Appendix D – Noise and Vibration Assessment

1000 LA PLAYA DRIVE PROJECT NOISE AND VIBRATION ASSESSMENT

Hayward, California

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INTRODUCTION

The project proposes the construction of 47 single-family residences on lots ranging from approximately 2,925 to 4,350 square feet at 1000 La Playa Drive in Hayward, California. The site is currently developed with a 74,750 square foot, three-story retail commercial building and a surface parking lot. This retail development would be demolished as part of the project. The current General Plan land use designation of the site is Retail and Office Commercial and is zoned Neighborhood Commercial (CN). The proposed project would require a General Plan Amendment to Medium Density Residential and rezoning to Planned Development (PD).

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 ambient noise conditions in the project vicinity; 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 L_{dn}. 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 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.

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

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

City of Hayward

City of Hayward 2040 General Plan. The City of Hayward 2040 General Plan Hazards Element establishes policies to control noise within the community. Applicable goals and policies presented in the General Plan are as follows:

GOAL HAZ-8. Minimize human exposure to excessive noise and ground vibration.

Policy HAZ-8.1: Locating Noise Sensitive Uses. The City shall strive to locate noise sensitive uses (e.g., residences, schools, hospitals, libraries, religions institutions, and convalescent homes) away from major noise sources of noise.

Policy HAZ-8.2: Noise Study and Mitigation. The City shall require development projects in areas where they may be exposed to major noise sources (e.g., roadways, rail lines, and airport, or other non-transportation noise sources) to conduct a project level environmental noise analysis. The noise analysis shall determine noise exposure and noise standard compatibility with respect to the noise standards identified in Table HAZ-1 and shall incorporate noise mitigation when located in noise environments that are not compatible with the proposed use of the project. The study shall use Table HAZ-1 (Exterior Noise Standards for Various Land Uses) and Figure HAZ-1 (Future Noise Contour Map) to determine potential noise exposure impacts, noise compatibility thresholds, and the need for mitigation. The City shall determine mitigation measures based on project-specific noise studies, and may include sound barriers, building setbacks, the use of closed windows and the installation of heating and air conditioning ventilation systems, and the installation of noise attenuating windows and wall/ceiling insulation.

Policy HAZ-8.5: Residential Noise Standards. The City shall require the design of new residential development to comply with the following noise standards:

- The maximum acceptable interior noise level for all new residential units (single-family, duplex, mobile home, multi-family, and mixed-use units) shall be and L_{dn} of 45 dB with windows closed.

- The maximum acceptable exterior noise level for the primary open space area of a detached single-family home, duplex or mobile home, which is typically the backyard or a fenced side yard, shall be an L_{dn} of 60 dB. This standard shall be measured at the approximate center of the primary open space area. This standard does not apply to secondary open space areas, such as front yards, balconies, stoops, and porches.

Policy HAZ-8.8: Park Noise. The City shall coordinate with the Hayward Area Recreation and Park District (HARD) and the East Bay Regional Park District (EBRPD) to establish and enforce hours of operation for park and recreational facilities near residential homes.

Policy HAZ-8.15: Airport Noise Evaluation and Mitigation. The City shall require project applicants to evaluate potential airport noise impacts if the project is located within the 60 dB CNEL contour line of the Hayward Executive Airport or Oakland International Airport (as mapped in the Airport Land Use Compatibility Plan). All projects shall be required to mitigate impacts to comply with the interior and exterior noise standards established by the Airport Land Use Compatibility Plan.

Policy HAZ-8.20: Construction Noise Study. The City may require development projects subject to discretionary approval to assess potential construction noise impacts on nearby sensitive uses and to minimize impacts on those uses, to the extent feasible.

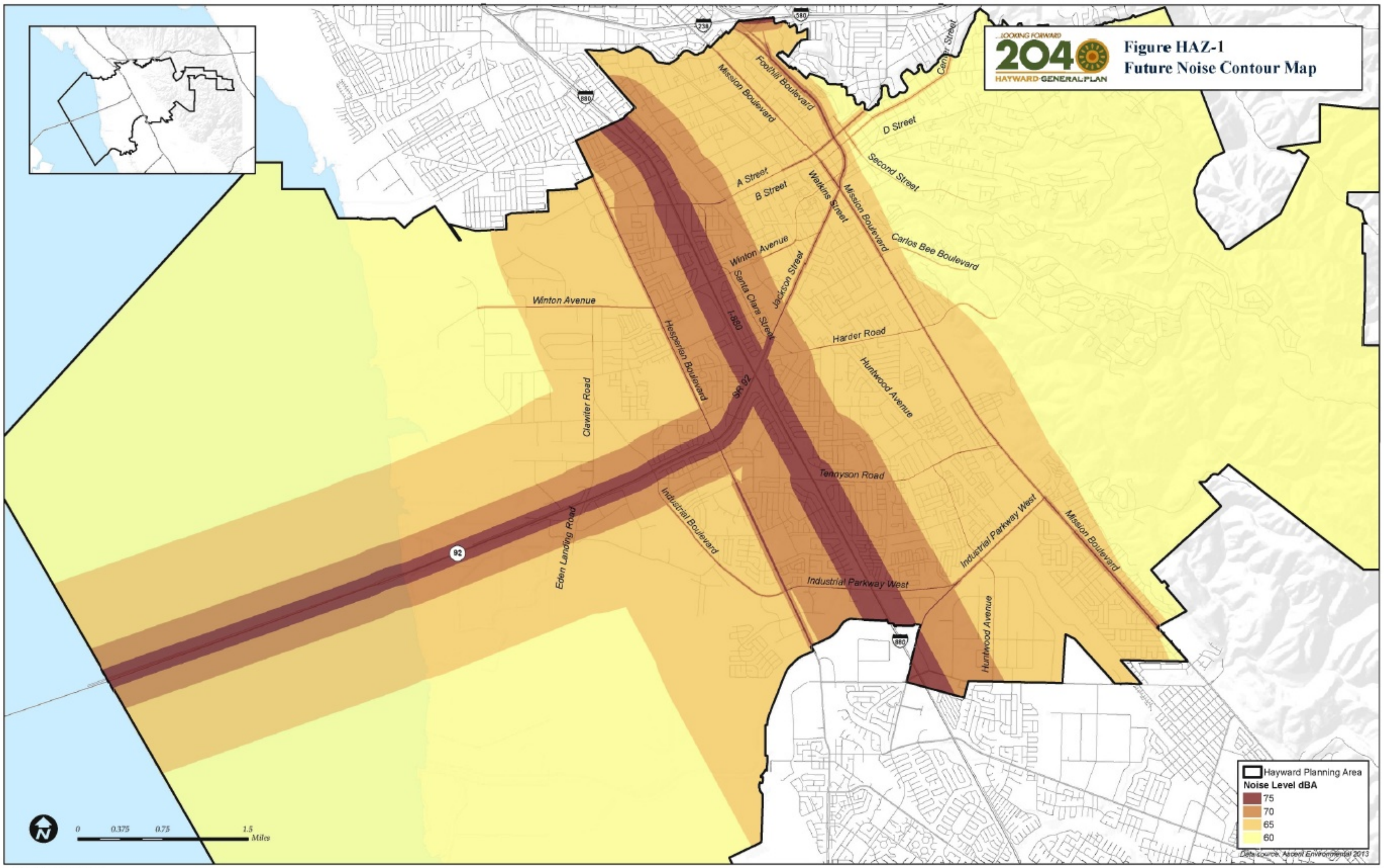
Policy HAZ-8.21: Construction and Maintenance Noise Limits. The City shall limit the hours of construction and maintenance activities to the less sensitive hours of the day (7:00 a.m. to 7:00 p.m. Monday through Saturday and 10:00 a.m. to 6:00 p.m. on Sundays and holidays).

Policy HAZ-8.22: Vibration Impact Assessment. The City shall require a vibration impact assessment for proposed projects in which heavy-duty construction equipment would be used (e.g. pile driving, bulldozing) within 200 feet of an existing structure or sensitive receptor. If applicable, the City shall require all feasible mitigation measures to be implemented to ensure that no damage or disturbance to structures or sensitive receptors would occur.

TABLE HAZ-1 Exterior Noise Compatibility Standards for Various Land Uses	
Land Use Type	**Highest Level of Exterior Noise Exposure that is Regarded as "Normally Acceptable"[a] (Ldn[b] or CNEL[c])**
Residential: Single-Family Homes, Duplex, Mobile Home	60
Residential: Townhomes and Multi-Family Apartments and Condominiums	65
Urban Residential Infill[d] and Mixed-Use Projects[e]	70
Lodging: Motels and Hotels	65
Schools, Libraries, Churches, Hospitals, Nursing Homes	70
Auditoriums, Concert Hall, Amphitheaters	Mitigation based on site-specific study
Sports Arena, Outdoor Spectator Sports	Mitigation based on site-specific study
Playgrounds, Neighborhood Parks	70
Golf Courses, Riding Stables, Water Recreation, Cemeteries	75
Office Buildings: Business, Commercial, and Professional	70
Industrial Manufacturing, Utilities, Agriculture	75

Source: Governor's Office of Planning and Research, *State of California General Plan Guidelines 2003,* October 2003.

a. As defined in the *State of California General Plan Guidelines 200,* "Normally Acceptable" means that the specified land uses is satisfactory, based upon the assumption that any building involved is of normal conventional construction, without any special noise mitigation. For projects located along major transportation corridors (major freeways, arterials, and rail lines) this "normally acceptable" exterior noise level may be exceeded for certain areas of the project site (e.g. the frontage adjacent to the corridor or parking areas) with the exception of primary open space areas (see policies HAZ-8.5 and HAZ-8.6).
b. Ldn or Day Night Average is an average 24-hour noise measurement that factors day and night noise levels.
c. CNEL or Community Noise Equivalent Level measurements are a weighted average of sound levels gathered throughout a 24-hour period.
d. Urban residential infill would include all types of residential development within existing or planned urban areas (such as Downtown, The Cannery Neighborhood, and the South Hayward BART Urban Neighborhood) and along major corridors (such as Mission Boulevard).
e. Mixed-Use Projects would include all mixed-use developments throughout the City of Hayward.



