APPENDIX H

NOISE ASSESSMENT

STANFORD UNIVERSITY
PORTOLA TERRACE
NOISE AND VIBRATION ASSESSMENT

Portola Valley, California

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Project: 19-219

INTRODUCTION

A roughly 6-acre portion of a 75.4-acre parcel located at 3510 Alpine Road, in Portola Valley, California, is proposed to be developed as Stanford University faculty housing. The proposed project would create 27 single-family units, and three low-income multifamily buildings containing four units per building. All single-family units would be two-story buildings, and include an attached garage and off-street parking space. The three low-income multifamily buildings would include five off-street parking spaces. There will be 89 parking spaces in total, including 60 garage/driveway spaces, 24 standard on-site spaces, and 7 accessible on-site spaces. A central shared common space will include a playground, picnic area, and visitor parking area.

The portion of the parcel to be developed is currently operated as the Alpine Rock Ranch, a wedge-shaped piece of land located in the northeast corner of the property. Alpine Road runs along the eastern side of the site, while the northern boundary is formed by rural-residential properties along Westridge Drive, and a heavily wooded hillside to the west designates the western edge of the site.

This report evaluates the project's potential to result in significant noise and vibration impacts with respect to applicable California Environmental Quality Act (CEQA) guidelines. The report is divided into three sections: 1) the Setting Section provides a brief description of the fundamentals of environmental noise and 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 Section discusses noise and land use compatibility utilizing policies in the City's General Plan (Comprehensive Plan); and, 3) the Impacts and Mitigation Measures Section describes the significance criteria used to evaluate project impacts and provides a discussion of each project impact. In summary, no significant impacts were identified as a result of the construction or operation of the project.

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* (*L_{dn}* or *DNL*) is essentially the same as CNEL, with the exception that the evening time period is dropped and all occurrences during this three-hour period are grouped into the daytime period.

Effects of Noise

Sleep and Speech Interference

The thresholds for speech interference indoors are about 45 dBA if the noise is steady and above 55 dBA if the noise is fluctuating. Outdoors the thresholds are about 15 dBA higher. Steady noises of sufficient intensity (above 35 dBA) and fluctuating noise levels above about 45 dBA have been shown to affect sleep. Interior residential standards for multi-family dwellings are set by the State of California at 45 dBA L_{dn}. Typically, the highest steady traffic noise level during the daytime is about equal to the L_{dn} and nighttime levels are 10 dBA lower. The standard is designed for sleep and speech protection and most jurisdictions apply the same criterion for all residential uses. Typical structural attenuation is 12 to 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 to 62 dBA L_{dn} with open windows and 65 to 70 dBA L_{dn} if the windows are closed. Levels of 55 to 60 dBA are common along collector streets and secondary arterials, while 65 to 70 dBA is a typical value for a primary/major arterial. Levels of 75 to 80 dBA are normal noise levels

at the first row of development outside a freeway right-of-way. In order to achieve an acceptable interior noise environment, bedrooms facing secondary roadways need to be able to have their windows closed; those facing major roadways and freeways typically need special glass windows.

Annoyance

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

Fundamentals of Groundborne Vibration

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

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

The two primary concerns with construction-induced vibration, the potential to damage a structure and the potential to interfere with the enjoyment of life, are evaluated against different vibration limits. Human perception to vibration varies with the individual and is a function of physical

setting and the type of vibration. Persons exposed to elevated ambient vibration levels, such as people in an urban environment, may tolerate a higher vibration level.

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

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

TABLE 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.

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, September 2013.

Regulatory Background - Noise

The State of California and the town of Portola Valley have established regulatory criteria that are applicable in this assessment. The State CEQA Guidelines, Appendix G, the California Building Code, and the Town of Portola Valley General Plan are used to assess the potential significance of impacts related to the construction and operation of the project. A summary of the applicable regulatory criteria is provided below.

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

(a) Generation of a substantial temporary or permanent increase in ambient noise levels in the vicinity of the project in excess of standards established in the local General Plan or Noise Ordinance, or applicable standards of other agencies;

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

(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.

Pursuant to recent court decisions, the impacts of site constraints, such as exposure of the proposed project to excessive levels of noise and vibration, are not included in the Impacts and Mitigation Section of this report. These items are discussed in a separate section addressing the project's consistency with the policies set forth in the City's Comprehensive Plan.

CEQA does not define what noise level increase would be considered substantial. Typically, an increase in the L_{dn} noise level resulting from the project at noise sensitive land uses of 3 dBA or greater would be considered a significant impact when projected noise levels would exceed those considered acceptable for the affected land use. An increase of 5 dBA L_{dn} or greater would be considered a significant impact when projected noise levels would remain within those considered acceptable for the affected land use.

Town of Portola Valley General Plan. Part 4 of the 2010 General Plan (Environmental Quality) discusses noise. The following goals and policies apply to the proposed project:

4316 Goal 1: Develop Land Uses Compatible with the Noise Environment.

Transportation Generated Noise (Policies 1–3)

1. The town will utilize the noise contours in Figure 1 and noise/land use compatibility standards on Figure 2.

2. New development of residential or other noise-sensitive land uses are discouraged in noise impacted areas unless effective mitigation measures are incorporated into the project design to reduce noise levels in outdoor activity areas to 55 dBA L_{dn} or less.

3. Interior noise levels shall not exceed 45 L_{dn} in all new residential units (single- and multi-family). Residential development sites exposed to exterior noise levels exceeding 55 L_{dn} shall be analyzed following protocols in the 2007 California Building Code (Chapter 12, Appendix Section 1207.11.2) or the most recent revision.

Non-Transportation Noise (Policy 4)

4. New development of noise-sensitive land uses are discouraged where the noise level due to non-transportation noise sources will exceed the standards of Table 3. Where noise sensitive land uses exist or are proposed in areas exposed to existing or proposed exterior non-transportation noise levels exceeding the performance levels of Table 3, an acoustical analysis shall be submitted by an applicant so that the noise mitigation may be included in the design of the new development.

4318 Goal 3: Mitigate Noise from New Projects

1. Noise created by new transportation noise sources (e.g., increased traffic or a new roadway) shall be mitigated so as to not cause the following criteria to be exceeded or to cause a significant adverse community response:

    - Cause the L_{dn} at noise-sensitive uses to increase by 3 dBA or more and exceed the "normally acceptable" level. See Figure 2 for the definition of "normally acceptable."

- Cause the L_{dn} at noise-sensitive uses to increase by 5 dBA or more and remain "normally acceptable."

Where a proposed transportation noise source is likely to produce noise levels that would exceed the above standards, an acoustical analysis shall be required as a part of project review or as part of the environmental review process so that noise mitigation may be included in the project design.

