LAND USE COMPATIBILITY AND STATIONARY NOISE ANALYSIS

55 BROOKDALE RESIDENTIAL PROJECT

CITY OF SAN RAFAEL, CALIFORNIA

LSA

August 2021

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Submitted to:

Mr. Michael Folk
55 Brookdale, LLC
P.O. Box 554
Corte Madera, California 94925

Prepared by:

LSA
157 Park Place
Pt. Richmond, California 94801
510.236.6810

Project No. BKD2101

LSA

August 2021

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LAND USE COMPATIBILITY AND STATIONARY NOISE ANALYSIS

INTRODUCTION

This noise land use compatibility analysis has been prepared to evaluate the potential on-site noise impacts and mitigation measures associated with the proposed 55 Brookdale Residential Project (project) in the City of San Rafael (City), California. This report, as required by the City, includes a review of the future exterior noise environment, as well as an architectural plan review to confirm that interior noise levels would comply with Policies in the Noise Element of the San Rafael General Plan and the San Rafael Code of Ordinances. Where necessary, building upgrades, including higher rated windows and doors, were assessed.

Additionally, this report will ensure that a heating, ventilation, and air conditioning (HVAC) system is provided for dwelling units exposed to high noise levels and that stationary noise from such equipment will be at an adequate distance from the nearest noise sensitive receptors.

PROJECT LOCATION AND DESCRIPTION

The proposed project site is located at 55 Brookdale Avenue in the City of San Rafael, California, and would construct two new residential apartment buildings and three residential "garden houses", an outdoor common use area, and parking structures including five car lifts. Existing residences are located on adjacent parcels to the north and south of the project. Residential uses are also located across Lincoln Avenue to the west. The project Location Map is presented in Figure 1 while the project's Site Plan is presented in Figure 2.

LSA

FIGURE 1

0 500 1000
FEET

N

Project Location

55 Brookdale Residential Project

Location Map

SOURCES: Nearmap 5/22/2021; LSA, 2021

P:\BKD2101 55 Brookdale\Products\Graphics\Figure_1.ai (8/3/2021)