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City of Hayward Municipal Code. The City's Municipal Code contains a Noise Ordinance that limits noise levels during construction activities and at adjacent properties. Section 4-1.03.1 of the Municipal Code outlines residential and commercial property noise limits and Section 4-1.03.4 outlines construction noise limits. The applicable Municipal Code sections are presented below:

Section 4-1.03.1 Noise Restriction by Decibel

(a) Residential Property Noise Limits.

1. No person shall produce or allow to be produced by human voice, machine, device, or any combination of same, on residential property, a noise level at any point outside of the property plane that exceeds seventy (70) dBA between the hours of 7:00 a.m. and 9:00 p.m. or sixty (60) dBA between the hours of 9:00 p.m. and 7:00 a.m.

2. No person shall produce or allow to be produced by human voice, machine, device, or any combinations of same, on multifamily residential property, a noise level more than sixty (60) dBA three feet from any wall, floor, or ceiling inside any dwelling unit on the same property, when windows and doors of the dwelling unit are closed, except within the dwelling unit in which the noise source or sources may be located.

(b) Commercial and Industrial Property Noise Limits. Except for commercial and industrial property abutting residential property, no person shall produce or allow to be produced by human voice, machine, device, or any other combination of same, on commercial or industrial property, a noise level at any point outside of the property plane that exceeds seventy (70) dBA. Commercial and industrial property that abuts residential property shall be subject to the residential property noise limits set forth in sections (a)(1) and (2) above.

Section 4-1.03.4 Construction and Alteration of Structures; Landscaping Activities

Unless otherwise provided pursuant to a duly issued permit or a condition of approval of a land use entitlement, the construction, alteration, or repair of structures and any landscaping activities, occurring between the hours of 10:00 a.m. and 6:00 p.m. on Sundays and holidays, and 7:00 a.m. and 7:00 p.m. on other days, shall be subject to the following:

(a) No individual device or piece of equipment shall produce a noise level exceeding eighty-three (83) dBA at a distance of twenty-five (25) feet from the source. If the device or equipment is housed within a structure on the property, the measurement shall be made outside the structure at a distance as close as possible to twenty-five (25) feet from the equipment.

(b) The noise level at any point outside the property plane shall not exceed eighty-six (86) dBA.

(c) During all other times, the decibel levels set forth in Section 4-1.03.1 shall control.

Existing Noise Environment

The project site is located at 1000 La Playa Drive in Hayward, California. The site is currently developed with a 74,750 square foot, three-story retail commercial building and a surface parking lot. The site is bound by La Playa Drive to the north; Calaroga Avenue and existing residences to the east; existing residences to the south; and a church and automotive shop to the west.

The existing noise environment at the site results primarily from local vehicular traffic along the surrounding roadways. Operational noise from the adjacent automotive shop and aircraft associated with Hayward Executive Airport and Oakland International Airport would also contribute to the noise environment.

A noise monitoring survey was performed at the site beginning on Monday July 26, 2021, and concluding on Thursday July 29, 2021. The monitoring survey included two long-term and two short-term noise measurements, as shown in Figure 1.

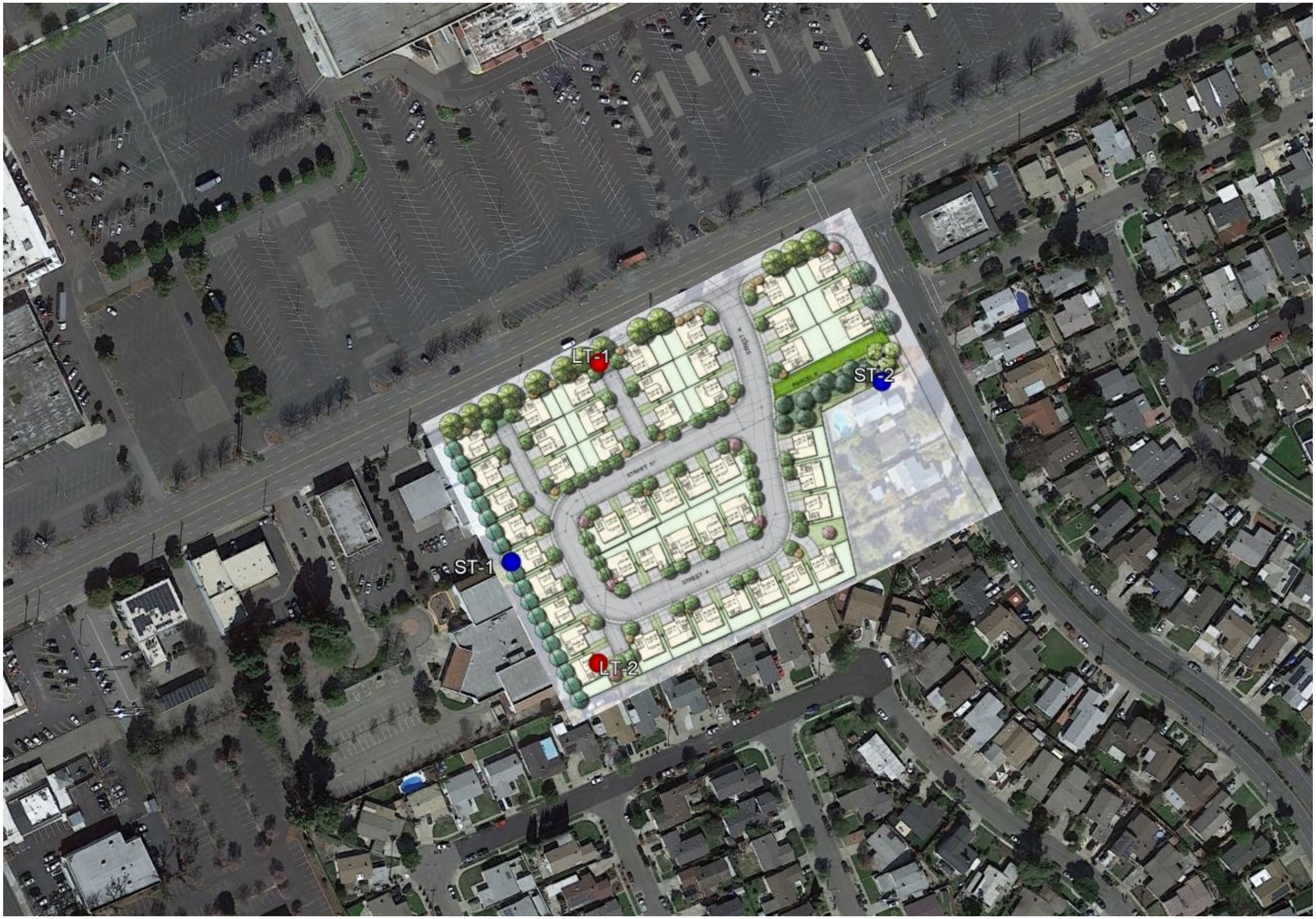
Long-term noise measurement LT-1 was made approximately 60 feet south of the centerline of La Playa Drive in a tree near the roadway. Hourly average noise levels at this location typically ranged from 56 to 65 dBA L_{eq} during the day and from 45 to 58 dBA L_{eq} at night. The day-night average noise level from Monday July 26, 2021, through Thursday July 29, 2021, was 62 dBA L_{dn}. The daily trend in noise levels at LT-1 is shown in Figures 2 through 5.

LT-2 was made in the southwestern corner of the project site, approximately 440 feet south of the centerline of La Playa Drive. Hourly average noise levels at this location typically ranged from 50 to 61 dBA L_{eq} during the day and from 42 to 52 dBA L_{eq} at night. The day-night average noise level from Monday July 26, 2021, through Thursday July 29, 2021, was 56 dBA L_{dn}. The daily trend in noise levels at LT-2 is shown in Figures 6 through 9.

Both of the short-term noise measurements were conducted on Monday July 26, 2021, in 10-minute intervals starting at 11:30 a.m. ST-1 was made along the western boundary of the project site near the existing church and was set back approximately 255 feet from the centerline of La Playa Drive. Typical traffic along La Playa Drive in this time period consisted of passenger vehicles, which generated noise levels of 50 to 57 dBA, with a noisy car producing noise levels up to 68 dBA. Additionally, several planes flew overhead in this time period, generating noise levels of 55 to 72 dBA. The 10-minute L_{eq} measured at ST-1 was 56 dBA.

ST-2 was made near the eastern boundary of the project site, approximately 90 feet from the centerline of Calaroga Avenue. The location of ST-2 was directly under the flight path of overhead planes. Vehicular traffic along Calaroga Avenue generated noise levels of 49 to 73 dBA, and overhead planes generated noise levels of 55 to 65 dBA. The 10-minute L_{eq} measured at ST-2 was 57 dBA. Table 4 summarizes the results for both short-term measurements.

FIGURE 1 Noise Measurement Locations



Source: Google Earth, 2021.