2. Noise created by new non-transportation noise sources shall be mitigated so as to not cause the land use receiving the noise to exceed interior and exterior noise level standards of Table 3. Where proposed non-transportation noise sources are likely to produce noise levels that would exceed the standards of Table 3, an acoustical analysis shall be required as a part of project review or as part of the environmental review process so that noise mitigation may be included in the project design.

3. All acoustical analyses shall:
   - Be the responsibility of the applicant for the project.
   - Be prepared by a qualified person experienced in the fields of environmental noise assessment and architectural acoustics.
   - Include representative noise level assessments with sufficient sampling periods and locations to adequately describe local conditions.
   - Estimate existing and projected (20 years) noise levels in terms of L_{dn} and/or the standards of Table 3, and compare those levels to the policies of this Element.
   - Recommend mitigation to achieve compliance with the adopted policies and standards of this Element. Where the noise source in question consists of intermittent single events, the report must address the effects of maximum noise levels in sleeping rooms in terms of possible sleep disturbance.
   - Describe a post-project assessment program that could be used to evaluate the effectiveness of the proposed mitigation measures.

4319 Goal 4: Control Noise from Construction and Yard Maintenance Activities

1. Implement appropriate standard controls for all construction projects carried out by contractors or homeowners.

2. Implement appropriate standard controls for yard maintenance activities carried out by commercial companies and homeowners.

3. Require ASCC review for all construction projects scheduled for or lasting more than 24 months and submittal of construction staging, timing and noise management plans.

4. Develop a guidance manual to provide information to the public regarding noise control.

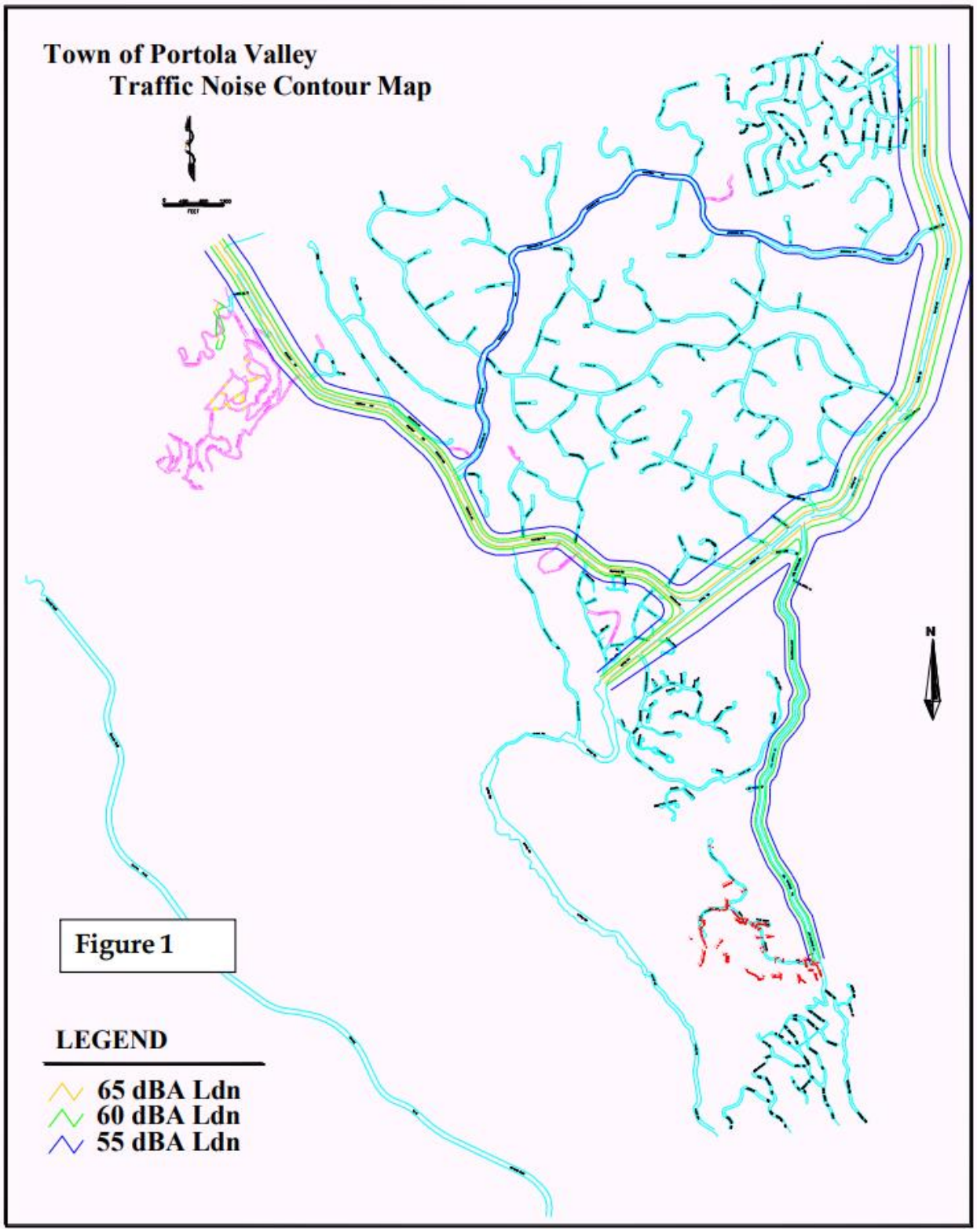
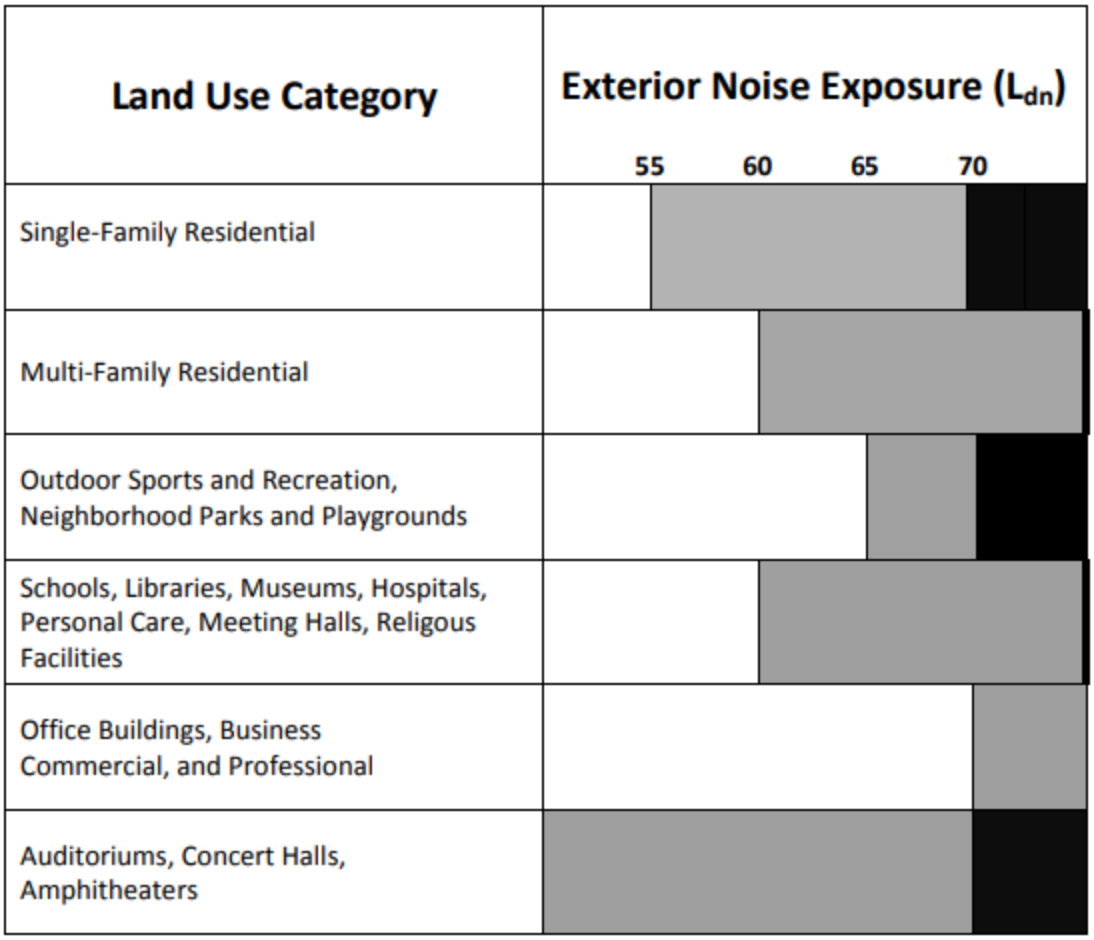