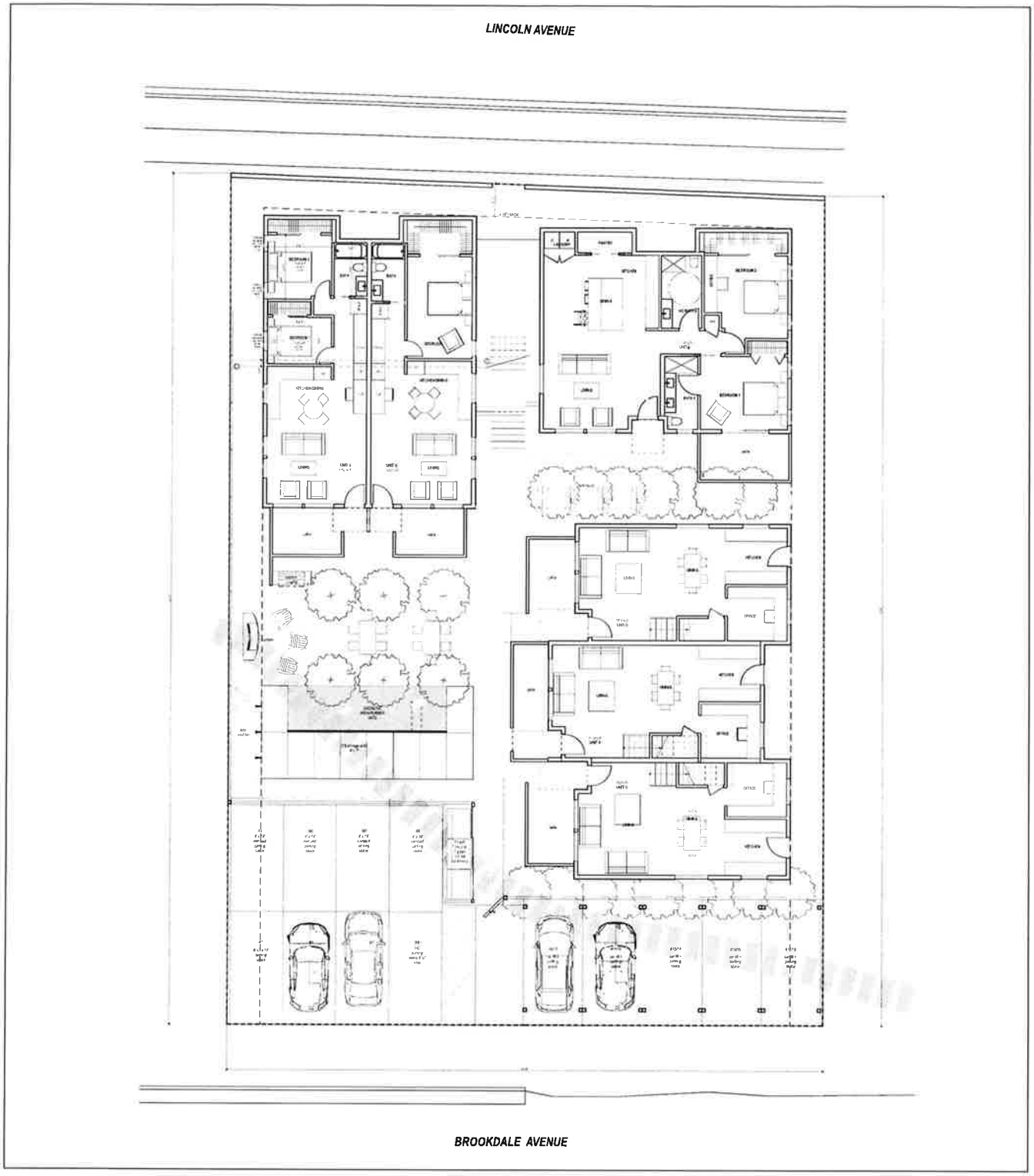

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FIGURE 2

0 8 16
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N PROJECT NORTH
TRUE NORTH

55 Brookdale Residential Project
Proposed Site Plan

SOURCE: Polsky Perlstein Architects, 2021

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NOISE FUNDAMENTALS

CHARACTERISTICS OF SOUND

Noise is usually defined as unwanted sound. Noise consists of any sound that may produce physiological or psychological damage and/or interfere with communication, work, rest, recreation, and sleep.

To the human ear, sound has two significant characteristics: pitch and loudness. Pitch is generally an annoyance, while loudness can affect the ability to hear. Pitch is the number of complete vibrations, or cycles per second, of a sound wave, which results in the tone's range from high to low. Loudness is the strength of a sound, and it describes a noisy or quiet environment; it is measured by the amplitude of the sound wave. Loudness is determined by the intensity of the sound wave combined with the reception characteristics of the human ear. Sound intensity refers to the power carried by sound waves per unit area in a direction perpendicular to that area. This characteristic of sound can be precisely measured with instruments. The analysis of a project defines the noise environment of the project area in terms of sound pressure level and its effect on adjacent sensitive land uses.

Measurement of Sound

Sound pressure level is measured with the A-weighted decibel scale to correct for the relative frequency response of the human ear. That is, an A-weighted noise level de-emphasizes low and very high frequencies of sound, similar to the human ear's de-emphasis of these frequencies. Decibels, unlike linear units (e.g., inches or pounds), are measured on a logarithmic scale representing points on a sharply rising curve.

For example, 10 decibels (dB) is 10 times more intense than 1 dB, 20 dB is 100 times more intense than 1 dB, and 30 dB is 1,000 times more intense than 1 dB. Thirty decibels (30 dB) represents 1,000 times as much acoustic energy as 1 dB. The decibel scale increases as the square of the change, representing the sound pressure energy. A sound as soft as human breathing is about 10 times greater than 0 dB. The decibel system of measuring sound gives a rough connection between the physical intensity of sound and its perceived loudness to the human ear. A 10 dB increase in sound level is perceived by the human ear as only a doubling of the sound's loudness. Ambient sounds generally range from 30 dB (very quiet) to 100 dB (very loud).