FIGURE 2 Daily Trend in Noise Levels at LT-1, Monday, July 26, 2021

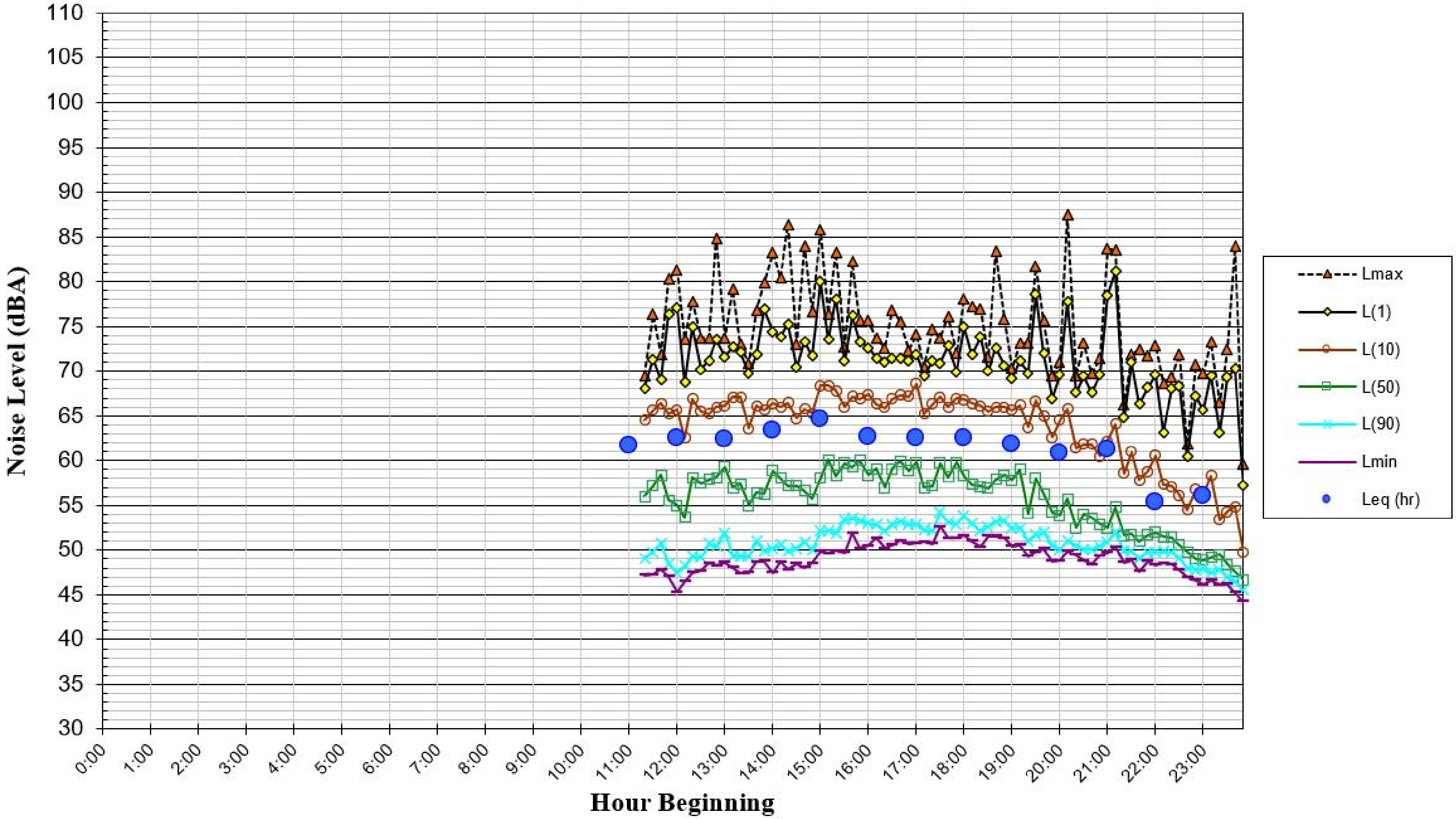


FIGURE 3 Daily Trend in Noise Levels at LT-1, Tuesday, July 27, 2021

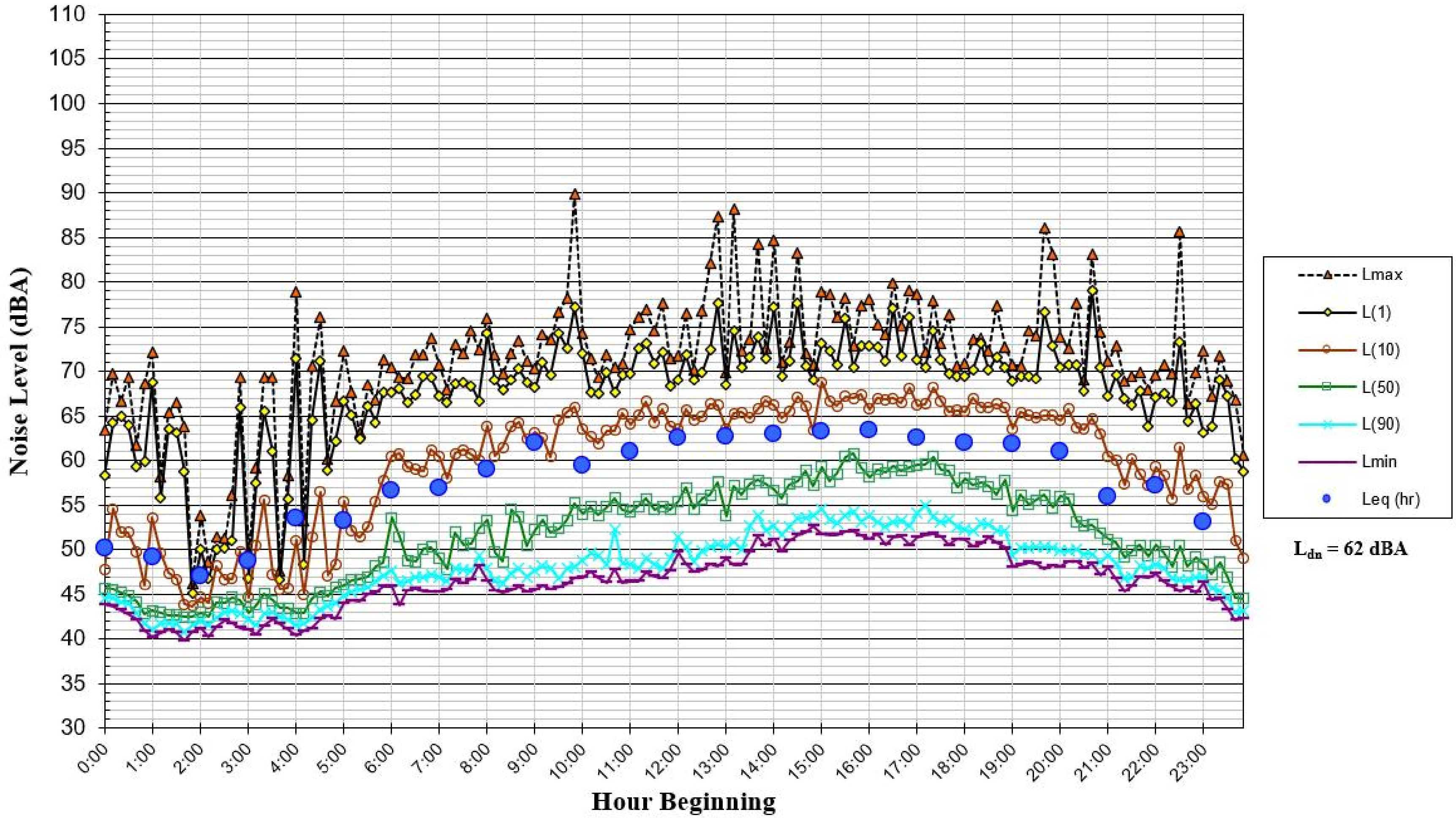


FIGURE 4 Daily Trend in Noise Levels at LT-1, Wednesday, July 28, 2021

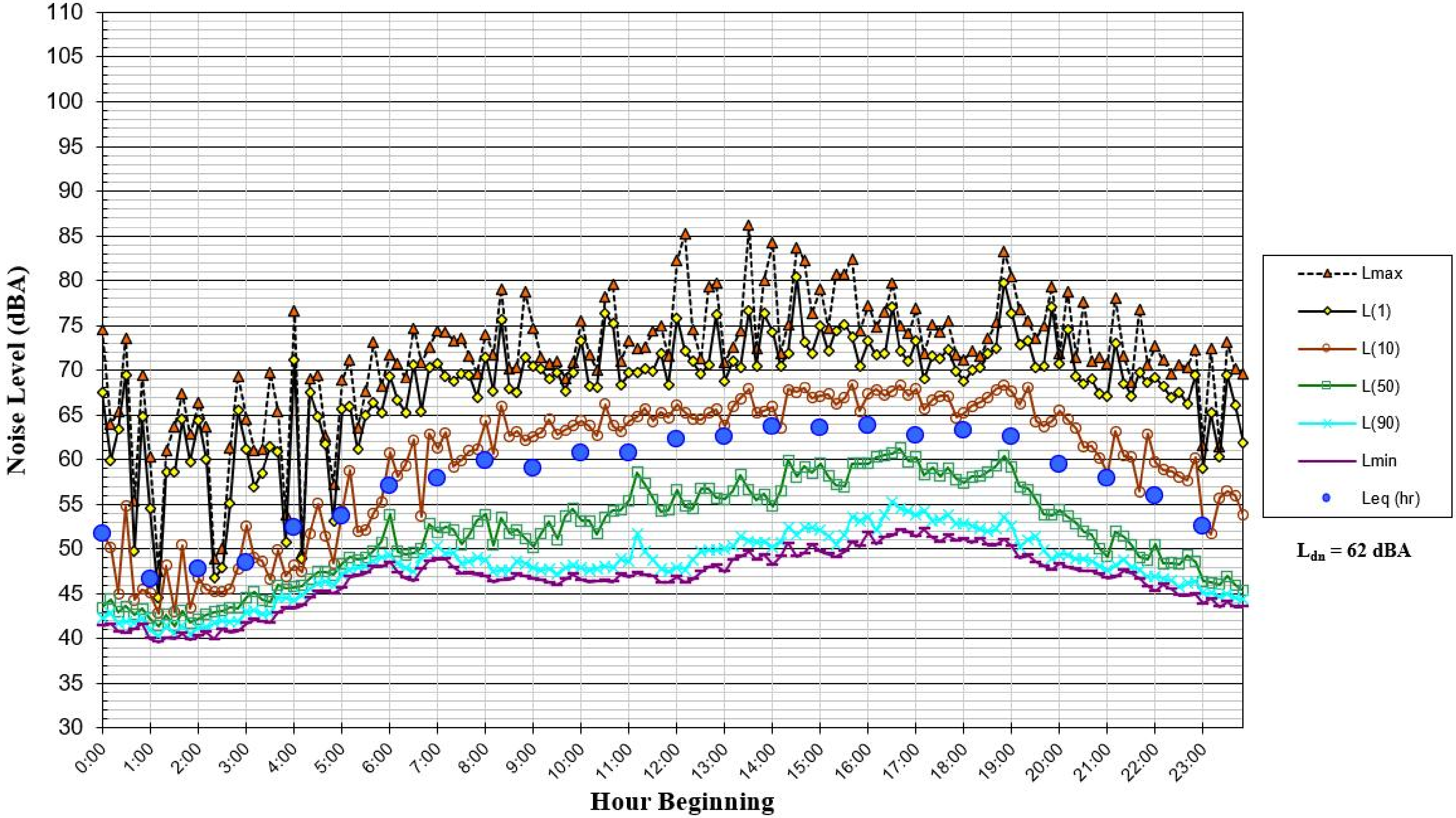


FIGURE 5 Daily Trend in Noise Levels at LT-1, Thursday, July 29, 2021

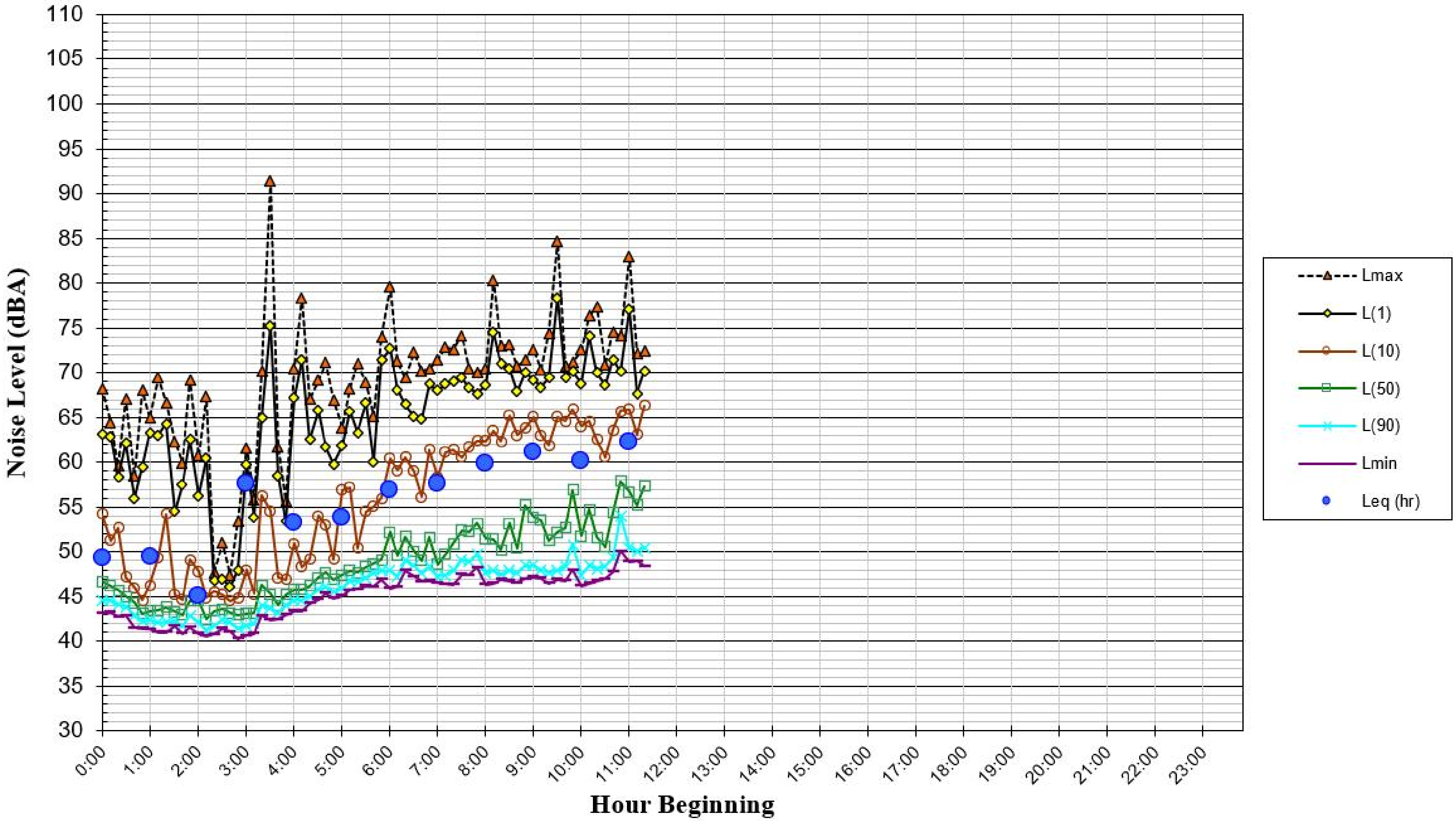


FIGURE 6 Daily Trend in Noise Levels at LT-2, Monday, July 26, 2021

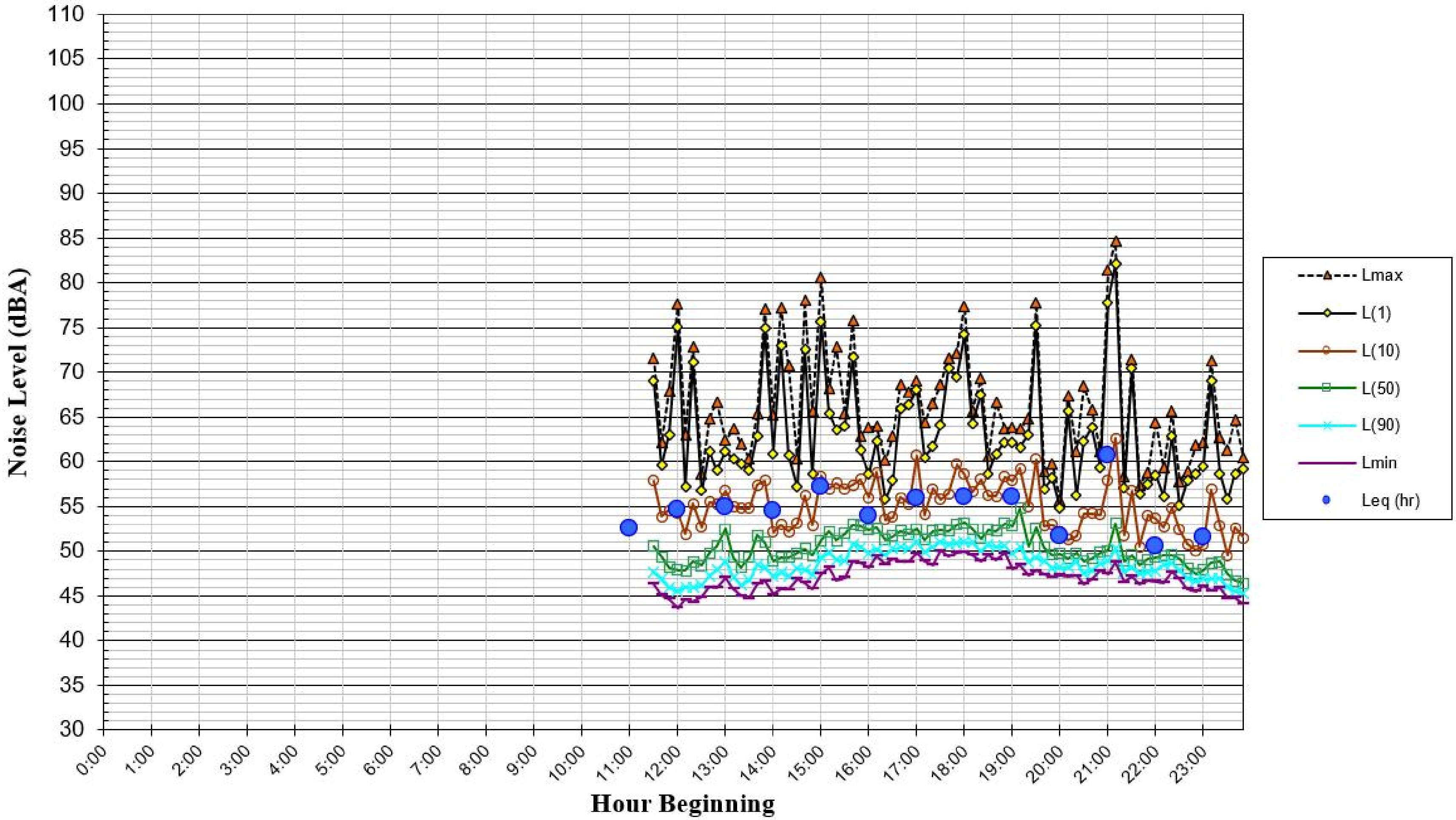


FIGURE 7 Daily Trend in Noise Levels at LT-2, Tuesday, July 27, 2021

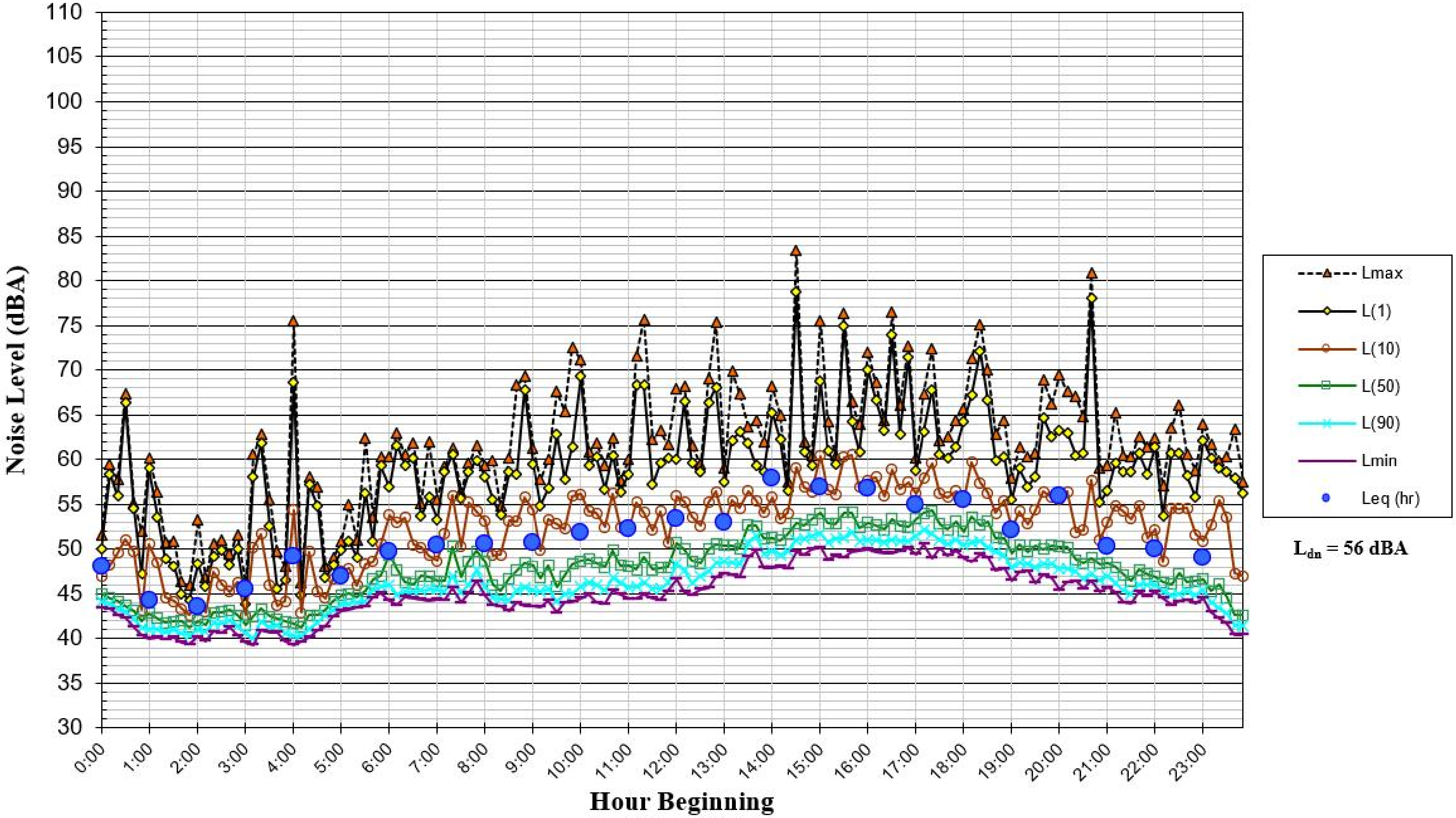


FIGURE 8 Daily Trend in Noise Levels at LT-2, Wednesday, July 28, 2021

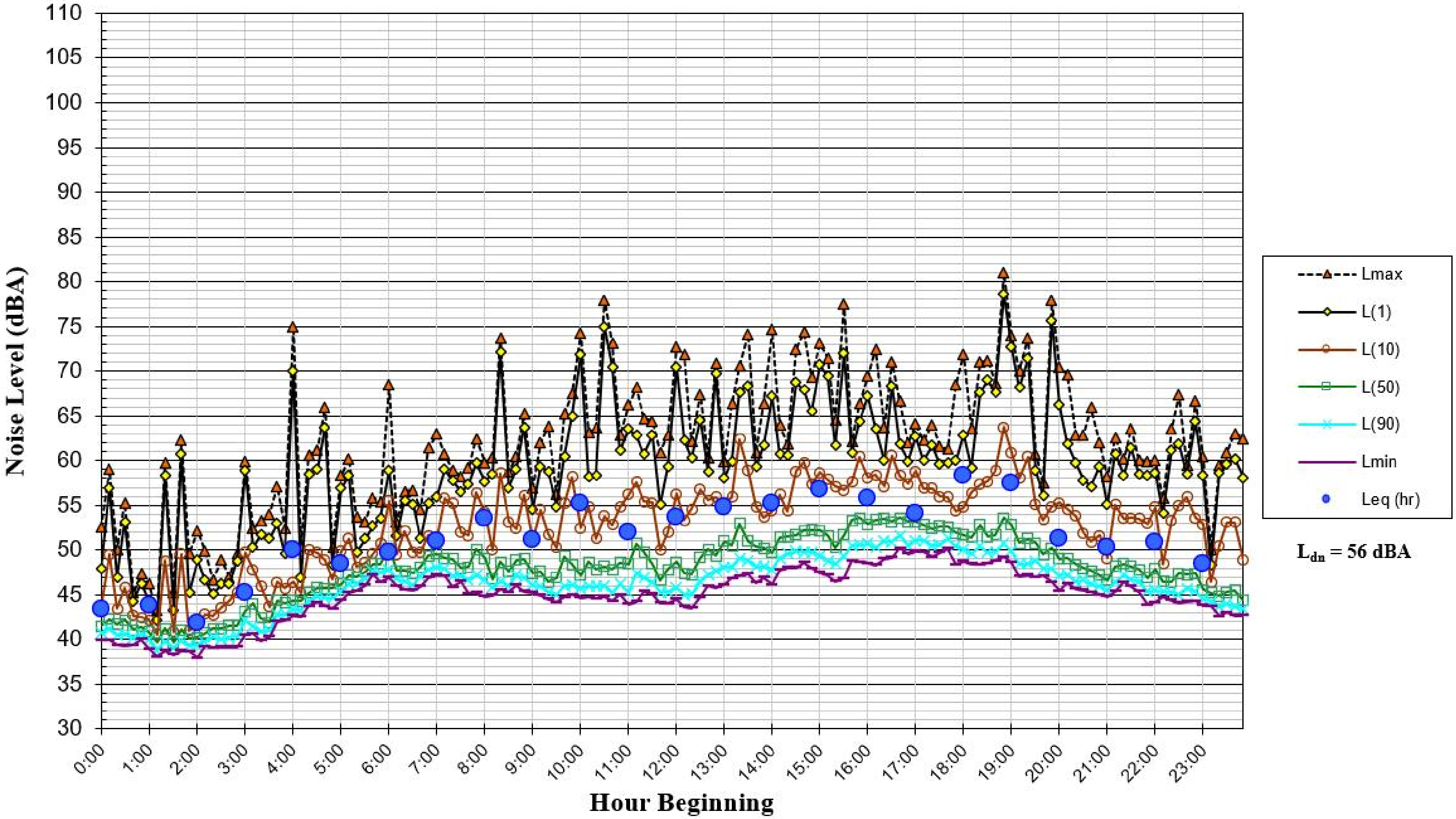


FIGURE 9 Daily Trend in Noise Levels at LT-2, Thursday, July 29, 2021

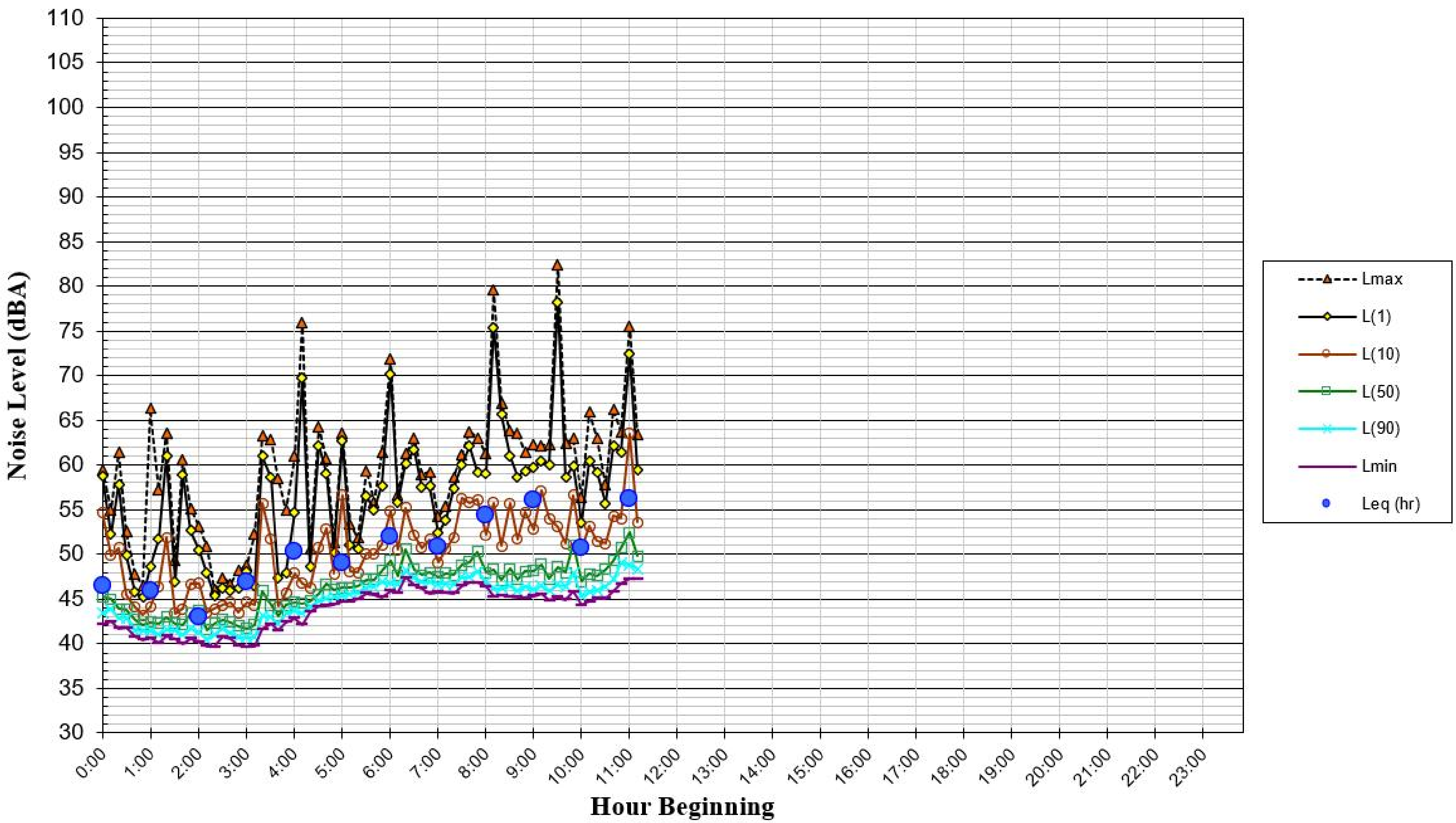


TABLE 4 Summary of Short-Term Noise Measurements (dBA)

Noise Measurement Location (Date, Time)	L_{max}	$L_{(1)}$	$L_{(10)}$	$L_{(50)}$	$L_{(90)}$	L_{eq}
ST-1: Western boundary of project site (7/26/2021, 11:30-11:40)	72	69	57	52	48	56
ST-2: ~90 feet west of the centerline of Calaroga Avenue (7/26/2021, 11:50-12:00)	73	67	61	52	49	57

PLAN CONSISTENCY ANALYSIS

Noise and Land Use Compatibility

The Hazards Element of the City of Hayward 2040 General Plan sets forth policies with the goal of minimizing the impact of noise on people through noise reduction and suppression techniques and through appropriate land use policies in the City of Hayward. The applicable General Plan policies were presented in detail in the Regulatory Background section and are summarized below for the proposed project:

- The City's acceptable exterior noise level standard is 60 dBA L_{dn} or less for the proposed single-family residential land uses.

- The City's acceptable exterior noise level standard is 70 dBA L_{dn} or less for neighborhood parks.

- The City's acceptable interior noise level standard is 45 dBA L_{dn} or less for the proposed single-family residential land uses with the windows closed.

According to the future 2040 contours, which is provided in the General Plan and shown above, the future noise environment at the project site would range from 70 to 75 dBA L_{dn} by the year 2040. However, this is a screening tool that does not consider shielding effects due to sound walls and intervening buildings. Based on the ambient measurements made at the site and the existing traffic volumes along the surrounding roadways, future noise levels at the project site would not be expected to increase by more than 3 dBA under future conditions.