Town of Portola Valley
Traffic Noise Contour Map
N
Figure 1
LEGEND
65 dBA Ldn
60 dBA Ldn
55 dBA Ldn

Figure 2 – Land Use Compatibility for Transportation Noise



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

Conditionally Acceptable: Specified land use may be permitted only after detailed analysis of the noise reduction requirements and needed noise insulation features included in the design

Unacceptable: New construction or development should generally not be undertaken because mitigation is usually not feasible to comply with noise element policies

TABLE 3 Non-Transportation Noise Standards

Land Use Receiving the Noise	Hourly Noise-Level Descriptor	Exterior Noise-Level Standard In Any Hour (dBA)		Interior Noise-Level Standard In Any Hour (dBA)	
		Daytime (7am-10pm)	Nighttime (10pm-7am)	Daytime (7am-10pm)	Nighttime (10pm-7am)
Residential	L_{eq}	50	40	40	30
	L_{max}	65	55	55	45
Medical, convalescent	L_{eq}	55	45	45	35
	L_{max}	70	60	55	45
Theater, auditorium	L_{eq}	--	--	35	35
	L_{max}	--	--	50	50
Religious Facility, meeting hall	L_{eq}	55	--	40	40
	L_{max}		--	55	55
Office building	L_{eq}	--	--	45	--
School, library, museum	L_{eq}	55	--	40	--
	L_{max}		--	55	--
Playground, park	L_{eq}	55	--	--	--

Notes:

a) The Residential standards apply to all residentially zoned properties.

b) Each of the noise levels specified above shall be lowered by 5 dBA for tonal noises characterized by a whine, screech, or hum, noises consisting primarily of speech or music, or recurring impulsive noises.

c) The exterior noise standards are measured at the property line of the receiving property.

d) 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 noise of sufficient intensity, above 35 dBA, and fluctuating noise levels above about 45 dBA have been shown to affect sleep.

Existing Noise Environment

The project site is located near the eastern boundary of Portola Valley, roughly three quarters of a mile west of Interstate 280, and near the intersection of Alpine Road and Westridge Drive. Residential properties exist just to the north of the site along Westridge Drive. Alpine Road runs along the eastern border of the site, while woodlands exist to the south and west.

A noise monitoring survey was performed to document existing noise levels in the project vicinity beginning on Wednesday, January 22, 2020 and concluding on Friday, January 24, 2020. The monitoring survey included two long-term (LT-1 and LT-2) noise measurements and one short-term (ST-1) noise measurement. All measurement locations are shown in Figure 1. The existing noise environment in the project vicinity results primarily from local vehicular traffic along Alpine Road. Occasional aircraft also contribute to the noise environment.

Long-term noise measurement LT-1 was made at the north end of the project site, approximately 530 feet west of the centerline of Alpine Road, and at the fence line of one of the nearest residential properties bordering the site. Hourly average noise levels typically ranged from 43 to 53 dBA L_{eq} during the day and from 41 to 47 dBA L_{eq} at night. The day-night average noise level on Thursday, January 23, 2020 was 52 dBA L_{dn}. The daily trend in noise levels at LT-1 is shown in Figures 2 through 4.

LT-2 was made at the south end of the project site, approximately 110 feet west of the centerline of Alpine Road, which was representative of the setback of the proposed buildings adjacent to the roadway. Hourly average noise levels typically ranged from 50 to 57 dBA L_{eq} during the day and from 34 to 53 dBA L_{eq} at night. The day-night average noise level on Thursday, January 23, 2020 was 55 dBA L_{dn}. The daily trend in noise levels at LT-2 is shown in Figures 5 through 7.

A short-term noise measurement was made over a 10-minute period, concurrent with the long-term noise data, on Wednesday, January 22, 2020 in order to complete the noise survey. ST-1 was made along the northern property line of the site between 11:30 am and 11:40 am. In addition to the roadway traffic, three jets passed overhead, producing maximum instantaneous noise levels of 53 to 60 dBA. During the 101 light passenger vehicle pass-bys, noise levels of 52 to 59 dBA were measured. Four trucks passed the site in this 10-minute period, generating noise levels of 61 to 65 dBA. The 10-minute average noise level measured at ST-1 was 55 dBA $L_{eq(10\text{-}min)}$. The short-term measurement results are summarized in Table 4.

FIGURE 1 Noise Measurement Locations

Source: Google Earth 2020.