Sound levels are generated from a source, and their decibel level decreases as the distance from that source increases. Sound levels dissipate exponentially with distance from their noise sources. For a single point source, sound levels decrease approximately 6 dB for each doubling of distance from the source. This drop-off rate is appropriate for noise generated by stationary equipment. If noise is produced by a line source (e.g., highway traffic or railroad operations) the sound decreases 3 dB for each doubling of distance in a hard site environment. Line source sound levels decrease 4.5 dB for each doubling of distance in a relatively flat environment with absorptive vegetation.

There are many ways to rate noise for various time periods, but an appropriate rating of ambient noise affecting humans also accounts for the annoying effects of sound. The equivalent continuous

sound level (L_{eq}) is the total sound energy of time-varying noise over a sample period. However, the predominant rating scales for human communities in the State of California are the L_{eq} and Community Noise Equivalent Level (CNEL) or the day-night average noise level (L_{dn}) based on A-weighted decibels (dBA). CNEL is the time-varying noise over a 24-hour period, with a 5 dBA weighting factor applied to the hourly L_{eq} for noise occurring from 7:00 p.m. to 10:00 p.m. (defined as relaxation hours) and a 10 dBA weighting factor applied to noise occurring from 10:00 p.m. to 7:00 a.m. (defined as sleeping hours). L_{dn} is similar to the CNEL scale but without the adjustment for events occurring during the relaxation and sleeping hours. CNEL and L_{dn} are within 1 dBA of each other and are normally interchangeable.

Other noise rating scales of importance when assessing the annoyance factor include the maximum instantaneous noise level (L_{max}), which is the highest exponential time-averaged sound level that occurs during a stated time period. The noise environments discussed in this analysis for short-term noise impacts are specified in terms of maximum levels denoted by L_{max}, which reflects peak operating conditions and addresses the annoying aspects of intermittent noise. It is often used together with another noise scale, or noise standards in terms of percentile noise levels, in noise ordinances for enforcement purposes. For example, the L_{10} noise level represents the noise level exceeded 10 percent of the time during a stated period. The L_{50} noise level represents the median noise level. Half the time the noise level exceeds this level, and half the time it is less than this level. The L_{90} noise level represents the noise level exceeded 90 percent of the time and is considered the background noise level during a monitoring period. For a relatively constant noise source, the L_{eq} and L_{50} are approximately the same.

Noise impacts can be described in three categories. The first category includes audible impacts that refer to increases in noise levels noticeable to humans. Audible increases in noise levels generally refer to a change of 3 dB or greater because this level has been found to be barely perceptible in exterior environments. Additionally, an increase of more than 5 dBA is typically considered readily perceptible in an exterior environment. The second category, potentially audible, refers to a change in the noise level between 1 dB and 3 dB. This range of noise levels has been found to be noticeable only in laboratory environments. The last category includes changes in noise levels of less than 1 dB, which are inaudible to the human ear. Only audible changes in existing ambient or background noise levels are considered potentially significant.

Physiological Effects of Noise

Physical damage to human hearing begins at prolonged exposure to sound levels higher than 85 dBA. Exposure to high sound levels affects the entire system, with prolonged sound exposure in excess of 75 dBA increasing body tensions, thereby affecting blood pressure and functions of the heart and the nervous system. In comparison, extended periods of sound exposure above 90 dBA would result in permanent cell damage. When the sound level reaches 120 dBA, a tickling sensation occurs in the human ear, even with short-term exposure. This level of sound is called the threshold of feeling. As the sound reaches 140 dBA, the tickling sensation is replaced by a feeling of pain in the ear (i.e., the threshold of pain). A sound level of 160–165 dBA will result in dizziness or a loss of equilibrium. The ambient or background noise problem is widespread and generally more concentrated in urban areas than in outlying, less-developed areas.

