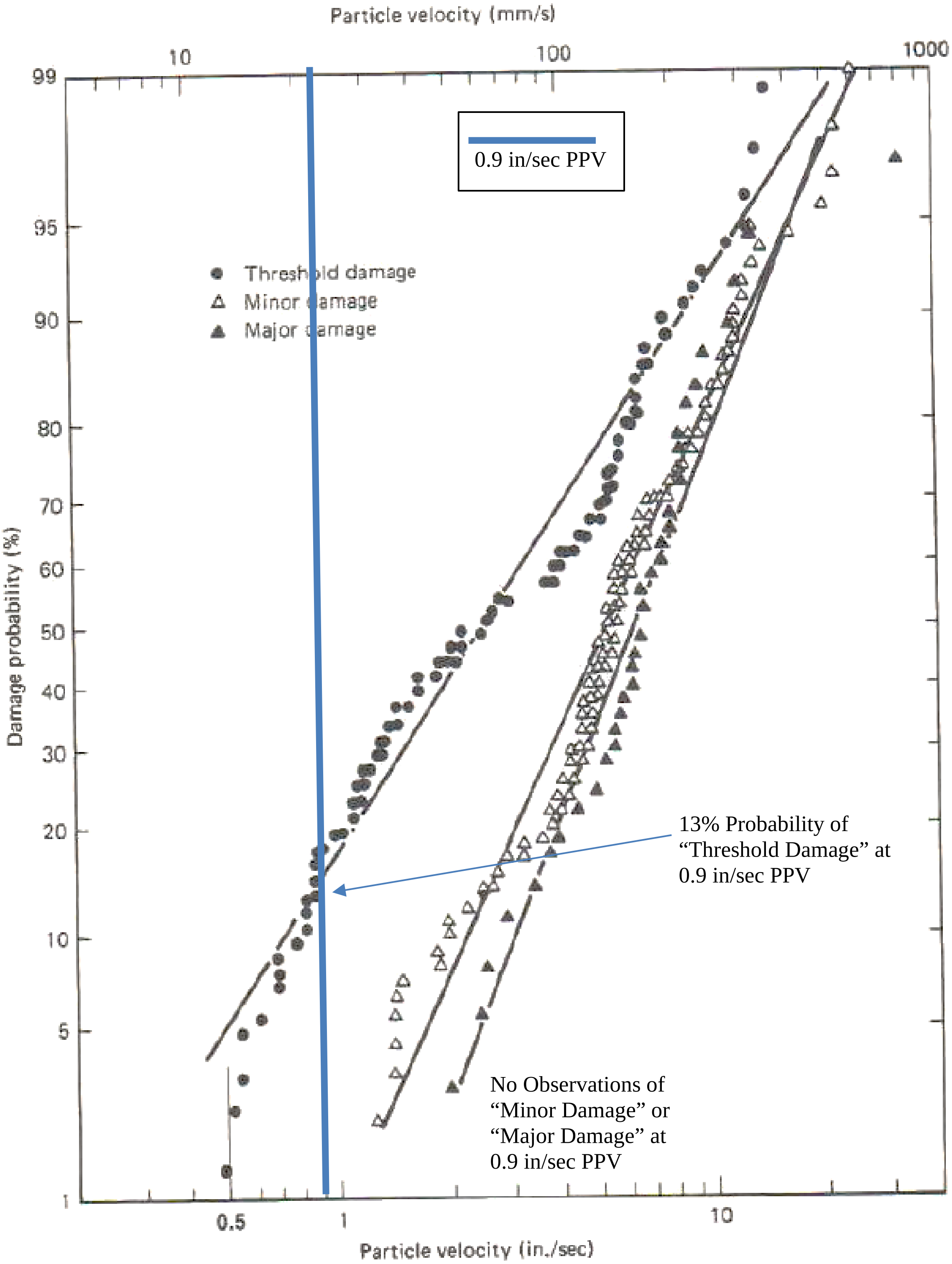
In summary, the construction of the project would generate vibration levels exceeding 0.3 in/sec PPV at non-historic properties within 20 feet of the site. This would be considered a significant impact.