FIGURE 2 Daily Trend in Noise Levels at LT-1, Wednesday, January 22, 2020

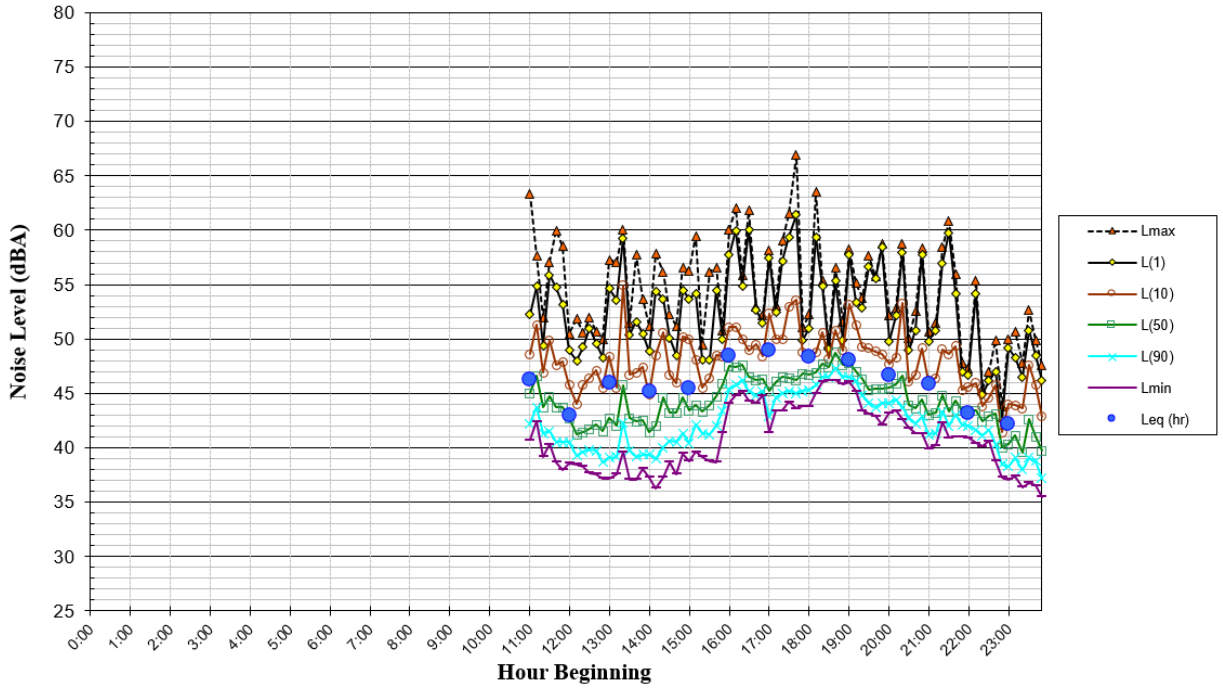


FIGURE 3 Daily Trend in Noise Levels at LT-1, Thursday, January 23, 2020

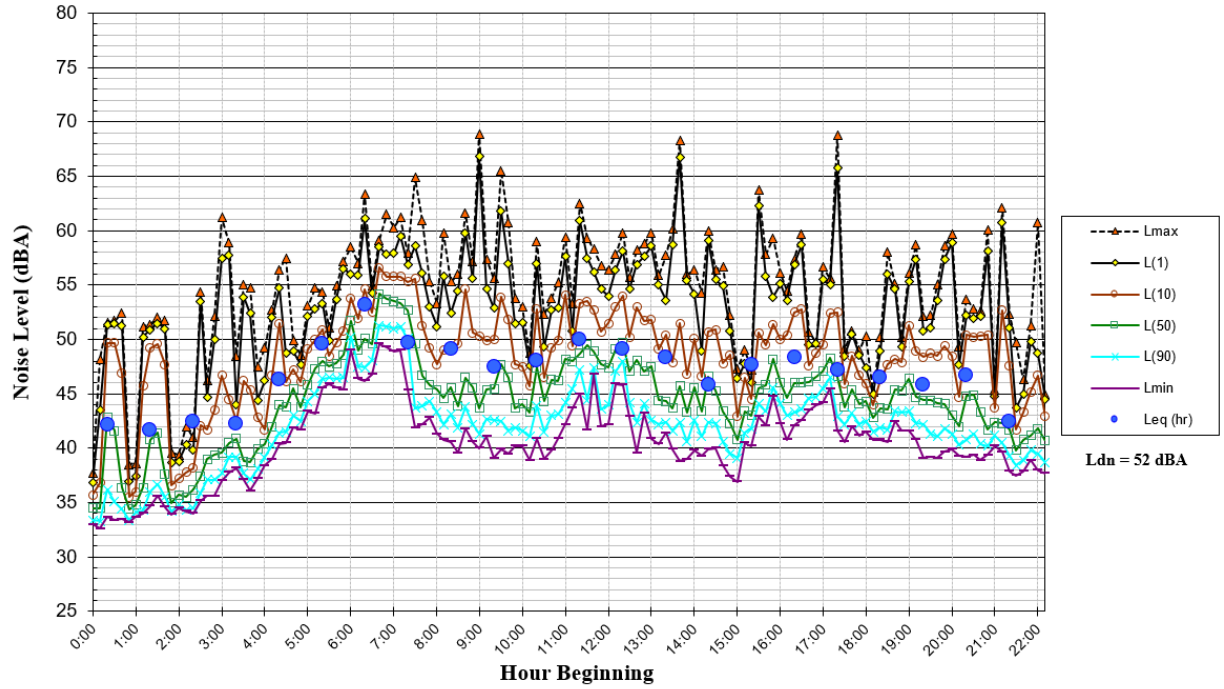


FIGURE 4 Daily Trend in Noise Levels at LT-1, Friday, January 24, 2020

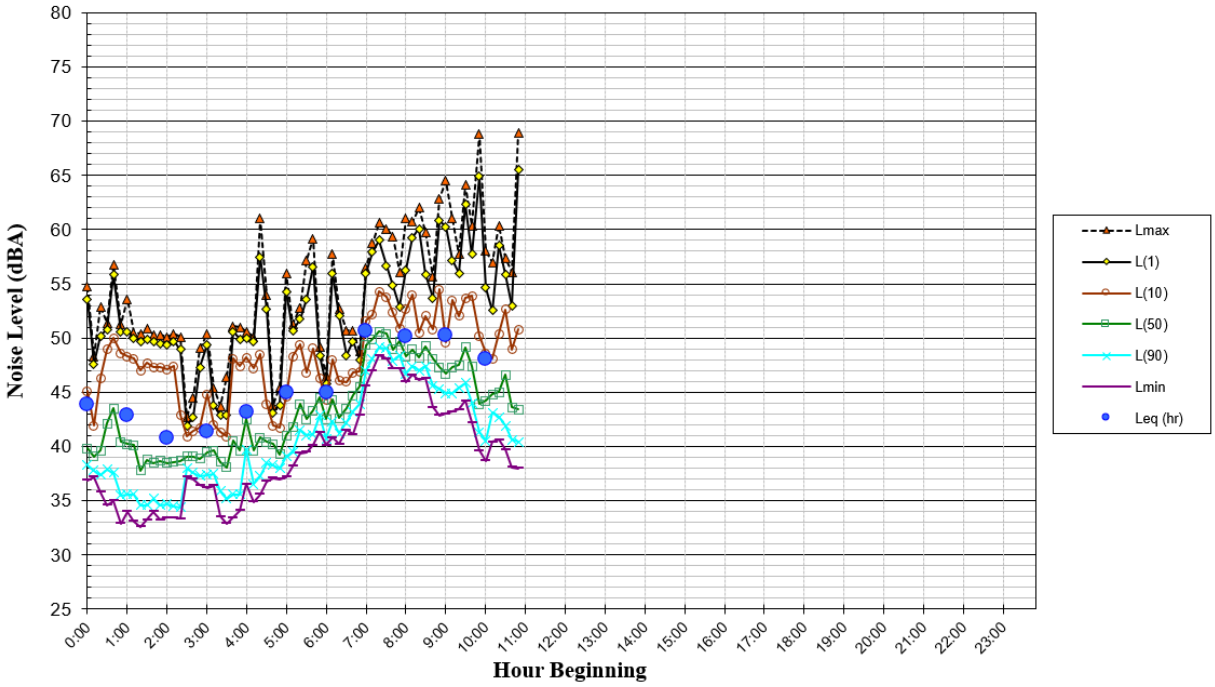


FIGURE 5 Daily Trend in Noise Levels at LT-2, Wednesday, January 22, 2020

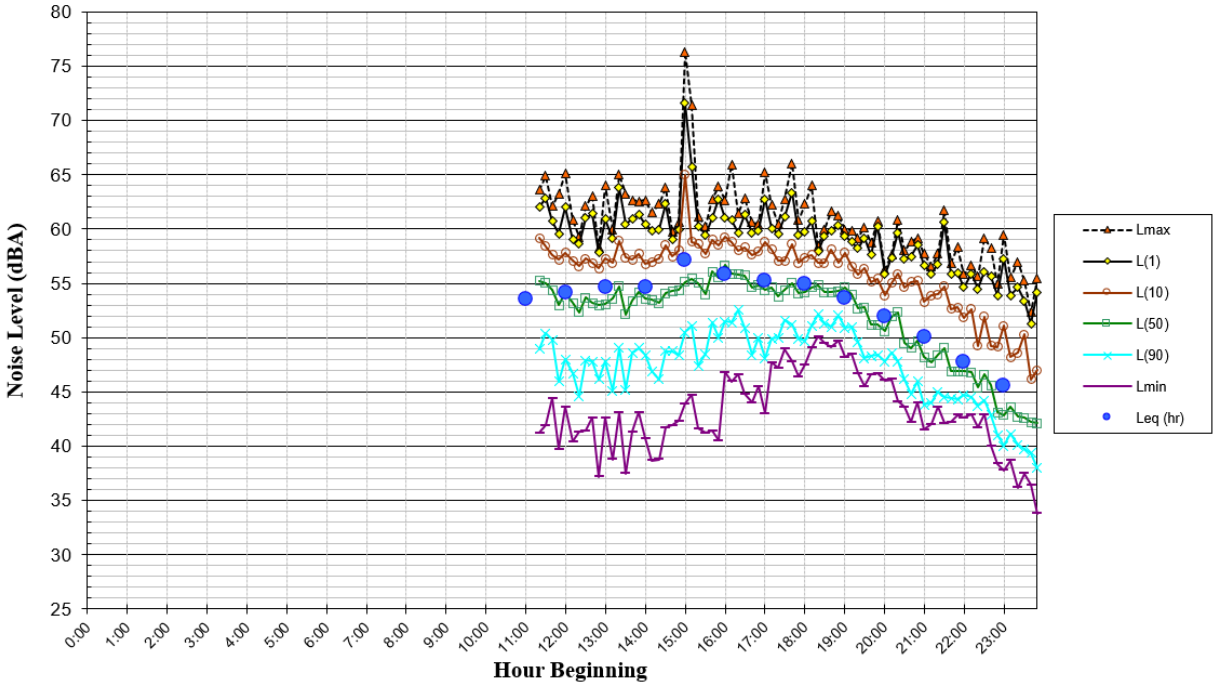


FIGURE 6 Daily Trend in Noise Levels at LT-2, Thursday, January 23, 2020

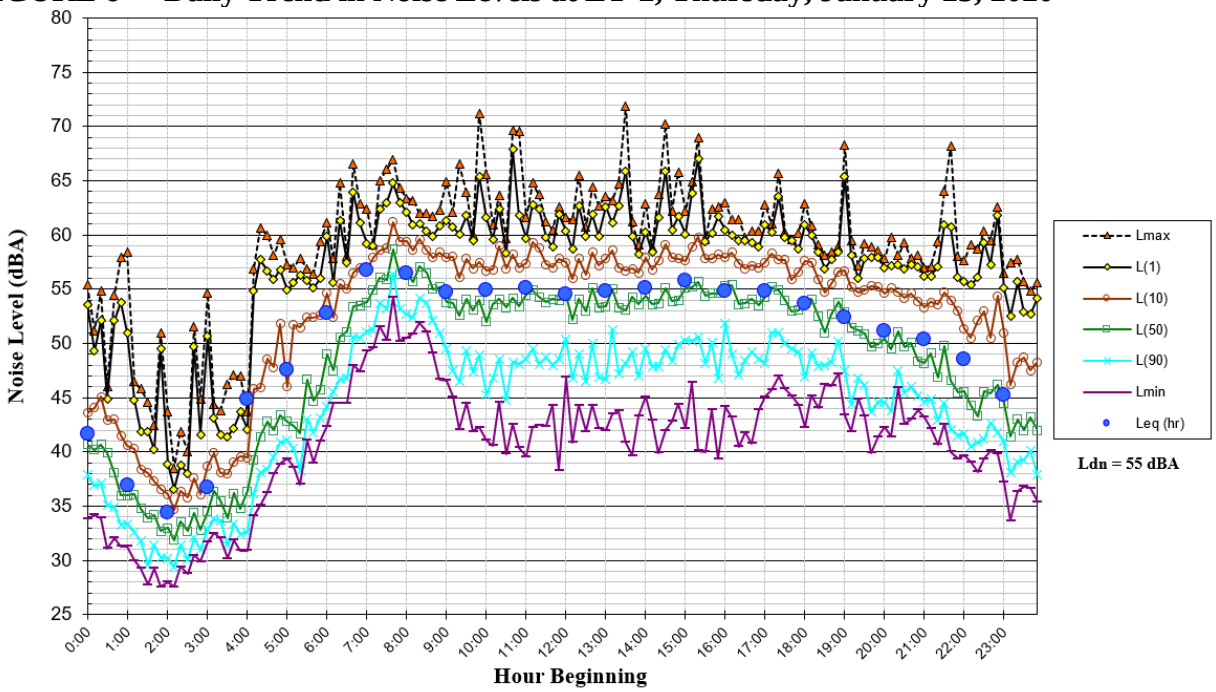


FIGURE 7 Daily Trend in Noise Levels at LT-2, Friday, January 24, 2020

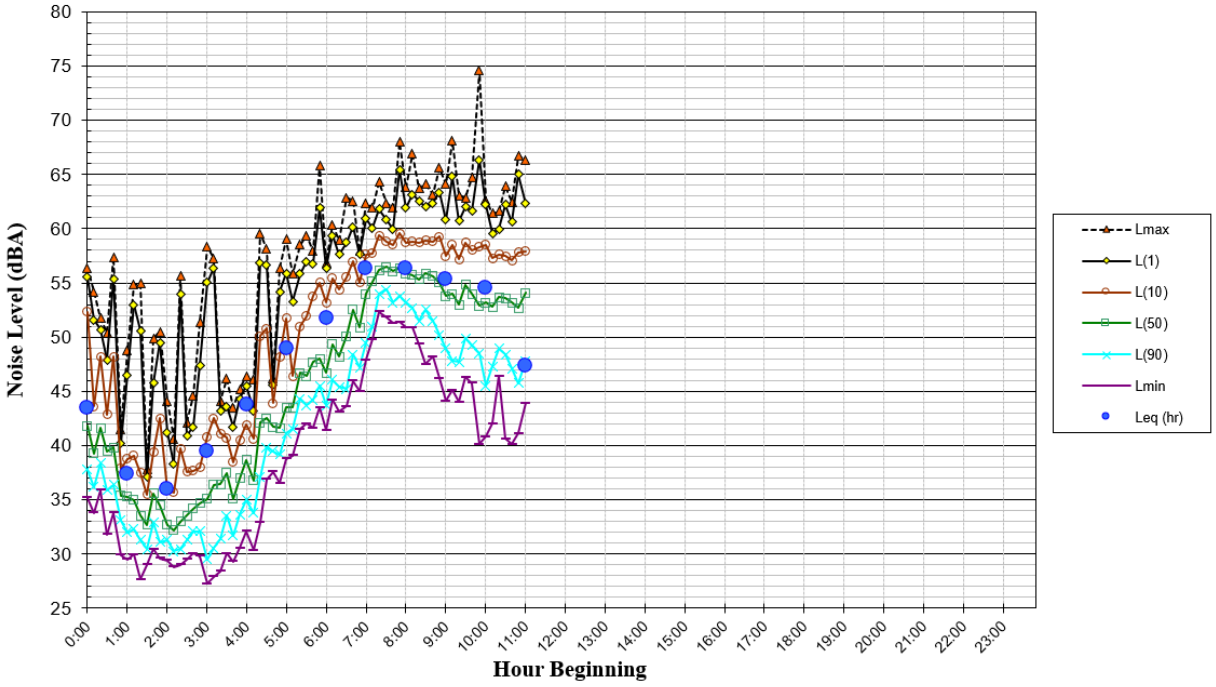


TABLE 4 Summary of Short-Term Noise Measurements (dBA)

Noise Measurement Location (Date, Time)	L_{max}	$L_{(1)}$	$L_{(10)}$	$L_{(50)}$	$L_{(90)}$	$L_{eq(10\text{-}min)}$
ST-1: ~200' West of the Alpine Road Centerline (1/22/2020, 11:30-11:40 am)	65	64	58	54	47	55

PLAN CONSISTENCY ANALYSIS

Noise and Land Use Compatibility

The Town of Portola Valley has established a normally acceptable exterior noise threshold of 55 dBA L_{dn} for single-family residential buildings and a 60 dBA L_{dn} threshold for multi-family residential buildings. This exterior noise standard would be enforced at the centers of private rear yards or common use areas and not at private balconies or decks. It is required that interior noise levels be maintained at 45 dBA L_{dn} or less when the building falls within