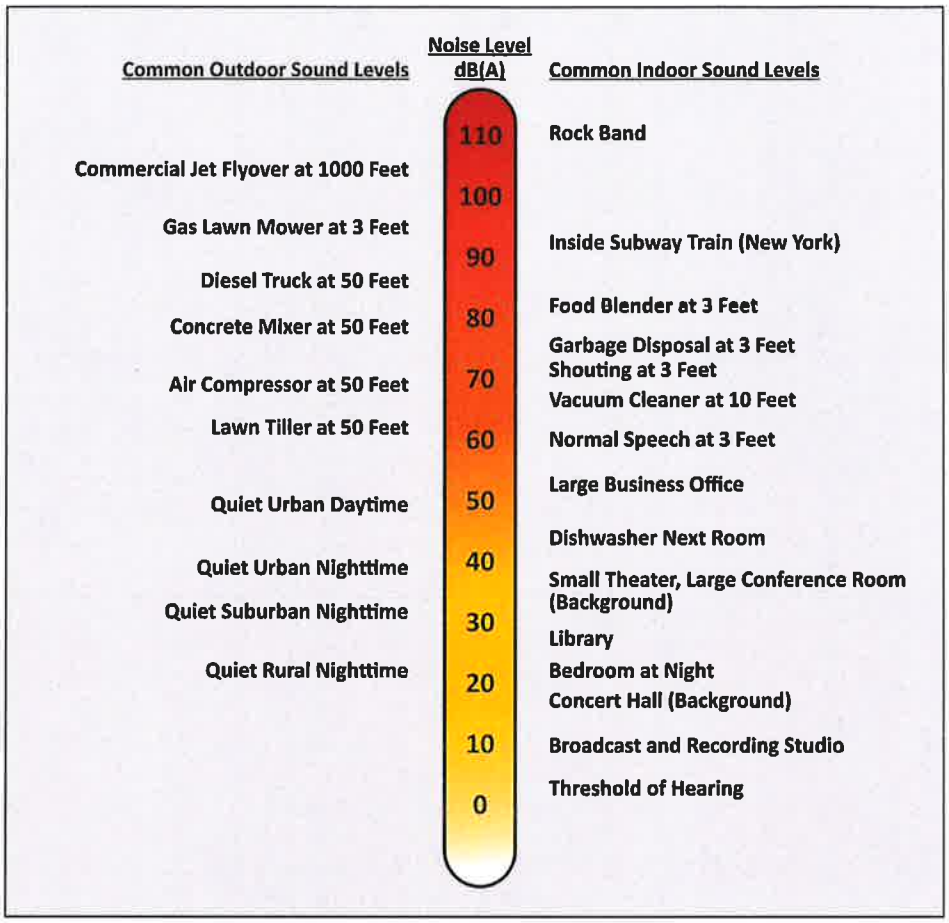
Table A lists definitions of acoustical terms, and Table B shows common sound levels and their sources.

Table A: Definitions of Acoustical Terms

Term	Definitions
Decibel, dB	A unit of sound level that denotes the ratio between two quantities that are proportional to power; the number of decibels is 10 times the logarithm (to the base 10) of this ratio.
Frequency, Hz	Of a function periodic in time, the number of times that the quantity repeats itself in 1 second (i.e., the number of cycles per second).
A-Weighted Sound Level, dBA	The sound level obtained by use of A-weighting. 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. (All sound levels in this report are A-weighted unless reported otherwise.)
L_{01}, L_{10}, L_{50}, L_{90}	The fast A-weighted noise levels that are equaled or exceeded by a fluctuating sound level 1%, 10%, 50%, and 90% of a stated time period, respectively.
Equivalent Continuous Noise Level, L_{eq}	The level of a steady sound that, in a stated time period and at a stated location, has the same A-weighted sound energy as the time varying sound.
Community Noise Equivalent Level, CNEL	The 24-hour A-weighted average sound level from midnight to midnight, obtained after the addition of 5 dBA to sound levels occurring in the evening from 7:00 p.m. to 10:00 p.m. and after the addition of 10 dBA to sound levels occurring in the night between 10:00 p.m. and 7:00 a.m.
Day/Night Noise Level, L_{dn}	The 24-hour A-weighted average sound level from midnight to midnight, obtained after the addition of 10 dBA to sound levels occurring in the night between 10:00 p.m. and 7:00 a.m.
L_{max}, L_{min}	The maximum and minimum A-weighted sound levels measured on a sound level meter, during a designated time interval, using fast time averaging.
Ambient Noise Level	The all-encompassing noise associated with a given environment at a specified time. It is usually a composite of sound from many sources from many directions, near and far; no particular sound is dominant.
Intrusive	The noise that 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 1991).