TABLE 14 Vibration Source Levels for Construction Equipment

Equipment		PPV (in/sec)				
		South Hotel (7 ft)	North Commercial Office Building (45 ft)	East Commercial Office Building (125 ft)	Northeast, Residential Multi-Family Buildings (200ft)	East Residential Multi-Family Buildings (380 ft)
Clam shovel drop		**0.819**	0.106	0.034	0.021	0.010
Hydromill (slurry wall)	in soil	0.032	0.004	0.001	0.001	0.0004
	in rock	0.069	0.009	0.003	0.002	0.001
Vibratory Roller		**0.852**	0.110	0.036	0.021	0.011
Hoe Ram		**0.361**	0.047	0.015	0.009	0.004
Large bulldozer		**0.361**	0.047	0.015	0.009	0.004
Caisson drilling		**0.361**	0.047	0.015	0.009	0.004
Loaded trucks		**0.308**	0.040	0.013	0.008	0.004
Jackhammer		0.142	0.018	0.006	0.004	0.002
Small bulldozer		0.012	0.002	0.0005	0.0003	0.0002

Source: Transit Noise and Vibration Impact Assessment Manual, Federal Transit Administration, Office of Planning and Environment, U.S. Department of Transportation, September 2018, as modified by Illingworth & Rodkin, Inc., July 2021.

FIGURE 5 Probability of Cracking and Fatigue from Repetitive Loading



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

Mitigation Measure 2:

The project shall implement the following measures, in addition to the best practices specified in the Construction Best Management Practices of this report, to minimize the impacts of groundborne vibration.

Construction Vibration Monitoring, Treatment, and Reporting Plan: The project proponent shall implement a construction vibration monitoring plan to document conditions prior to, during, and after vibration generating construction activities. All plan tasks shall be undertaken under the direction of a licensed Professional Structural Engineer in the State of California and be in accordance with industry-accepted standard methods. The construction vibration monitoring plan shall include, but not be limited to, the following measures:

- The report shall include a description of measurement methods, equipment used, calibration certificates, and graphics as required to clearly identify vibration-monitoring locations.

- A list of all heavy construction equipment to be used for this project and the anticipated time duration of using the equipment that is known to produce high vibration levels (clam shovel drops, vibratory rollers, hoe rams, large bulldozers, caisson drillings, loaded trucks, jackhammers, etc.) shall be submitted to the Director of Planning or Director's designee of the Department of Planning, Building and Code Enforcement by the contractor. This list shall be used to identify equipment and activities that would potentially generate substantial vibration and to define the level of effort required for continuous vibration monitoring. Phase demolition, earth-moving, and ground impacting operations so as not to occur during the same time period.

- Where possible, use of the heavy vibration-generating construction equipment shall be prohibited within 20 feet of any adjacent building.

- Document conditions at all buildings located within 20 feet of construction prior to, during, and after vibration generating construction activities. All plan tasks shall be undertaken under the direction of a licensed Professional Structural Engineer in the State of California and be in accordance with industry-accepted standard methods. Specifically:

    - Vibration limits shall be applied to vibration-sensitive structures located within 20 feet of any construction activities identified as sources of high vibration levels.

- Develop a vibration monitoring and construction contingency plan to identify structures where monitoring would be conducted, set up a vibration monitoring schedule, define structure-specific vibration limits, and address the need to conduct photo, elevation, and crack surveys to document before and after construction conditions. Construction contingencies shall be identified for when vibration levels approached the limits.

- At a minimum, vibration monitoring shall be conducted during demolition and excavation activities.

- If vibration levels approach limits, suspend construction and implement contingency measures to either lower vibration levels or secure the affected structures.

- Designate a person responsible for registering and investigating claims of excessive vibration. The contact information of such person shall be clearly posted on the construction site.

- Conduct a post-construction survey on structures where either monitoring has indicated high vibration levels or complaints of damage has been made. Make appropriate repairs or compensation where damage has occurred as a result of construction activities.

Implementation of this mitigation measure would reduce the impact to a less-than-significant level.