the 55 dBA L_{dn} noise contour of a transportation-generated noise source, as determined by the local general plan noise element. The current noise levels were measured at 55 dBA L_{dn} at a distance of 110 feet from the centerline of Alpine Road (LT-2).

Future Exterior Noise Environment

The future noise environment at the project site would continue to result primarily from vehicular traffic along Alpine Road. The 2010 Town of Portola Valley General Plan Noise Element[1] provided noise contours in the project vicinity. According to these figures, existing noise levels at the project site and surrounding areas are between 55 and 60 dBA L_{dn}, and would continue to be 55 and 60 dBA L_{dn} in the future. In addition, the proposed 27 single-family units, and three low-income multifamily buildings would generate approximately 26 to 34 trips during the peak hours and approximately 343 daily trips. The relatively low volume of additional traffic along roadways serving the site would not measurably increase the ambient noise environment on an hourly average or daily average basis. According to the site plan, a common outdoor area is shown centrally located within the project site, with setbacks from the centerline of the Alpine Road ranging from 220 to 390 feet. The future exterior noise levels would be below 55 dBA L_{dn} at this outdoor space. The outdoor use areas associated with the proposed residential site are not expected to exceed the Town's exterior noise level limit. Therefore, the proposed project is compatible with the future noise environment at the project site and additional noise control measures are not required.

Future Interior Noise Environment

The closest residential unit to Alpine Road would be approximately 115 feet west of the centerline of the road. At this setback, future hourly average noise levels during daytime hours would range from 50 to 57 dBA $L_{eq(1\text{-}hr)}$, and a day-night average noise level of 55 dBA L_{dn} would be expected at the building exterior. The Town of Portola Valley requires that residential interior noise levels

be maintained at 45 dBA L_{dn} or less. Interior noise levels would vary depending upon the design of the buildings (relative window area to wall area) and the selected construction materials and methods. Standard residential construction provides approximately 15 dBA of exterior to interior noise reduction, assuming the windows are partially open for ventilation. Standard construction with the windows closed provides approximately 20 to 25 dBA of noise reduction in interior spaces. For this project, the set-back from Alpine Road is sufficient to ensure that the interior noise level standard would be met assuming standard construction methods with the windows open for ventilation. No additional noise insulation features (e.g., sound-rated construction methods) would be required.

NOISE IMPACTS AND MITIGATION MEASURES

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.