Table B: Common Sound Levels and Noise Sources



Source: LSA Associates, Inc. (2016).

APPLICABLE NOISE STANDARDS

The following information provides the City's applicable exterior and interior noise level standards to which potential noise impacts will be compared. Where appropriate, exceedances will be identified, and mitigation will be recommended.

CITY OF SAN RAFAEL GENERAL PLAN

The Noise Element of the City of San Rafael General Plan (City of San Rafael 2021) (Noise Element) establishes residential land use compatibility standards for noise exposure to new developments. The land use compatibility noise criteria provide the basis for decisions on location of land uses in relation to noise sources and for determining noise mitigation requirements.

The Noise Compatibility Guidelines for San Rafael, presented in Table 9-2 of the Noise Element, state that noise levels up to 65 dBA L_{dn} are considered "normally acceptable[1]" for multi-family uses while levels from 65 dBA L_{dn} to 75 dBA L_{dn} are considered "conditionally acceptable[2]".

Additionally, an interior noise level requirement of 45 dBA L_{dn} is established for all residential uses in the City of San Rafael.

SAN RAFAEL MUNICIPAL CODE

General noise limits are listed in Section 8.13.040 of The City of San Rafael's Municipal Code (City of San Rafael 2021), and stationary noise sources are applicable to residential property limits as follows:

> *A. Residential property noise limits.*
>
> *1. No person shall produce, suffer or allow to be produced by any machine, animal or device, or by any other means, a noise level greater than the following, when measured on any residential property:*
>
> *a. Daytime: 60 dBA intermittent*
> *50 dBA constant*
>
> *b. Nighttime: 50 dBA intermittent*
> *40 dBA constant*
>
> *For intermittent sound, the one second rms maximum level (L_{max}) shall be used. For constant sound, the average level (L_{eq}) shall be used.*

[1] Normally Acceptable: Specified land use is satisfactory based upon the assumption that any buildings involved are of normal conventional construction, without any special noise insulation requirements.

[2] Conditionally Acceptable: New construction or development should be undertaken only after a detailed analysis of the noise reduction requirements is made and the needed noise insulation features are included in the design. Conventional construction, but with closed windows and fresh air supply systems or air conditioning will normally suffice.

OVERVIEW OF THE EXISTING NOISE ENVIRONMENT

The primary existing noise sources in the project area are transportation facilities including US-101 (Redwood Hwy.), Lincoln Avenue, and the Sonoma-Marin Area Rail Transit (SMART) rail line. Brookdale Avenue and periodic aircraft operations serve as secondary sources on the project site.

To assess the existing noise conditions in the area, one long-term, 24-hour, and two short-term noise measurements were conducted from April 14, 2021, to April 15, 2021. The locations of the noise measurements are shown on Figure 3 and the results are summarized in Table C. Noise measurement data information is provided in Appendix A of this analysis.