Future Exterior Noise Environment

Outdoor use areas at the project site would include residential backyards and a neighborhood park on Parcel A.

<u>Residential Land Uses</u>

The residences nearest to La Playa Drive would be facing east and west, with backyards located between the houses. The centers of the nearest backyards would be approximately 80 feet from the centerline of La Playa Drive. The proposed residences located on either side of the backyards and the existing buildings located on the adjacent site would provide partial shielding for the backyards. Assuming no additional shielding from privacy fences around the yards, the future exterior noise levels at the center of the nearest backyards would be 61 dBA L_{dn} at a distance of 80 feet.

The site plan does indicate privacy fences around each backyard. Details pertaining to the privacy fences are unknown at this time; however, it is assumed that the privacy fences would be a minimum height of 5 feet tall. Assuming the fences are continuous from grade to top, with no cracks or gaps, and would be constructed from materials having a minimum surface density of three lbs/ft^2, these privacy fences would provide adequate shielding to achieve 60 dBA L_{dn} at the centers of all residential backyards.

<u>Neighborhood Park</u>
The neighborhood park located on Parcel A would be shielded from La Playa Drive by intervening residences and their privacy fences. However, this park would be located along Calaroga Avenue, and the center of the park would be set back approximately 155 feet from the centerline of the roadway. At this distance and assuming partial shielding from the surrounding residences, future exterior noise levels would be at or below 70 dBA L_{dn}.

All residential backyards and the proposed neighborhood park would be expected to meet the City's exterior noise thresholds. No further noise-reducing measures would be required.

Future Interior Noise Environment

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 L_{dn}, 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 L_{dn}, 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.

The nearest residential façades along La Playa Drive would be set back approximately 60 feet from the centerline. At this distance, the rooms facing these façades would be exposed to future exterior noise levels of 65 dBA L_{dn}. Assuming windows to be partially open for ventilation, future interior noise levels would be 50 dBA L_{dn}. These interior noise levels would exceed the 45 dBA L_{dn} threshold and would require noise insulation features.