    - A significant noise impact would be identified if construction-related noise would temporarily increase ambient noise levels at sensitive receptors. The Town of Portola Valley considers a project that will Cause the L_{dn} at noise-sensitive uses to increase by 3 dBA or more and exceed the "normally acceptable" level to be a significant noise impact.

    - A significant permanent noise level increase would occur if project-generated traffic would result in the L_{dn} at noise-sensitive uses to increase by 5 dBA or more and remain "normally acceptable."

    - A significant noise impact would be identified if the project would expose persons to or generate noise levels that would exceed applicable noise standards presented in the General Plan or Municipal Code.

- A significant impact would be identified if the construction of the project would generate excessive vibration levels surrounding receptors. Groundborne vibration levels exceeding 0.3 in/sec PPV would have the potential to result in cosmetic damage to normal buildings.

- A significant noise impact would be identified if the project would expose people residing or working in the project area to excessive aircraft noise levels.

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. This is a **less-than-significant** temporary noise impact.

The potential for temporary noise impacts due to project construction activities would 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. Policy 4319 of the Town's General Plan requires that all construction operations within the Town to implement appropriate standard controls for all construction projects carried out by contractors or homeowners, implement appropriate standard controls for yard maintenance activities carried out by commercial companies and homeowners, require ASCC review for all construction projects scheduled for or lasting more than 24 months and submittal of construction staging, timing and noise management plans, and develop a guidance manual to provide information to the public regarding noise control. The Municipal Code permits commercial construction activities between 8:00 am and 5:30 pm Monday through Friday.

Construction activities generate considerable amounts of noise, especially during earth-moving activities and during the construction of the building's foundation when heavy equipment is used. The highest noise levels would be generated during grading, excavation, and foundation construction. The hauling of excavated materials and construction materials would generate truck trips on local roadways, as well.

The construction schedule provided was approximately 22 months, or 462 construction workdays. Construction activities for individual projects are typically carried out in stages. During each stage of construction, there would be a different mix of equipment operating, and noise levels would vary by stage and vary within stages, based on the amount of equipment in operation and the location at which the equipment is operating. Typical construction noise levels at a distance of 50 feet are shown in Tables 5 and 6. Table 5 shows the maximum noise levels produced by various construction equipment, and Table 6 shows the average noise level range by construction phase. Most demolition and construction noise falls with the range of 80 to 90 dBA L_{max} at a distance of 50 feet from the source. Average noise levels produced by the construction of domestic housing projects generally fall within the range of 65 to 88 dBA L_{eq} at the nearest receptors located approximately 50 feet from the construction work area. Because the nearby noise-sensitive receptors at this site are further away than most general residential projects, noise levels at the nearest receptors to the site would be expected to be much lower than at typical residential construction sites. Construction-generated noise levels drop off at a rate of about 6 dBA per doubling of the distance between the source and receptor. Shielding by buildings or terrain often result in lower construction noise levels at distant receptors.

TABLE 5 Construction Equipment 50-Foot Noise Emission Limits

Equipment Category	L_{max} Level (dBA)[1,2]	Impact/Continuous
Arc Welder	73	Continuous
Auger Drill Rig	85	Continuous
Backhoe	80	Continuous
Bar Bender	80	Continuous
Boring Jack Power Unit	80	Continuous
Chain Saw	85	Continuous
Compressor[3]	70	Continuous
Compressor (other)	80	Continuous
Concrete Mixer	85	Continuous
Concrete Pump	82	Continuous
Concrete Saw	90	Continuous
Concrete Vibrator	80	Continuous
Crane	85	Continuous
Dozer	85	Continuous
Excavator	85	Continuous
Front End Loader	80	Continuous
Generator	82	Continuous
Generator (25 KVA or less)	70	Continuous
Gradall	85	Continuous
Grader	85	Continuous
Grinder Saw	85	Continuous
Horizontal Boring Hydro Jack	80	Continuous
Hydra Break Ram	90	Impact
Impact Pile Driver	105	Impact
Insitu Soil Sampling Rig	84	Continuous
Jackhammer	85	Impact
Mounted Impact Hammer (hoe ram)	90	Impact
Paver	85	Continuous
Pneumatic Tools	85	Continuous
Pumps	77	Continuous
Rock Drill	85	Continuous
Scraper	85	Continuous
Slurry Trenching Machine	82	Continuous
Soil Mix Drill Rig	80	Continuous
Street Sweeper	80	Continuous
Tractor	84	Continuous
Truck (dump, delivery)	84	Continuous
Vacuum Excavator Truck (vac-truck)	85	Continuous
Vibratory Compactor	80	Continuous
Vibratory Pile Driver	95	Continuous
All other equipment with engines larger than 5 HP	85	Continuous

Notes:

[1] Measured at 50 feet from the construction equipment, with a "slow" (1 sec.) time constant.

[2] Noise limits apply to total noise emitted from equipment and associated components operating at full power while engaged in its intended operation.

[3] Portable Air Compressor rated at 75 cfm or greater and that operates at greater than 50 psi.

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

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

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

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

Table 7 summarizes the construction noise levels calculated with the Federal Highway Administration's Roadway Construction Noise Model (RCNM v1.1) based on construction equipment assumptions provided by the project applicant. The maximum instantaneous noise level (L_{max}) and average noise level (L_{eq}) is shown for each type of equipment. The average noise level for the construction phase was conservatively calculated assuming the operation of all construction equipment simultaneously.

TABLE 7 Construction Noise Levels Calculated with RCNM at 260 Feet (dBA)

Construction Phase	Equipment Type	Equipment L_{max}	Equipment L_{eq}	Construction Phase L_{eq}
Demolition	Excavator	66	62	62
Site Preparation	Rubber Tired Dozers	67	63	66
	Tractors/Loaders/Backhoes	63	59	
Grading / Excavation	Graders	71	67	69
	Rubber Tired Dozers	67	63	
	Tractors/Loaders/Backhoes	63	59	
Trenching	Tractor/Loader/Backhoe	63	59	62
Building Exterior	Forklifts	60	53	64
	Tractors/Loaders/Backhoes	63	59	
	Welders	60	56	
Building Interior	Air Compressors	63	59	60
	Aerial Lift	60	53	
Paving	Pavers	63	60	72
	Paving Equipment	71	68	
	Rollers	66	59	
	Tractors/Loaders/Backhoes	63	59	

Source: Illingworth & Rodkin, Inc., September 2019.

Adjacent residential land uses are exposed to ambient daytime noise levels typically ranging from 43 to 57 dBA L_{eq} due to traffic along Alpine Road. During busy construction periods, noise levels would generally fall within the range of 62 to 72 dBA L_{eq} at the nearest receptors located approximately 260 feet from the center of construction work area. Noise levels due to construction activities would substantially exceed ambient conditions for the construction period.