Table C: Existing Noise Level Measurements

Location Number	Location Description	Daytime Noise Levels[1] (dBA L_{eq})	Nighttime Noise Levels[2] (dBA L_{eq})	Average Daily Noise Levels (dBA L_{dn})	Primary Noise Sources
LT-1	Across Brookdale Avenue from southeast corner of project site, Approximately 160 feet from US-101 southbound (SB) lanes, 85 feet from the SMART train tracks.	56.5-63.6	49.9–63.4	65.0	Traffic on US-101 and Brookdale Avenue. SMART train events and faint traffic on Lincoln Avenue.
ST-1[3]	On sidewalk of short stretch of Brookdale Avenue north of the project site, 130 feet from center of Lincoln Avenue, 150 from SMART train tracks, and 230 from US-101 SB lanes.	51.9-58.9	45.2-58.8	58.9	Traffic on US-101, Brookdale Ave, SMART train events, and traffic on Lincoln Avenue.
ST-2[3]	Along Lincoln Avenue, approximately 30 feet from the centerline, near northwest corner of project site.	59.8-66.9	53.2-66.7	68.3	Traffic on Lincoln Avenue, US-101 traffic contributing to ambient noise levels.

Source: Compiled by LSA (April 2021).
[1] Daytime Noise Levels = noise levels during the hours of 7:00 a.m. to 10:00 p.m.
[2] Nighttime Noise Levels = noise levels during the hours of 10:00 p.m. to 7:00 a.m.
[3] Short-term measurement data estimated based on corresponding long-term measurement intervals.
L_{dn} = Day/Night Noise Level
dBA = A-weighted decibels
ft = foot/feet