All remaining residences on the site would have greater setbacks from La Playa Drive and would have some shielding from intervening residences and other existing structures surrounding the site. These residences would be exposed to future exterior noise levels below 65 dBA L_{dn}.

Noise Insulation Features to Reduce Future Interior Noise Levels

A suitable form of forced-air mechanical ventilation, as determined by the local building official, should be provided for all residences on the project site, so that windows can be kept closed at the occupant's discretion to control interior noise and achieve the interior noise standards. The implementation of these noise insulation features would reduce interior noise levels to 45 dBA L_{dn} or less.

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 at existing noise-sensitive receptors surrounding the project site.
    - A significant temporary noise impact would occur if: 1) any individual piece of equipment would exceed 83 dBA at a distance of 25 feet from the equipment or the housing in which it is located; 2) noise levels shall not exceed 86 dBA at any point outside the property plane; or 3) ambient noise levels at noise-sensitive receptors is exceeded by 5 dBA L_{eq} for a period of more than one year.
    - A significant permanent noise level increase would occur if the project would result in: a) a noise level increase of 5 dBA L_{dn} or greater, with a future noise level of less than 60 dBA L_{dn}, or b) a noise level increase of 3 dBA L_{dn} or greater, with a future noise level of 60 dBA L_{dn} or greater.
    - 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.
- 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 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.

Policy HAZ-8.21 of the City's General Plan and Section 4-1.03.4 of the City's Municipal Code limits construction operations to between 7:00 a.m. and 7:00 p.m. Monday through Saturday and between 10:00 a.m. and 6:00 p.m. on Sundays and holidays unless otherwise provided pursuant to a duly issued permit or condition of approval of a land use entitlement. Assuming construction would be limited to these allowable hours, noise levels produced by individual devices or piece of construction equipment shall not exceed 83 dBA at a distance of 25 feet from the equipment or from the housing in which the equipment is located. Noise levels shall not exceed 86 dBA at any point outside the property plane. Additionally, temporary construction would be annoying to surrounding land uses if the ambient noise environment increased by at least 5 dBA L_{eq} for an extended period of time. Therefore, the temporary construction noise impact would also be considered significant if project construction activities produced noise levels exceeding the ambient noise environment by 5 dBA L_{eq} or more for a period longer than one year at surrounding receptors.

Project construction will occur from 7:00 a.m. to 7:00 p.m. It is assumed that construction would be limited to Mondays through Saturdays.

For the residences located along La Playa Drive, daytime ambient noise levels would be represented by LT-1, which ranged from 56 to 65 dBA L_{eq}. The ambient noise environment for the existing residences set back from La Playa Drive ranged from 50 to 61 dBA L_{eq} during daytime hours, according to LT-2.

Construction activities generate considerable amounts of noise, especially during earth-moving activities when heavy equipment is used. Construction activities for individual projects are typically carried out in phases. During each phase of construction, there would be a different mix of equipment operating, and noise levels would vary by phase and vary within phases, based on the amount of equipment in operation and the location at which the equipment is operating. The typical range of maximum instantaneous noise levels for the proposed project would be 70 to 90 dBA L_{max} at a distance of 50 feet (see Table 5) from the equipment. When propagated to 25 feet, the levels in Table 5 would increase by 6 dBA. Therefore, the City's 83 dBA maximum limit for individual pieces of equipment would potentially be exceeded at a distance of 25 feet, which would result in a significant temporary noise impact.

Table 6 shows the hourly average noise level ranges, by construction phase, typical for various types of projects. Hourly average noise levels generated by construction are about 65 to 88 dBA

L_{eq} for residential developments, measured at a distance of 50 feet from the center of a busy construction site. 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.

A detailed list of equipment expected to be used during each phase of project construction was provided for this analysis and is summarized in Table 7. 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 was estimated at the property line of each surrounding land use. 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. These noise level estimates are also shown in Table 7. Noise levels in Table 7 do not assume reductions due to intervening buildings or existing barriers.

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 Estimated Construction Noise Levels at Nearby Land Uses

Phase of Construction	Time Duration	Construction Equipment (Quantity)	Calculated Hourly Average Noise Levels, L_{eq} (dBA)				
			Ambient Noise Levels = 56 to 65 dBA L_{eq}			Ambient Noise Levels = 50 to 61 dBA L_{eq}	
			West Comm. (280ft)	North Comm. (275ft)	East Comm. & Res. – Opp. Calaroga Ave (430ft)	East Res. – Adjacent (210ft)	South Res. (250ft)
			L_{eq}, dBA	L_{eq}, dBA	L_{eq}, dBA	L_{eq}, dBA	L_{eq}, dBA
Demolition	10/1/2021-10/20/2021	Concrete/Industrial Saw (1) Excavator (2) Tractor/Loader/Backhoe (1)	71	71	67	73	72
Site Preparation	10/20/2021-10/21/2021	Grader (2)	69	69	65	72	70
Grading/ Excavation	10/21/2021-1/12/2022	Excavator (2) Grader (1) Rubber-Tired Dozer (1) Tractor/Loader/Backhoe (1)	71	71	67	73	72
Trenching	1/12/2021-3/2/2022	Tractor/Loader/Backhoe (1)	65	65	61	68	66
Building – Exterior	3/2/2022-7/19/2022	Crane (1) Forklift (1) Aerial Lift (1)	60	60	56	62	61
Building – Interior/ Architectural Coating	7/19/2022-2/13/2023	Air Compressor (2)	62	62	58	64	63
Paving	2/13/2023-3/3/2023	Cement & Mortar Mixer (2) Paver (2) Paving Equipment (2) Roller (1) Tractor/Loader/Backhoe (1)	73	73	69	75	74

As shown in Table 7, the City's 86 dBA noise limit for construction is not expected to be exceeded for the majority of activities. However, when single pieces of equipment are operating near a property line shared with a noise-sensitive receptor, construction noise levels would at times be exceeded. Additionally, ambient levels at the surrounding uses would potentially be exceeded by 5 dBA L_{eq} or more at various times throughout construction. Project construction is expected to last for a period of approximately 14 months. Since individual pieces of equipment would potentially exceed 83 dBA at a distance of 25 feet, the City's 86 dBA threshold would potentially be exceeded anywhere outside the project site, and ambient noise levels at surrounding land uses would be exceeded by 5 dBA or more for a period of more than one year, the temporary construction noise impact would be considered significant and would require mitigation.

Mitigation Measure 1a:

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. Construction activities will be conducted in accordance with the provisions of the City's General Plan and the Municipal Code, which limits temporary construction work to between the hours of 7:00 a.m. and 7:00 p.m. Monday through Saturday and between 10:00 a.m. to 6:00 p.m. on Sundays and holidays. Further, 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.

Construction Best Management Practices

Develop a construction noise control plan, including, but not limited to, the following construction best management controls:

- Equipment and trucks used for construction shall use the best available noise control techniques (e.g., improved mufflers, equipment redesign, use of intake silencers, ducts, engine enclosures, and acoustically attenuating shields or shrouds);

- Impact tools (e.g., jackhammers, pavement breakers, and rock drills) used for construction shall be hydraulically or electrically powered wherever possible to avoid noise associated with compressed air exhaust from pneumatically powered tools;

- Stationary noise sources shall be located as far from adjacent receptors as possible, and they shall be muffled and enclosed within temporary sheds, incorporate insulation barriers, or include other measures.

- Construct temporary noise barriers, where feasible, to screen stationary noise-generating equipment. Temporary noise barrier fences would provide a 5 dBA noise reduction if the noise barrier interrupts the line-of-sight between the noise source and receptor and if the barrier is constructed in a manner that eliminates any cracks or gaps.

- Unnecessary idling of internal combustion engines should be strictly prohibited.

- 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. 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.

- Where feasible, temporary power service from local utility companies should be used instead of portable generators.

- Locate cranes, if used, as far from adjoining noise-sensitive receptors as possible.

- During final grading, substitute graders for bulldozers, where feasible. Wheeled heavy equipment are quieter than track equipment and should be used where feasible.

- Substitute nail guns for manual hammering, where feasible.

- Avoid the use of circular saws, miter/chop saws, and radial arm saws near the adjoining noise-sensitive receptors. Where feasible, shield saws with a solid screen with material having a minimum surface density of 2 lbs/ft^2 (e.g., such as ¾" plywood).

- Maintain smooth vehicle pathways for trucks and equipment accessing the site and avoid local residential neighborhoods as much as possible.

- During interior construction, the exterior windows facing noise-sensitive receptors should be closed.

- During interior construction, locate noise-generating equipment within the building to break the line-of-sight to the adjoining receptors.

- 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 site, minimizing disruption and annoyance. With the implementation of these controls, as well as the General Plan and Municipal Code limits on allowable construction hours, and considering that construction is temporary, the impact would be reduced to a less-than-significant level.

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

A significant permanent noise increase would occur if the project would substantially increase noise levels at existing sensitive receptors in the project vicinity. A substantial increase would occur if: a) the noise level increase is 5 dBA L_{dn} or greater, with a future noise level of less than 60 dBA L_{dn} at residences; or b) the noise level increase is 3 dBA L_{dn} or greater, with a future noise level of 60 dBA L_{dn} or greater at residences. According to the 2040 noise contours included in the City's General Plan, the surrounding residences would have future noise levels exceeding 60 dBA L_{dn}. 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 included peak hour turning movements for the existing traffic volumes and existing plus project traffic volumes at five intersections in the vicinity of the project site. By comparing the existing plus project traffic scenario to the existing scenario, the project would result in traffic noise increases of less than 1 dBA L_{dn} along every roadway segment included in the study. Therefore, the project would not result in a permanent noise increase of 3 dBA L_{dn} or more at noise-sensitive receptors in the project vicinity. 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 and Municipal Code at sensitive receptors surrounding the site. **This would be a less-than-significant**.

Section 4-1.03.1 of the City of Hayward Municipal Code limits noise levels to 70 dBA between 7:00 a.m. and 9:00 p.m. and to 60 dBA between 9:00 p.m. and 7:00 a.m., as measured at any receiving property line.

Various mechanical equipment, such as heating, ventilation, and air conditioning (HVAC) units, are typical for residential dwellings. At the time of this study, the type, size, number, and generated noise levels of such units were unknown. Additionally, the locations of potential HVAC units on the project site are unavailable at this time. For purposes of assessing the worst-case scenario, each residential unit is assumed to have an HVAC system, and the units would be located along the exterior building façades at the rear or side of the structures.

Typical noise levels produced by residential HVAC units would range from 53 to 63 dBA at 3 feet during operation. These types of units typically cycle on and off continuously during daytime and nighttime hours. The single-family residences are located along the southern, southeastern, and western boundaries of the project site would have the backyards facing off-site receptors. The HVAC units at each of the proposed residences would be a minimum of 15 feet from the shared property lines, which would include a privacy fence along the edge of the property. Assuming no shielding from the privacy fence, the HVAC units would range from 39 to 49 dBA L_{eq} at 15 feet. With the inclusion of the fence, a minimum reduction of 5 dBA would be expected. Therefore, this would be a less-than-significant impact.

Mitigation Measure 1c: None required.

Impact 2: Exposure to Excessive Groundborne Vibration. Construction-related vibration levels could potentially exceed applicable vibration thresholds at nearby sensitive land uses. **This is a 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.

For structural damage, the California Department of Transportation recommends a vibration limit of 0.5 in/sec PPV for buildings structurally sound and designed to modern engineering standards, which typically consist of buildings constructed since the 1990s. A conservative 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, which would include older residences built with conventional materials. For ancient 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 ancient buildings or buildings that are documented to be structurally weakened adjoin the project site. Therefore, groundborne vibration levels exceeding the conservative 0.3 in/sec PPV limit would have the potential to result in a significant vibration impact.

Vibration levels exceeding 0.3 in/sec PPV 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.

Table 8 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 8 also summarizes the distances to the 0.3 in/sec PPV threshold.

TABLE 8 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., August 2021.

Table 9 summarizes the vibration levels at each of the surrounding structures 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. 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 9), which are different than the distances used to propagate construction noise levels (as shown in Table 7), were estimated under the assumption that each piece of equipment from Table 8 was operating along the nearest boundary of the project site, which would represent the worst-case scenario.

As shown in Table 8, the 0.3 in/sec PPV threshold would potentially be exceeded within about 20 feet of the surrounding buildings, and due to the close proximity of the commercial buildings to the west of the project site (about 5 feet) and the nearest adjacent residences to the south and southeast (about 10 to 15 feet), the use of most construction equipment along the shared property lines would potentially exceed the threshold, as shown in Table 9. All other buildings would be more than 100 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.[1] The findings of this study have been applied to buildings affected by construction-generated vibrations.[2] As reported in USBM RI 8507[1] and reproduced by Dowding,[2] Figure 10 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 10, maximum vibration levels of 1.2 in/sec PPV would result in about 20% chance of threshold or cosmetic damage. No minor or major damage would be expected at the 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 buildings within 20 feet of the project site.

Neither cosmetic, minor, or major damage would occur at buildings located 20 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 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 the threshold of 0.3 in/sec PPV at structures within 20 feet of the site. This would be considered a significant impact.

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[1] 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.

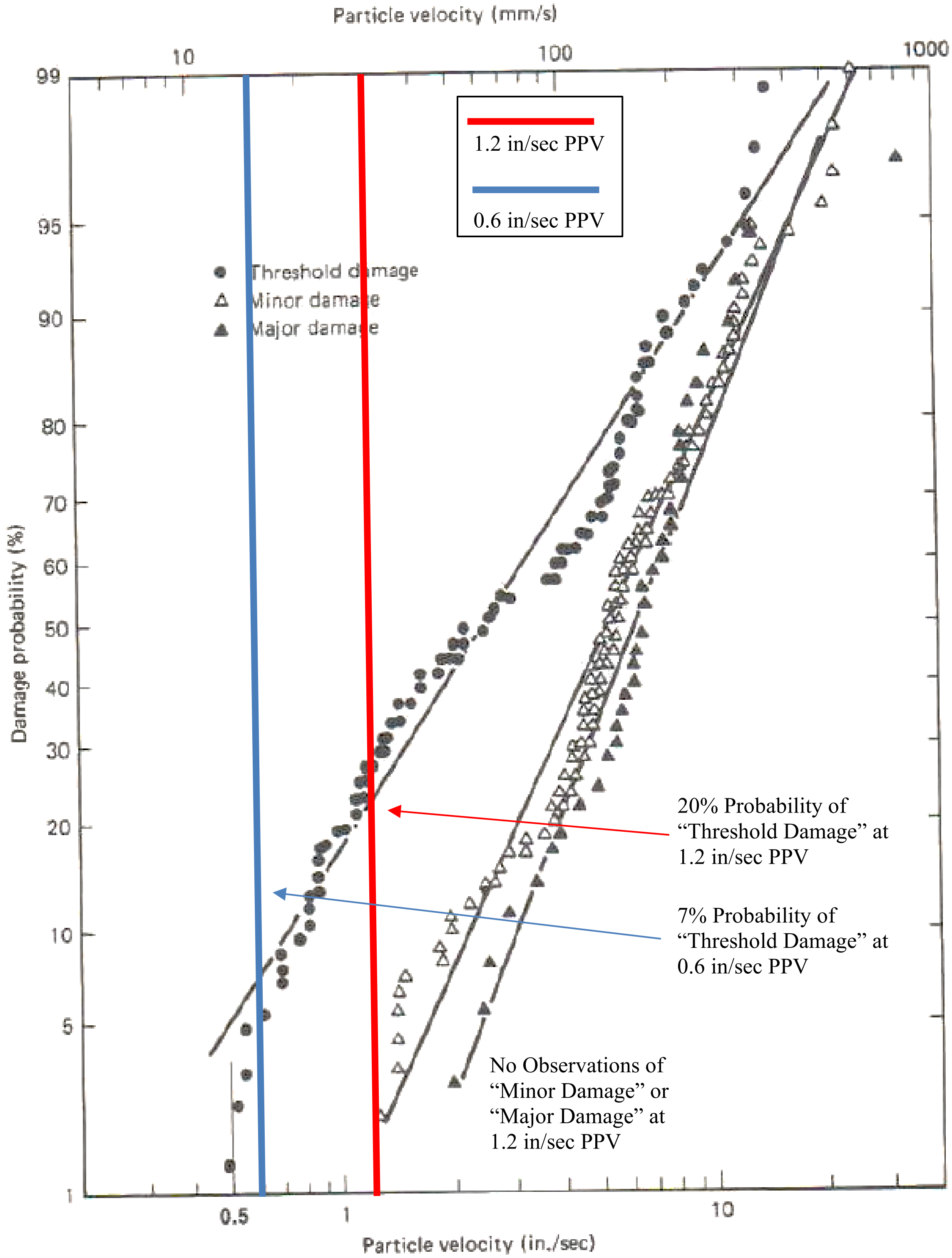
[2] Dowding, C.H., Construction Vibrations, Prentice Hall, Upper Saddle River, 1996.

TABLE 9 Vibration Source Levels for Construction Equipment

Equipment		PPV (in/sec)				
		West Commercial Buildings (5ft)	South Residences (10ft)	Southeast Residences (15ft)	North Commercial Buildings (425ft)	East Residences & Commercial Buildings (105ft)
Clam shovel drop		**1.186**	**0.553**	**0.354**	0.009	0.042
Hydromill (slurry wall)	in soil	0.047	0.022	0.014	0.0004	0.002
	in rock	**0.100**	0.047	0.030	0.001	0.004
Vibratory Roller		**1.233**	**0.575**	**0.368**	0.009	0.043
Hoe Ram		**0.523**	0.244	0.156	0.004	0.018
Large bulldozer		**0.523**	0.244	0.156	0.004	0.018
Caisson drilling		**0.523**	0.244	0.156	0.004	0.018
Loaded trucks		**0.446**	0.208	0.133	0.003	0.016
Jackhammer		**0.206**	0.096	0.061	0.002	0.007
Small bulldozer		0.018	0.008	0.005	0.0001	0.001

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., August 2021.

FIGURE 10 Probability of Cracking and Fatigue from Repetitive Loading



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

Mitigation Measure 2:

Within 20 feet of the existing commercial or residential buildings:

- Compaction activities shall not be conducted using a vibratory roller. Within this area, compaction shall be performed using smaller hand tampers.

- Demolition, earth-moving, and ground-impacting operations shall be phased so as not to occur at the same time and shall use the smallest equipment possible to complete the work. The use of large bulldozers, hoe rams, drill-rigs shall be avoided within 20 feet of existing commercial or residential buildings.

- Construction and demolition activities shall not involve clam shell dropping operations.

The implementation of this mitigation measure would reduce vibration levels to 0.1 in/sec PPV or less, below the thresholds used to assess the potential for cosmetic damage or human annoyance due to construction-related vibration. Therefore, the impact would be mitigated to a less-than-significant level.

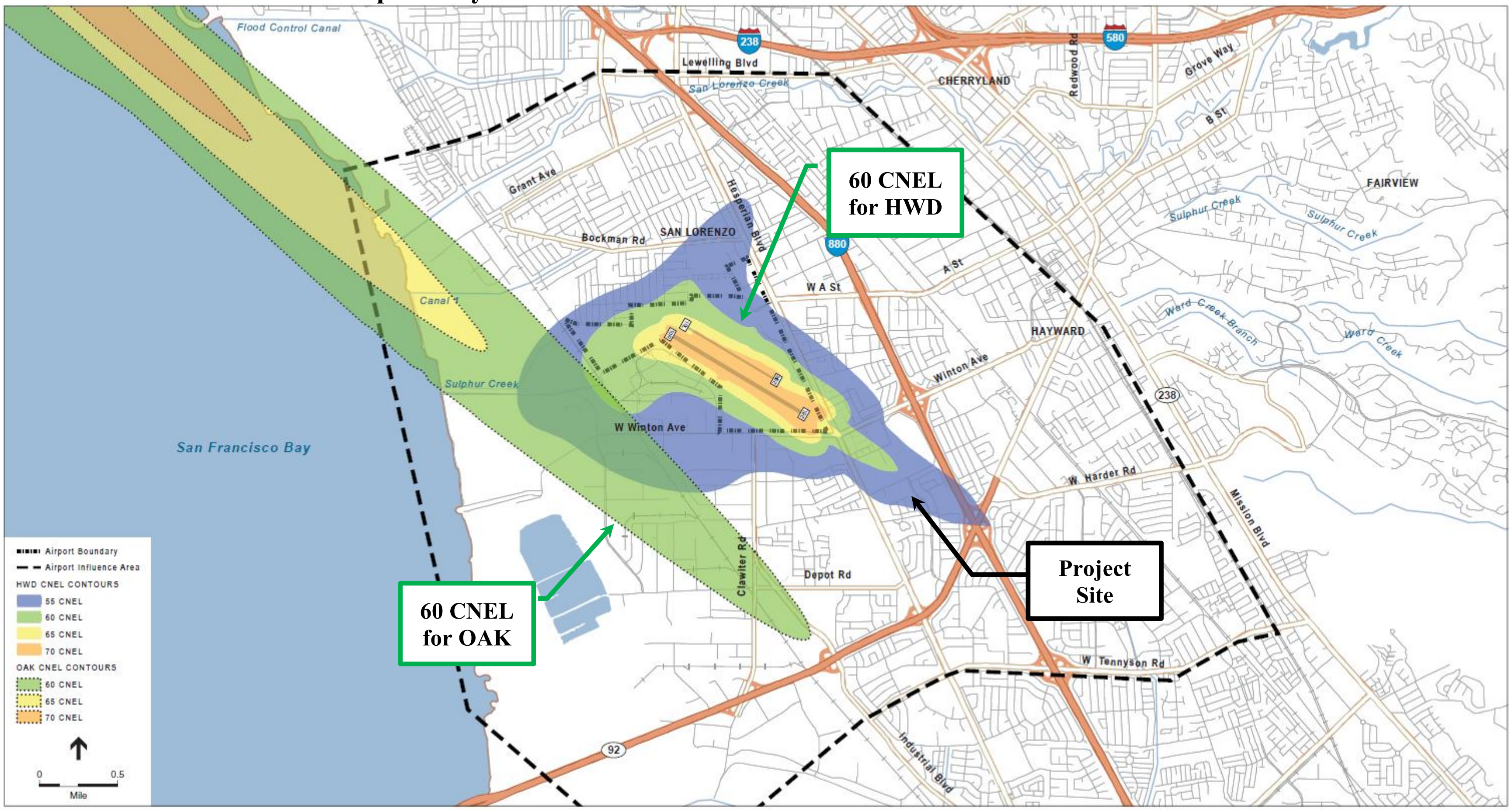
Impact 3: **Excessive Aircraft Noise.** The proposed project would be located in a compatible noise environment with respect to noise generated by Hayward Executive Airport and Oakland International Airport. **This is a less-than-significant impact**.

Hayward Executive Airport is a city-owned, public-use airport located just over 0.5 miles northwest of the project site, and Oakland International Airport is a public-use airport owned by the Port of Oakland that is located approximately 7 miles northwest of the project site. Aircraft-related noise, which was observed during the ambient noise survey, would be audible at the project site. Figure 11 shows the Noise Compatibility Zones for both airports, which can be found in the Hayward Executive Airport : Airport Land Use Compatibility Plan,[3] with the project site identified on the map. The project site lies outside the 60 dBA CNEL noise contour for both airports. While the project site is within the 55 dBA CNEL contour, exterior and interior noise levels resulting from aircraft would be compatible with the proposed project. This is a less-than-significant impact.

Mitigation Measure 3: **None required.**

[3] *Hayward Executive Airport: Airport Land Use Compatibility Plan*, prepared by ESA for the Alameda County ALUC, August 2012.

FIGURE 11 HWD Noise Compatibility Zones



SOURCE: ESA Airports, 2010; California Airport Land Use Planning Handbook, 2000; ESRI

Hayward Executive Airport Land Use Compatibility Plan . 202229
Figure 3-3
HWD Noise Compatibility Zones