The potential short-term noise impacts associated with project construction activities would be mitigated by the implementation of General Plan Policy 4319, incorporated into the construction plan and implemented during all phases of construction activity. Construction noise would be minimized to the extent feasible, reducing the noise exposure of neighboring properties to a **less-than-significant** level.

Mitigation Measure 1a: None required.

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

According to Policy 4318 of the Town's General Plan, a significant permanent noise increase would occur if the project would increase noise levels at noise-sensitive receptors by 3 dBA L_{dn} or more where ambient noise levels exceed the "normally acceptable" noise level standard. Where ambient noise levels are at or below the "normally acceptable" noise level standard, noise level increases of 5 dBA L_{dn} or more would be considered significant. The City's General Plan defines the "normally acceptable" outdoor noise level standard for the residential land uses to be 55 dBA L_{dn}. Existing ambient levels were 55 dBA L_{dn} at the proposed residential units nearest to Alpine Road. Therefore, a significant impact would occur if traffic due to the proposed project would permanently increase ambient levels by 3 dBA L_{dn}. For reference, a 3 dBA L_{dn} noise increase would be expected if the project would double existing traffic volumes along a roadway.

The traffic study calculated trip generation information, which are 26 net additional trips during the peak AM hour and 34 net additional trips during the peak PM hour. The project's contribution to permanent noise level increases along roadways serving the site is not significant. The proposed project would not result in a permanent noise increase of 3 dBA L_{dn} or more and the impact is less-than-significant impact. Similarly, cumulative traffic noise levels would not be substantially increased, and the project would not cause a "cumulatively considerable" contribution to increased traffic noise levels in the project vicinity.

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 or Municipal Code at the nearby sensitive receptors. **This is a less-than-significant impact.**

The project would include mechanical equipment, such as heating, ventilation, and air conditioning systems. Based on a review of the project plans, the condensing units of residential heat pump

systems would be located at ground level on the side yards of each single-family unit. Noise levels produced by a typical residential heat pump are approximately 56 dBA at 3 feet during operation.

Mechanical equipment would be anticipated to run continuously during the daytime and nighttime hours. Noise levels at nearby residential properties would be limited to 50 dBA during daytime hours (7:00 a.m. to 10:00 p.m.) and to 40 dBA at night (10:00 p.m. to 7:00 a.m.). No equipment is anticipated for a project of this scale that would make meeting the applicable noise limits with standard noise control measures difficult.

Mechanical equipment associated with the proposed project is anticipated to produce noise levels less than 35 dBA at the nearest existing residential property lines to the north. Operational noise levels would not exceed the most conservative 40 dBA L_{eq} nighttime residential threshold at surrounding land uses and would generally be below ambient noise levels in the area. This is a **less-than-significant impact**.

Mitigation Measure 1c: None required.

Impact 2: Exposure to Excessive Groundborne Vibration due to Construction. Construction-related vibration levels resulting from activities are not expected to exceed 0.3 in/sec PPV at the surrounding 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 site demolition, preparation work, foundation work, and new building framing and finishing. The proposed project is not expected to require pile driving, which can cause excessive vibration.

The California Department of Transportation recommends a vibration limit of 0.5 in/sec PPV for buildings structurally sound and designed to modern engineering standards in order to reduce the potential for cosmetic damage to structures. Cosmetic damage is defined as hairline cracking in plaster, the opening of old cracks, the loosening of paint or the dislodging of loose objects. A vibration limit of 0.3 in/sec PPV has been used for buildings that are found to be structurally sound but where structural damage is a major concern (see Table 3 above for further explanation). For historical buildings or buildings that are documented to be structurally weakened, a conservative limit of 0.08 in/sec PPV is often used to provide the highest level of protection.

No historical buildings or buildings that are documented to be structurally weakened adjoin the project site. Groundborne vibration levels exceeding 0.3 in/sec PPV at nearby buildings would have the potential to result in a significant vibration impact because such levels would be capable of cosmetically damaging adjacent buildings. Cosmetic damage (also known as threshold damage) is defined as hairline cracking in plaster, the opening of old cracks, the loosening of paint or the dislodging of loose objects. Minor damage is defined as hairline cracking in masonry or the loosening of plaster. Major structural damage is defined as wide cracking or the shifting of foundation or bearing walls.

Construction vibration levels would vary depending on soil conditions, construction methods, and equipment used. Table 8 presents typical vibration levels from construction equipment at the reference distance of 25 feet. Calculations were also made to estimate vibration levels at the nearest residential and commercial structures surrounding the site. 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. Project-generated vibration levels would fall below the 0.3 in/sec PPV threshold when construction activities producing the highest vibration levels (e.g., vibratory roller) are 20 feet or more from the project site. Since all off-site structures are 25 feet or more from the project site boundaries, neither cosmetic, minor, or major damage would occur at these conventional buildings.

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 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. This would be a less-than-significant impact.

TABLE 8 Vibration Levels for Construction Equipment at Various Distances

Equipment		PPV at 25 ft. (in/sec)	Vibration Levels at Nearest Surrounding Building Façades (in/sec PPV)				
			Nearest Building (45ft)	Nearest Residence (60ft)	2nd Nearest Residence (275ft)	3rd Nearest Residence (365ft)	4th Nearest Residence (380ft)
Clam shovel drop		0.202	0.106	0.077	0.014	0.011	0.010
Hydromill (slurry wall)	in soil	0.008	0.004	0.003	0.001	0.000	0.000
	in rock	0.017	0.009	0.006	0.001	0.001	0.001
Vibratory Roller		0.210	0.110	0.080	0.015	0.011	0.011
Hoe Ram		0.089	0.047	0.034	0.006	0.005	0.004
Large bulldozer		0.089	0.047	0.034	0.006	0.005	0.004
Caisson drilling		0.089	0.047	0.034	0.006	0.005	0.004
Loaded trucks		0.076	0.040	0.029	0.005	0.004	0.004
Jackhammer		0.035	0.018	0.013	0.003	0.002	0.002
Small bulldozer		0.003	0.002	0.001	0.000	0.000	0.000

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., September 2020.

Mitigation Measure 2: None required.

Impact 3: **Excessive Aircraft Noise.** The project site is located over 6 miles from a public airport or public use airport and would not expose people residing or working in the project area to excessive aircraft noise. **This is a less-than-significant impact.**

Palo Alto Airport and Moffett Federal Airfield are public and civil-military airports located approximately 6.3 and 7.8 miles from the project site, respectively. The project site lies well outside both Palo Alto Airport and Moffett Federal Airfield noise contours. This means that future exterior noise levels due to aircraft from these airports are compatible with the proposed land use resulting in a less-than-significant impact.

Mitigation Measure 3: **None required.**