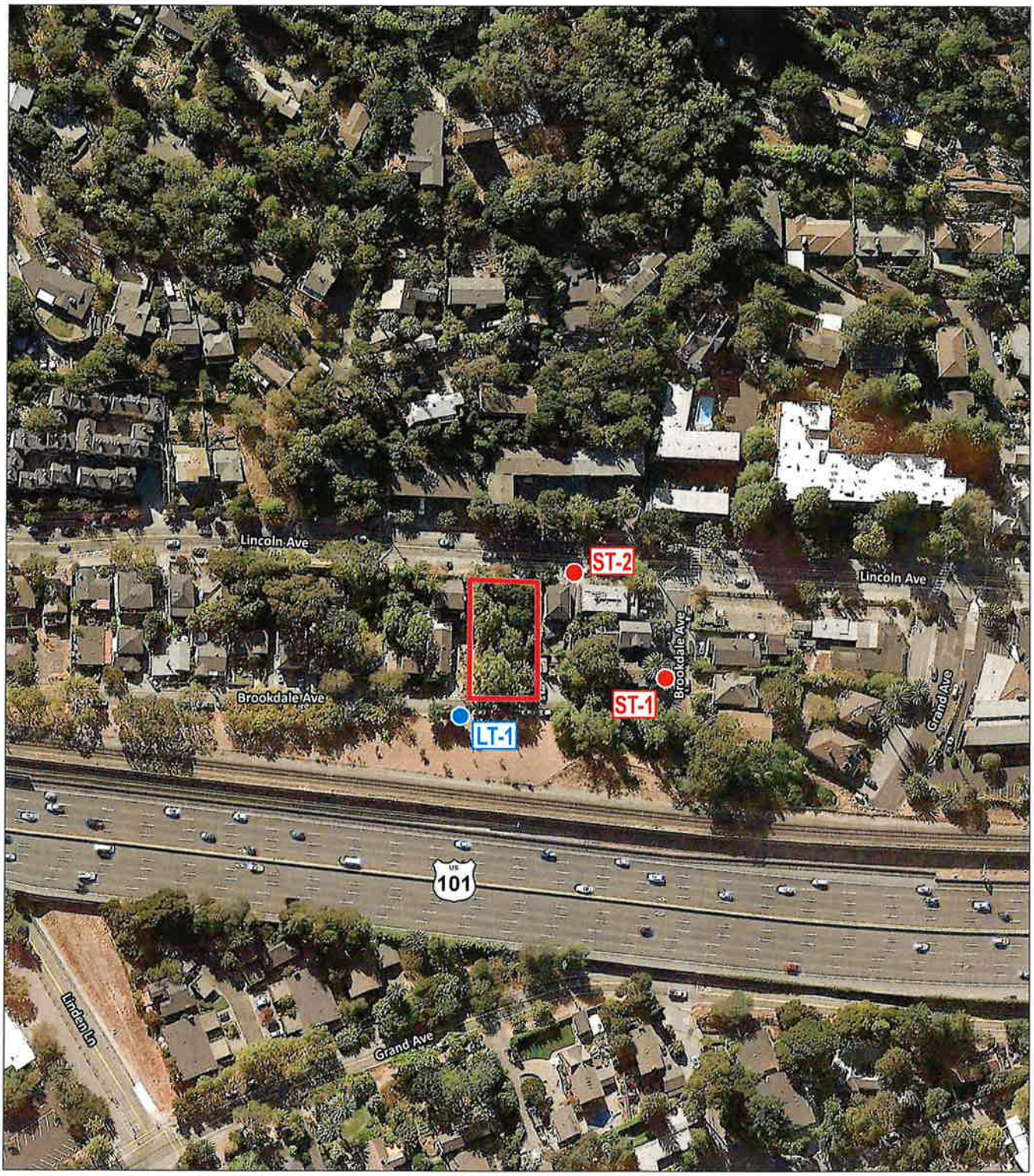


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FIGURE 3

0 75 150
FEET

PROJECT NORTH
TRUE NORTH

LT# Long-term Noise Monitoring Location (24 hours)

ST# Short-term Noise Monitoring Location (15 minutes)

Project Location

55 Brookdale Residential Project

Noise Monitoring Locations

SOURCES: Google Earth, 10/21/2020; LSA, 2021

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ON-SITE LAND USE COMPATIBILITY ANALYSIS

ON-SITE EXTERIOR NOISE ASSESSMENT

Exterior noise levels were assessed at the outdoor courtyard use toward the center of the project site. With noise attenuation provided by the proposed buildings and fences that would surround the courtyard, noise levels at the exterior use area for the residential project would approach 59.3 dBA L_{dn}. As such, noise levels from the surrounding roadways would not exceed the City's 65 dBA L_{dn} exterior noise standard at common usable outdoor areas. .

At the western façades of the proposed residential buildings approximately 20 feet from the nearest lane of Lincoln Avenue, exterior noise levels would reach 65.4 dBA L_{dn}. At the eastern façade of the proposed residential building, approximately 115 feet from southbound lanes of US-101, exterior noise levels would be 64.6 dBA L_{dn}. While there are not common usable outdoor areas at these exteriors, the higher noise exposure levels were used to assess interior noise levels at habitable rooms.

On-Site Interior Noise Assessment

Based on a review of the *Preliminary Site Plan and Elevation Renderings* (Polsky Perlstein Architects, February 2021), the following presents results of the on-site interior noise analysis at the interior uses of the proposed project.

In order to comply with the City's interior noise requirements of 45 dBA L_{dn} for residential uses, a minimum exterior to interior noise level reduction of 20.4 dBA would be required for resident units nearest to Lincoln Avenue, where exterior noise levels would approach 65.4 dBA L_{dn} at western facades. Minimum exterior to interior noise level reduction of 19.6 dBA would be required for resident units nearest to Brookdale Avenue and US 101, where exterior noise levels could approach 64.6 dBA L_{dn} at eastern facades of the residential buildings.

Based on the United States Environmental Protection Agency's (EPA) Protective Noise Levels (1978), with a combination of exterior walls, doors, and windows, standard construction for California (warm climate) buildings would provide more than 24 dBA in exterior-to-interior noise reduction with windows and doors closed (the national average is 25 dBA with windows and doors closed). Applying this reduction to the exterior noise levels at the building façades, interior noise levels would not exceed the City's interior noise standard of 45 dBA CNEL. Therefore, windows and doors with Sound Transmission Class (STC) ratings provided by standard building construction (minimum STC-28) would be sufficient. Mechanical ventilation systems are proposed as a project design feature, which would ensure that windows and doors could remain closed for a prolonged period of time. Therefore, no on-site interior traffic noise impacts would occur. No noise reduction measures are required.

STATIONARY NOISE ANALYSIS

The nearest noise sensitive uses are residential properties to the north, south, and across Lincoln Avenue to the west. Stationary noise sources from the proposed project would include noise generated from on-site heating, ventilation, and air conditioning (HVAC) noise. The proposed project would result in potential long-term off-site operational impacts, as described below.

Heating, Ventilation, and Air Conditioning Equipment

Adjacent residential uses to the north and south, as well as across Lincoln Avenue to the west, have the potential to be exposed to noise levels from HVAC units. The project is anticipated to have ductless mini split HVAC systems for each unit. The HVAC equipment could operate 24 hours per day. One HVAC unit was estimated to generate a noise level of up to 35 dBA L_{eq} at 5 ft, based on research of mini split AC units. LSA estimates up to 12 units operating simultaneously on proposed eastern and western building facades, which would increase the HVAC reference noise levels by 11 dBA, or 46 dBA L_{eq} at 5 ft. While a single receiver cannot physically be 5 feet from all 12 units operating, LSA used the increased reference levels as a conservative assessment.

Table D presents the reference noise levels from HVAC equipment and noise reduction needed to meet the City's nighttime noise standard of 40 dBA L_{eq} for residential uses. The noise reduction could be provided by distance alone (minimum 10 feet as shown in table) or a combination of shielding and distance. However, given that HVAC units would be further than 10 feet from all residential uses, shielding attenuation is not needed.

Existing ambient noise levels at residential uses adjacent to the site were calculated to be 47.9 dBA L_{eq} (primarily from traffic), which is 7.9 dBA higher than the 40 dBA L_{eq} stationary limit. Therefore, noise associated with the on-site HVAC equipment would not add significant noise to the existing ambient noise levels provided the 40 dBA L_{eq} limit is met.

Table D: Summary of Potential HVAC Noise Levels

Off-Site Land Use	Reference Noise Level (dBA L_{eq}) at 5 ft	Nighttime Noise Limit (dBA L_{eq}) at Residential Use	Noise Reduction Required (dBA)	Distance from Residence to Achieve Reduction (ft)
Residential	46	40	6	10

Source: Compiled by LSA (2021).
dBA = A-weighted decibels
ft = foot/feet
HVAC = heating, ventilation, and air conditioning
L_{eq} = equivalent continuous sound level

CONCLUSION

Exterior noise levels on the project site would meet the exterior noise requirements outlined in the Noise Element of the City of San Rafael General Plan. In order to comply with the City's interior noise level standards on-site, the proposed project shall implement the following noise reduction measure:

- Install sound-rated windows with a minimum rating of STC-28 at all residential rooms (e.g., bedrooms and living rooms) of the project.

REFERENCES

City of San Rafael. 2021. Noise Element of General Plan 2040. July.

City of San Rafael. 2021. Code of Ordinances. 8.13.040 - General noise limits: https://library.municode.com/ca/san_rafael/codes/code_of_ordinances?nodeId=TIT14ZO_DIVIVREAPALSEDI_CH14.16SIUSRE_14.16.260NOST

Polsky Perlstein Architects. 2021. Preliminary Site Plans and Elevations. February 17.

Milgard Windows. 2012. Various Acoustical Performance Test Reports – Milgard Windows.

APPENDIX A

NOISE MEASUREMENT FIELDWORK SHEETS

Noise Measurement Survey – 24 HR

Project Number: BKD2101
Project Name: 55 Brookdale Residential

Test Personnel: Jordan Roberts
Equipment: Larson Davis Spark 706RC

Site Number: LT-1 Dates: 4/14/21 – 4/15/21 Time: From 2:45 PM To 4:15 PM

Site Location: Across Brookdale Avenue from southeast corner of project site, Approximately 160 feet from US-101 southbound lanes, 85 feet from SMART train tracks.

Primary Noise Sources: Traffic on US-101, SMART train events, Brookdale Avenue

Location Photo: