# *2565 GRANT STREET RESIDENTIAL DEVELOPMENT NOISE AND VIBRATION ASSESSMENT*

## *Calistoga, California*

**June 21, 2023**

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I&R Job No.: 23-036

## INTRODUCTION

The project proposes the construction of 35 single-family lots and common open space parcels, with a new access road, at 2565 Grant Street in Calistoga, California. Currently, most of the project site is vineyards, with a single outbuilding in the northeast corner and an irrigation pond in the southern corner of the site. The land is to be cleared in preparation for the future development.

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 the 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 p.m. to 10:00 p.m.) and a 10 dB addition to nocturnal (10:00 p.m. to 7:00 a.m.) noise levels. The *Day/Night Average Sound Level* (*DNL* or $L_{dn}$) is essentially the same as CNEL, with the exception that the evening time period is dropped and all occurrences during this three-hour period are grouped into the daytime period.

## Effects of Noise

### *Sleep and Speech Interference*

The thresholds for speech interference indoors are about 45 dBA if the noise is steady and above 55 dBA if the noise is fluctuating. Outdoors the thresholds are about 15 dBA higher. Steady noises of sufficient intensity (above 35 dBA) and fluctuating noise levels above about 45 dBA have been shown to affect sleep. Interior residential standards for multi-family dwellings are set by the State of California at 45 dBA $L_{dn}$. Typically, the highest steady traffic noise level during the daytime is about equal to the $L_{dn}$ and nighttime levels are 10 dBA lower. The standard is designed for sleep and speech protection and most jurisdictions apply the same criterion for all residential uses. Typical structural attenuation is 12 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 – Noise

This section describes the relevant guidelines, policies, and standards established by Federal and State Agencies, and the City of Calistoga. The State CEQA Guidelines, Appendix G, are used to assess the potential significance of impacts pursuant to local General Plan policies or the applicable standards of other agencies. A summary of the applicable regulatory criteria is provided below.

**Federal Government**

***Federal Transit Administration.*** The Federal Transit Administration (FTA) has identified construction noise thresholds in the *Transit Noise and Vibration Impact Assessment Manual*,[1] which limit daytime construction noise to 80 dBA $L_{eq}$ at residential land uses and to 90 dBA $L_{eq}$ at commercial and industrial land uses.

**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;

1 Federal Transit Administration, *Transit Noise and Vibration Impact Assessment Manual*, FTA Report No. 0123, September 2018.

(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 Calistoga**

***City of Calistoga 2003 Noise Element of the General Plan.*** The purpose of the Noise Element of The City's 2003 General Plan is to identify and appraise noise generation in the community in order to minimize problems from intrusive sound and to ensure that the new development does not expose people to unacceptable noise levels. The following policies are applicable to the proposed project:

**Objective N-1.4** Minimize the potential for new development projects to create unacceptable noise levels at sensitive receptors such as residential areas, hospitals, convalescent homes and schools.

**Policy P1.4.-2** A noise study including field noise measurement shall be required for any proposed project which would:

- Place a potentially intrusive noise source near an existing noise sensitive receptor, or
- Place a noise sensitive land use near an existing potentially intrusive noise source.

**Policy P1.4-3** New development projects shall not be approved unless they are generally consistent with the Noise Compatibility Guidelines contained in Figure N-4.

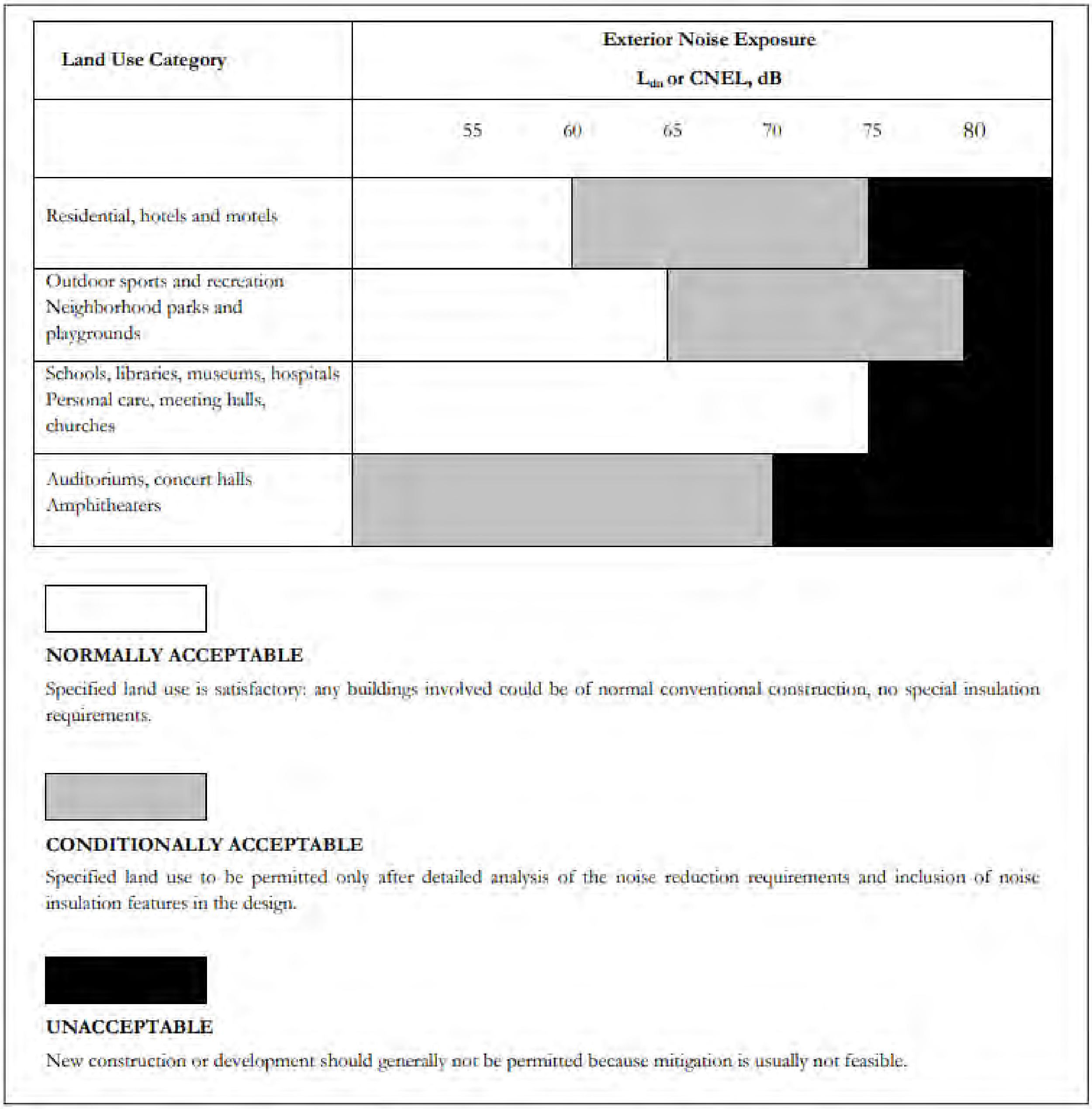


FIGURE N-4 **LAND USE COMPATIBILITY GUIDELINES FOR NOISE EXPOSURE**

***City of Calistoga Municipal Code***. Section 8.20.025 of the Calistoga Municipal Code, specifies prohibited hours for construction activity. According to the code, it shall be unlawful to conduct professional construction activity on Sunday or between 7:00 p.m. and 7:00 a.m. on weekdays.

**Regulatory Background – Vibration**

**State of California**

***California Department of Transportation.*** To avoid damage to buildings, Caltrans recommends that construction vibration levels are limited to 0.5 in/sec PPV for buildings structurally sound and designed to modern engineering standards, to 0.3 in/sec PPV for buildings that are found to be structurally sound but where structural damage is a major concern, and to 0.08 in/sec PPV for ancient buildings or buildings that are documented to be structurally weakened (see Table 3).

**Existing Noise Environment**

The project site is located at 2565 Grant Street in Calistoga, California. The land is to be cleared of all existing vineyards and structures in preparation for the project. Rural-residential properties exist along the northwest and east property lines, while additional single-family residences exist to the south, east, and northeast across Grant Street. Grant Street runs along the northeast property line, while the land to the southwest is currently undeveloped.

The noise environment at the site and in the surrounding area results primarily from local vehicular traffic along Grant Street to the northeast of the project site. Wildlife, such as frogs, and running water, also contribute to the noise environment.

A noise monitoring survey consisting of two long-term (LT-1 and LT-2) and three short-term (ST-1, ST-2, and ST-3) noise measurements was conducted between Thursday, March 30, 2023, and Monday, April 3, 2023. All measurement locations are shown in Figure 1.

Long-term noise measurement LT-1 was made approximately 185 feet southwest of the centerline of Grant Street. This location was chosen to represent noise levels at existing residences along Grant Street. Hourly average noise levels at LT-1 typically ranged from 42 to 52 dBA $L_{eq}$ during daytime hours (7:00 a.m. and 10:00 p.m.) and from 40 to 45 dBA $L_{eq}$ during nighttime hours (10:00 p.m. and 7:00 a.m.). The 24-hour day-night average noise levels at this location were 50 dBA $L_{dn}$ on Friday, March 31, 2023, 50 dBA $L_{dn}$ on Saturday, April 1, 2023, and 49 dBA $L_{dn}$ on Sunday, April 2, 2023. The daily trend in noise levels at LT-1 is shown in Figures A1 through A5 of Appendix A.

Long-term noise measurement LT-2 was made at the south end of the project site, near the Napa River. This location was chosen to represent noise levels at existing residences south of the project site. Unusually high noise levels documented at this location during the evening and nighttime hours are assumed to be from frogs in the nearby irrigation pond. Hourly average noise levels at LT-2 typically ranged from 40 to 54 dBA $L_{eq}$ during daytime hours (7:00 a.m. and 10:00 p.m.) and during nighttime hours (10:00 p.m. and 7:00 a.m.). The 24-hour day-night average noise levels at this location were 54 dBA $L_{dn}$ on Friday, March 31, 2023, 56 dBA $L_{dn}$ on Saturday, April 1, 2023, and 56 dBA $L_{dn}$ on Sunday, April 2, 2023. Because noise from frogs would not be a regularly occurring source of noise at this location, these noise levels could be omitted when calculating the 24-hour day-night average noise levels. When this noise is omitted, the 24-hour day-night average noise levels at this location are calculated to be 48 dBA $L_{dn}$ on Friday, March 31, 2023, 47 dBA

$L_{dn}$ on Saturday, April 1, 2023, and 48 dBA $L_{dn}$ on Sunday, April 2, 2023. The daily trend in noise levels at LT-2 is shown in Figures A5 through A10 of Appendix A. The figures show both the measured $L_{dn}$, as well as the calculated $L_{dn}$ with omitted noise from frogs.

Short-term noise measurements ST-1 and ST-2 were made on Thursday, March 30, 2023, between 11:10 a.m. and 11:40 a.m., while ST-3 was made on Monday, April 3, 2023, between 12:30 p.m. and 12:40 p.m. Table 4 summarizes the noise measurement results measured at each site.

ST-1 was made in front of 1564 Centennial Circle, approximately 30-feet from the centerline of the road. This location was chosen to represent noise levels at existing residences in the neighborhood to the southeast of the project site. Traffic noise from Centennial Circle typically ranged from 43 to 65 dBA. Sounds of wildlife, including birds, people talking, and running water also contributed to the noise environment at this location. The 10-minute $L_{eq}$ measured at ST-1 was 48 dBA.

ST-2 was made in front of 1597 Greenwood Avenue, approximately 20-feet from the centerline of the road. This location was chosen to represent noise levels at existing residences in the neighborhood to the northwest of the project site. Traffic noise from Greenwood Avenue typically ranged from 62 to 66 dBA. Distant traffic along Grant Street also contributed to the noise environment at this location and ranged from 35 to 39 dBA. The 10-minute $L_{eq}$ measured at ST-1 was 50 dBA.

ST-3 was made along the northwestern boundary of the site, and was chosen as a location to represent noise levels at the property lines of the existing residences to the northwest of the project site. Traffic noise from Grant Street typically ranged from 38 to 46 dBA. A brief wind gust generated noise levels up to 60 dBA. The 10-minute $L_{eq}$ measured at ST-3 was 46 dBA.

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

| Noise Measurement Location | Date, Time | Measured Noise Level, dBA | | | | | |
|---|---|---|---|---|---|---|---|
| | | $L_{max}$ | $L_{(1)}$ | $L_{(10)}$ | $L_{(50)}$ | $L_{(90)}$ | $L_{eq}$ |
| ST-1: 1564 Centennial Circle | 3/30/2023, 11:10-11:20 a.m. | 65 | 62 | 48 | 38 | 36 | 48 |
| ST-2: 1597 Greenwood Avenue | 3/30/2023, 11:30-11:40 a.m. | 66 | 65 | 42 | 38 | 37 | 50 |
| ST-3: 2565 Grant Street | 4/3/2023, 12:30-12:40 p.m. | 60 | 54 | 48 | 44 | 41 | 46 |

**FIGURE 1 Aerial Image of the Project Site and Surrounding Area with the Noise Measurement Locations and Noise-Sensitive Receptor Locations Identified**


Source: Google Earth, 2023.

## PLAN CONSISTENCY ANALYSIS

### Noise and Land Use Compatibility

The Noise Element of The City's 2003 General Plan aims to "minimize problems from intrusive sound and to ensure that the new development does not expose people to unacceptable noise levels." The applicable General Plan and California Building Code 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 residential land uses.

The noise environment at the project site would continue to result from traffic along Grant Street, as well as from the new access road on the project site. Traffic volumes were not provided for the proposed project; however, based on similar projects, it is estimated that the project will generate approximately 345 daily vehicle trips, with approximately 24 occurring during the a.m. peak hour and approximately 35 occurring during the p.m. peak hour. Federal Highway Administration's Traffic Noise Model (FHWA TNM), version 2.5, was used to model the peak traffic hour, when 35 vehicles are expected along the new road. The project trips generated by the proposed 35 residential units would increase traffic noise levels along Grant Street by 1 dBA $L_{dn}$ or less. To estimate a traffic noise increase under future conditions, a conservative 1% to 2% increase in traffic volumes each year for the next 20 years was assumed for standard traffic volume increase in a developed area. Under this assumption, the total increase by the year 2043 would be less than 2 dBA $L_{dn}$ at the project site along Grant street, and approximately 1 dBA $L_{dn}$ further from Grant Street.

*Future Exterior Noise Environment*

Single-family residences closest to Grant Street would have future exterior noise levels of 53 dBA $L_{dn}$ or lower. Other residences at the project site would have future exterior noise levels ranging from approximately 45 to 48 dBA $L_{dn}$. The noise levels at the property lines shared with the project site would range from 45 to 53 dBA $L_{dn}$. Therefore, the project is compatible with the future noise environment at the site.

*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 new residential buildings would be exposed to future exterior noise levels ranging from approximately 45 to 53 dBA $L_{dn}$. Assuming windows to be partially open, future interior noise levels in these units would be below 45 dBA $L_{dn}$.

## 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) 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.

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

The project applicant proposes to demolish the existing outbuilding on the north side of the project site and fill in the irrigation pond on the south side of the site. The construction schedule assumed that the earliest possible start date would be the beginning of July 2024, and the project is expected to be completed by the end of May 2026 (approximate 23-month period). Construction phases would include demolition, site preparation, grading, trenching, building construction, and paving. 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.

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.

Section 8.20.025 of the City's Municipal Code requires that all construction operations within the City restrict construction hours near residential uses to the allowable hours, which are between the hours of 7:00 a.m. and 7:00 p.m. Monday through Saturday.

While the City of Calistoga does not establish noise level thresholds for construction activities, this analysis uses the noise limits established by the Federal Transit Administration (FTA) to identify the potential for impacts due to substantial temporary construction noise. The FTA identifies construction noise limits in the *Transit Noise and Vibration Impact Assessment Manual*.[2] During daytime hours, an exterior threshold of 80 dBA $L_{eq}$ shall be enforced at residential land uses and 90 dBA $L_{eq}$ shall be enforced at commercial and industrial land uses.

Construction activities generate considerable amounts of noise, especially during earth-moving activities when heavy equipment is used. The hauling of excavated materials and construction materials would generate truck trips on local roadways, as well. For the proposed project, pile driving, which generates excessive noise levels, is not expected. 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. 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 72 to 88 dBA $L_{eq}$ for residential buildings, 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 results in lower construction noise levels at distant receptors.

Equipment expected to be used in each construction stage are summarized in Table 7, along with the quantity of each type of equipment and the reference noise level at 50 feet, assuming the operation of the two loudest pieces of construction equipment for each construction phase.

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 the two loudest pieces of equipment would operate simultaneously, as recommended by the FTA for construction noise evaluations. 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. Table 7 also summarizes the construction noise levels for the two loudest pieces of equipment propagated to the surrounding receiving land uses.

To assess construction noise impacts at existing noise-sensitive receptors, the worst-case hourly average noise level, which would result in the noise levels summarized in Table 7, was propagated

2 Federal Transit Administration, *Transit Noise and Vibration Impact Assessment Manual*, FTA Report No. 0123, September 2018.

from the geometrical center of the proposed nearest new building to each receptor. The worst-case hourly average noise level for the demolition phase was propagated from the geometrical center of the existing outbuilding on the north end of the site and the existing irrigation pond on the south side of the site, to each receptor. The worst-case hourly average noise level for the paving phase was propagated from the proposed edge of the access road nearest to each receptor. These noise level estimates are shown in Tables 8 and 9. Noise levels in Tables 8 and 9 do not assume reductions due to intervening 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 for the Proposed Project at a Distance of 50 feet**

| Phase of Construction | Total Workdays | Construction Equipment (Quantity) | Estimated Construction Noise Level at 50 feet |
|---|---|---|---|
| Demolition | 1 day | Excavator (1)[a]<br>Rubber-Tired Dozer (1)[a] | 80 dBA $L_{eq}$ |
| Site Preparation | 2 days | Grader (1)[a]<br>Rubber-Tired Dozer (1)[a]<br>Tractor/Loader/Backhoe (1) | 81 dBA $L_{eq}$ |
| Grading/ Excavation | 21 days | Scraper (1)<br>Grader (2)[a]<br>Tractor/Loader/Backhoe (1) | 84 dBA $L_{eq}$ |
| Trenching/ Foundation | 63 days | Tractor/Loader/Backhoe (1)<br>Excavator (1)[a]<br>Compactor (1)[a] | 80 dBA $L_{eq}$ |
| Building – Exterior | 364 days | Forklift (1)[a]<br>Tractor/Loader/Backhoe (1)[a] | 75 dBA $L_{eq}$ |
| Paving | 81 days | Cement and Mortar Mixer (1)[a]<br>Paver (1)[a]<br>Paving Equipment (2)<br>Roller (2)<br>Tractor/Loader/Backhoe (1)[a] | 78 dBA $L_{eq}$ |

[a] Denotes two loudest pieces of construction equipment per phase.

**TABLE 8 Estimated Construction Noise Levels at Nearby Noise-Sensitive Receptors R-1 through R-5**

| Phase of Construction | Calculated Hourly Average Noise Levels, $L_{eq}$ (dBA) | | | | |
|---|---|---|---|---|---|
| | R-1 (250 ft) | R-2 (300 ft) | R-3 (400 ft) | R-4 (410 ft) | R-5 (570 ft) |
| Demolition[a] | 64 at 340 ft | 59 at 600 ft | 66 at 260 ft | 66 at 270 ft | 52 at 1,320 ft |
| Site Preparation | 69 | 67 | 65 | 64 | 62 |
| Grading/ Excavation | 70 | 69 | 66 | 66 | 63 |
| Trenching/ Foundation | 66 | 64 | 61 | 61 | 58 |
| Building –Exterior | 61 | 59 | 57 | 56 | 53 |
| Paving[b] | 62 at 310 ft | 60 at 360 ft | 59 at 440 ft | 59 at 450 ft | 56 at 620 ft |

[a] Phase applies to the existing outbuilding and irrigation pond, not new buildings.
[b] Phase applies to access road, not new buildings.

**TABLE 9 Estimated Construction Noise Levels at Nearby Noise-Sensitive Receptors R-6 through R-10**

| Phase of Construction | Calculated Hourly Average Noise Levels, $L_{eq}$ (dBA) | | | | |
|---|---|---|---|---|---|
| | R-6 (420 ft) | R-7 (220 ft) | R-8 (230 ft) | R-9 (260 ft) | R-10 (340 ft) |
| Demolition[a] | 51 at 1,380 ft | 53 at 1,100 ft | 56 at 840 ft | 60 at 500 ft | 67 at 230 ft |
| Site Preparation | 64 | 70 | 69 | 68 | 66 |
| Grading/ Excavation | 66 | 71 | 71 | 70 | 67 |
| Trenching/ Foundation | 61 | 67 | 66 | 65 | 63 |
| Building –Exterior | 56 | 62 | 61 | 60 | 58 |
| Paving[b] | 58 at 460 ft | 63 at 270 ft | 62 at 290 ft | 62 at 310 ft | 61 at 320 ft |

[a] Phase applies to the existing outbuilding and irrigation pond, not new buildings.
[b] Phase applies to access road, not new buildings.

As shown in Tables 7 through 9, construction noise levels could intermittently range from 75 to 84 dBA $L_{eq}$ if activities occur 50 feet from nearby receptors. Construction noise levels would typically range from 51 to 71 dBA $L_{eq}$ at nearby residential land uses. Construction noise levels are not expected to exceed the exterior threshold of 80 dBA $L_{eq}$ at residential land uses. The project site is located within 500 feet of existing residential uses, and total construction is expected to last for a period of approximately 23 months.

Reasonable regulation of the hours of construction, as well as regulation of the arrival and operation of heavy equipment and the delivery of construction material, are necessary to protect the health and safety of persons, promote the general welfare of the community, and maintain the quality of life. The construction crew shall 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*

- Limit construction activities to the City's allowable hours of 7:00 a.m. to 7:00 p.m. on weekdays and prohibit construction on Sundays and holidays, where possible.

- 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.

- At a minimum, the construction contractor shall implement the following control measures: improved mufflers, equipment redesign, use of intake silencers, ducts, engine enclosures, and acoustically-attenuating shields or shrouds.

- Equipment used for project construction shall be hydraulically or electrically powered impact tools (e.g., jack hammers) wherever possible to avoid noise associated with compressed air exhaust from pneumatically-powered tools. Where use of pneumatically-powered tools is unavoidable, an exhaust muffler on the compressed air exhaust shall be used. A muffler could lower noise levels from the exhaust by up to about 10 dBA. External jackets on the tools themselves shall be used where feasible; this could achieve a reduction of 5 dBA. Quieter procedures shall be used (such as drilling rather than impact equipment) wherever feasible.

- The construction contractor shall not allow any construction equipment, trucks, or vehicles to idle.

- Locate stationary noise-generating equipment, such as air compressors or portable power generators, as far as possible from sensitive receptors as feasible. If they must be located near receptors, adequate muffling (with enclosures where feasible and appropriate) shall be used to reduce noise levels at the adjacent sensitive receptors. Any enclosure openings or venting shall face away from sensitive receptors.

- 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.

- Route construction-related traffic along major roadways and as far as feasible from sensitive receptors.

- Control noise from construction workers' radios to a point where they are not audible at existing residences bordering the project site.

- The contractor shall prepare a detailed construction schedule for major noise-generating construction activities. The construction plan shall identify a procedure for coordination with adjacent residential land uses so that construction activities can be scheduled to minimize noise disturbance.

- Designate a "disturbance coordinator" who would be responsible for responding to any complaints about construction noise. The disturbance coordinator will determine the cause of the noise complaint (e.g., bad muffler, etc.) and will require that reasonable measures be implemented to correct the problem. Conspicuously post a telephone number for the disturbance coordinator at the construction site and include in it the notice sent to neighbors regarding the construction schedule.

Implementation of the above best management practices would reduce construction noise levels emanating from the site, limit construction hours, and minimize disruption and annoyance. With the implementation of these practices and recognizing that noise generated by construction activities would occur over a temporary period, the temporary increase in ambient noise levels would be reduced to a less-than-significant level.

**Mitigation Measure 1a:** **No further mitigation required.**

**Impact 1b:** **Permanent Noise Level Increase/Exceed Applicable Standards.** The proposed project would not result in a substantial permanent noise level increase at receptors in the project vicinity. Operational noise levels generated by the proposed project would not exceed General Plan thresholds. This is a **less-than-significant** impact.

The City's Noise Element specifies a noise limit of 60 dBA $L_{dn}$ at receiving residential land uses. No commercial uses are in the vicinity of the project. Exceeding this limit would not be considered a significant impact under CEQA; however, it is recommended that this limit be considered for the proposed project.

*Project Traffic*

Peak hour trips generated by the proposed project would be 35 or fewer during both peak AM and peak PM hours. Compared to the existing volumes along Grant Street, these peak hour trips would result in a noise level increase of less than 1 dBA $L_{dn}$. The construction of the new access road though the site and resulting project traffic will increase noise levels at nearby noise-sensitive receptors by 1 dBA $L_{dn}$ or less. This is a less-than-significant impact.

*Mechanical Equipment*

Noise levels received at nearby sensitive land uses would depend on system design level specifications, including the equipment location, type, size, capacity, and enclosure design. These details are typically not available until later phases of the project design and development review process. Mechanical equipment that will service the buildings has not been selected as the project design is not far enough along at this point to provide such details. Generally, one HVAC unit will be provided per unit, and this analysis assumes that mechanical equipment will be located at the ground level and may be shielded by property line noise barriers and/or terrain, which will contain the noise on the property where it is generated.

Noise levels produced by a typical residential air conditioning condenser are approximately 66 dBA at 3 feet during operation. Based on the above generic assumptions and preliminary project plans, air conditioning condensers would be at least 180 feet or more from residential receptors in the vicinity and would not generate perceivable noise at nearby residences. No equipment is anticipated for a project of this scale that would make meeting the applicable noise limits with standard noise control measures difficult. However, during final design of the mechanical systems, the noise levels from the proposed equipment should be calculated to ensure compliance with the City's Municipal Code. This is a less-than-significant impact.

*Total Combined Project-Generated Noise*

The operational noise levels produced by the proposed project combined (i.e., traffic, mechanical equipment) would result in an increase of 1 dBA $L_{dn}$ or less at all existing noise-sensitive receptors in the project vicinity. Therefore, the proposed project would not result in a substantial increase above ambient noise levels in the project vicinity. This is a less-than-significant impact.

**Mitigation Measure 1b:** **No further mitigation required.**

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

The construction of the project may generate vibration when heavy equipment or impact tools (e.g., jackhammers, hoe rams) are used. Construction activities would include grading, foundation work, paving, and new building framing and finishing. According to the equipment list provided at the time of this study, impact or vibratory pile driving activities, which can cause excessive vibration, are not expected 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, 0.3 in/sec PPV for buildings that are found to be structurally sound but where structural damage is a major concern, and a conservative limit of 0.08 in/sec PPV for ancient buildings or buildings that are documented to be structurally weakened. No known ancient buildings or buildings that are documented to be structurally weakened adjoin the project area. Therefore, conservatively, groundborne vibration levels exceeding 0.3 in/sec PPV would have the potential to result in a significant vibration impact.

Table 10 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 10 also summarizes the distances to the 0.3 in/sec PPV threshold for all conventional buildings.

**TABLE 10 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., May 2023.

Table 11 summarizes the vibration levels at each of the surrounding buildings in the project vicinity. Vibration levels are highest close to the source and then attenuate with increasing distance at the rate $\left(D_{ref}/D\right)^{1.1}$, where $D$ is the distance from the source in feet and $D_{ref}$ is the reference distance of 25 feet. While construction noise levels increase based on the cumulative equipment in use simultaneously, construction vibration levels would be dependent on the location of individual pieces of equipment. That is, equipment scattered throughout the site would not generate a collective vibration level, but a vibratory roller, for instance, operating near the project site boundary would generate the worst-case vibration levels for the receptor sharing that property line. 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 11), which are different than the distances used to propagate construction noise levels (as shown in Tables 8 and 9), were estimated under the assumption that each piece of equipment from Table 11 was operating along the boundary of the construction aera, which would represent the worst-case scenario.

A study completed by the US Bureau of Mines analyzed the effects of blast-induced vibration on buildings in USBM RI 8507.[3] The findings of this study have been applied to buildings affected by construction-generated vibrations.[4] As reported in USBM RI 8507[6] and reproduced by Dowding,[7] Figure 2 presents the damage probability, in terms of "threshold damage" (described above as cosmetic damage), "minor damage," and "major damage," at varying vibration levels. Threshold damage, or cosmetic damage, 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.

Project construction activities would potentially generate vibration levels up to 0.023 in/sec PPV at the nearest building to the construction area. As shown in Figure 2, maximum vibration levels of 0.023 in/sec PPV or lower would result in virtually no measurable damage. No threshold, minor, or major damage would be expected at the buildings immediately adjoining the project site.

According to the National Register of Historic Places,[5] the nearest historical structure is the Greenwood Avenue Bridge, which was built in 1904 and is located approximately 1,000 feet north the project site. This building would not be exposed to vibration due to construction of the proposed project. No other historical structures are located closer to the project site.

Neither cosmetic, minor, or major damage would occur at historical or conventional 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 not generate vibration levels exceeding the 0.3 in/sec PPV threshold at conventional properties adjoining the project site, or 0.08 in/sec PPV at any nearby history structures. This is a less-than-significant impact.

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3 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.

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

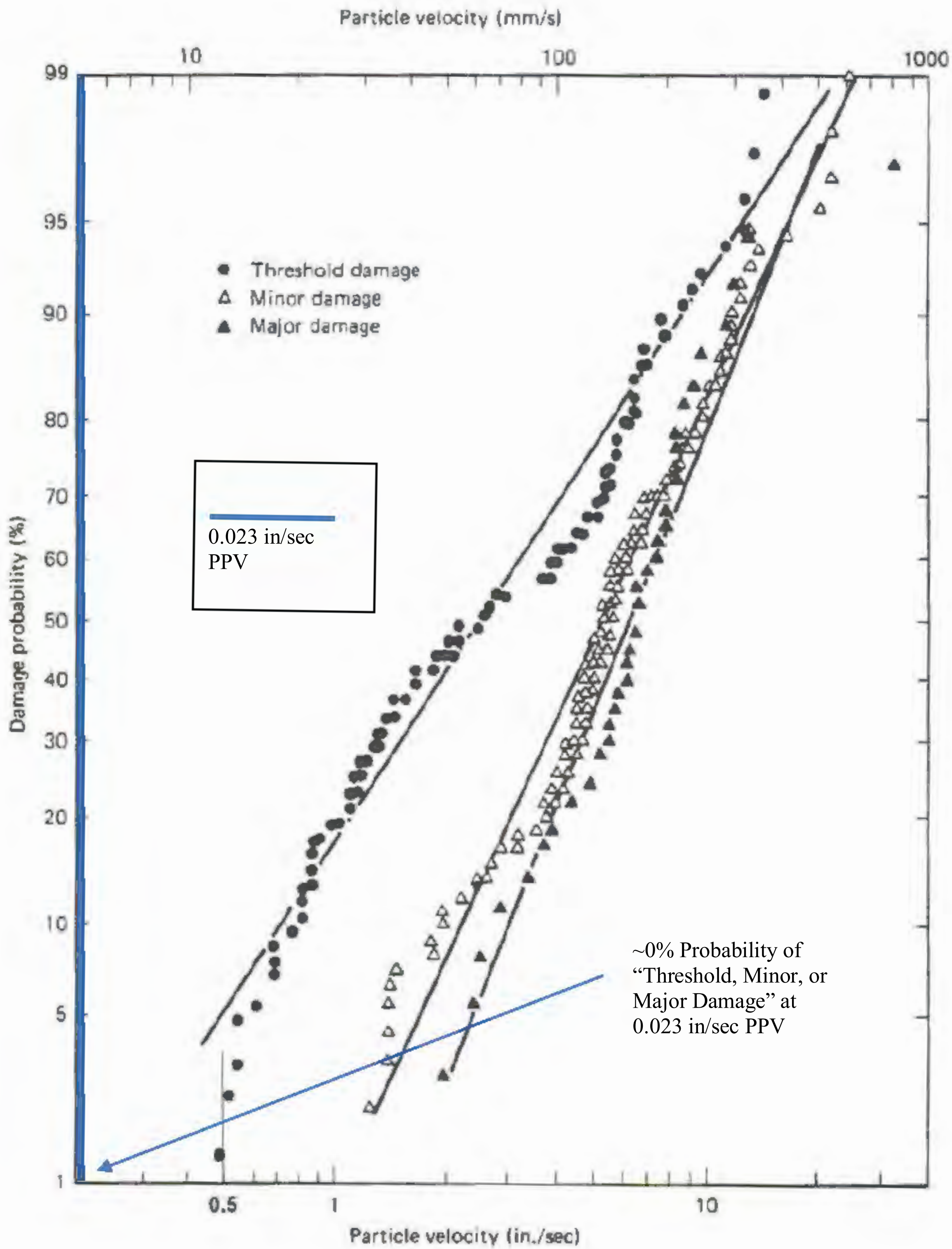
[5] National Register of Historic Places, *https://www.nps.gov/maps/full.html?mapId=7ad17cc9-b808-4ff8-a2f9-a99909164466*, Accessed April 27, 2023

**TABLE 11 Vibration Source Levels for Construction Equipment at Nearby Receptors**

| Equipment | | PPV (in/sec) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | R-7 (185 ft) | R-8 (200 ft) | R-10 (215 ft) | R-9 (220 ft) | R-1 (225 ft) | R-2 (265 ft) | R-4 (360 ft) | R-3 (370ft) | R-6 (385 ft) | R-5 (540 ft) |
| Clam shovel drop | | 0.022 | 0.021 | 0.019 | 0.018 | 0.018 | 0.015 | 0.011 | 0.010 | 0.010 | 0.007 |
| Hydromill (slurry wall) | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 | 0.000 | 0.000 | 0.000 | 0.000 |
| | 0.002 | 0.002 | 0.002 | 0.002 | 0.002 | 0.002 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 |
| Vibratory Roller | | 0.023 | 0.021 | 0.020 | 0.019 | 0.019 | 0.016 | 0.011 | 0.011 | 0.010 | 0.007 |
| Hoe Ram | | 0.010 | 0.009 | 0.008 | 0.008 | 0.008 | 0.007 | 0.005 | 0.005 | 0.004 | 0.003 |
| Large bulldozer | | 0.010 | 0.009 | 0.008 | 0.008 | 0.008 | 0.007 | 0.005 | 0.005 | 0.004 | 0.003 |
| Caisson drilling | | 0.010 | 0.009 | 0.008 | 0.008 | 0.008 | 0.007 | 0.005 | 0.005 | 0.004 | 0.003 |
| Loaded trucks | | 0.008 | 0.008 | 0.007 | 0.007 | 0.007 | 0.006 | 0.004 | 0.004 | 0.004 | 0.003 |
| Jackhammer | | 0.004 | 0.004 | 0.003 | 0.003 | 0.003 | 0.003 | 0.002 | 0.002 | 0.002 | 0.001 |
| Small bulldozer | | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 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., May 2023.

**FIGURE 2 Probability of Cracking and Fatigue from Repetitive Loading**




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

**Mitigation Measure 2:** **None needed.**

**Impact 3:** **Excessive Aircraft Noise.** The project site is located approximately 13 miles from the Sonoma County Airport, and the noise environment attributable to aircraft is not significant. There are no additional airports closer to the project site. This is a **less-than-significant** impact.

**Mitigation Measure 3:** **None required.**

**Cumulative Impacts**

Cumulative noise impacts would include either cumulative traffic noise increases under future conditions or temporary construction noise from cumulative construction projects. An increase of 1 dBA $L_{dn}$ or less is attributable solely to the proposed project. When combined with future traffic volume predictions, an increase of less than 2 dBA $L_{dn}$ will occur by the year 2043. Construction noise will be below 80 dBA $L_{eq}$ at residential land uses, and no commercial or industrial land uses are nearby, Construction will be temporary, and will occur at various locations on the site for short time periods. There are no known approved projects surrounding the project site that would be constructed during the same timeframe as the proposed project. Therefore, the noise-sensitive receptors surrounding the project site would not be subject to cumulative construction impacts.

APPENDIX A

FIGURE A1 Daily Trend in Noise Levels for LT-1, Thursday, March 30, 2023

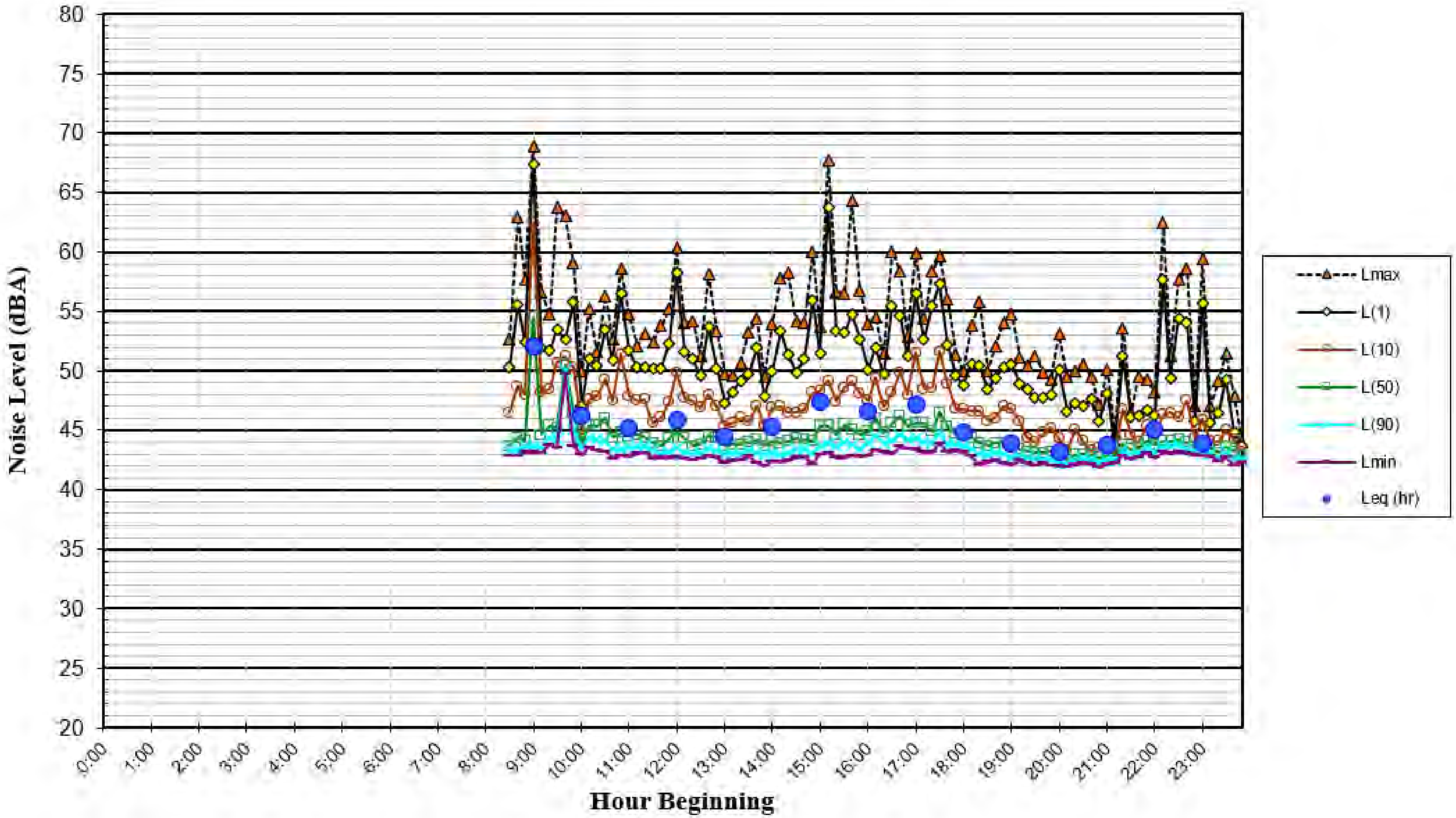


FIGURE A2 Daily Trend in Noise Levels for LT-1, Friday, March 31, 2023

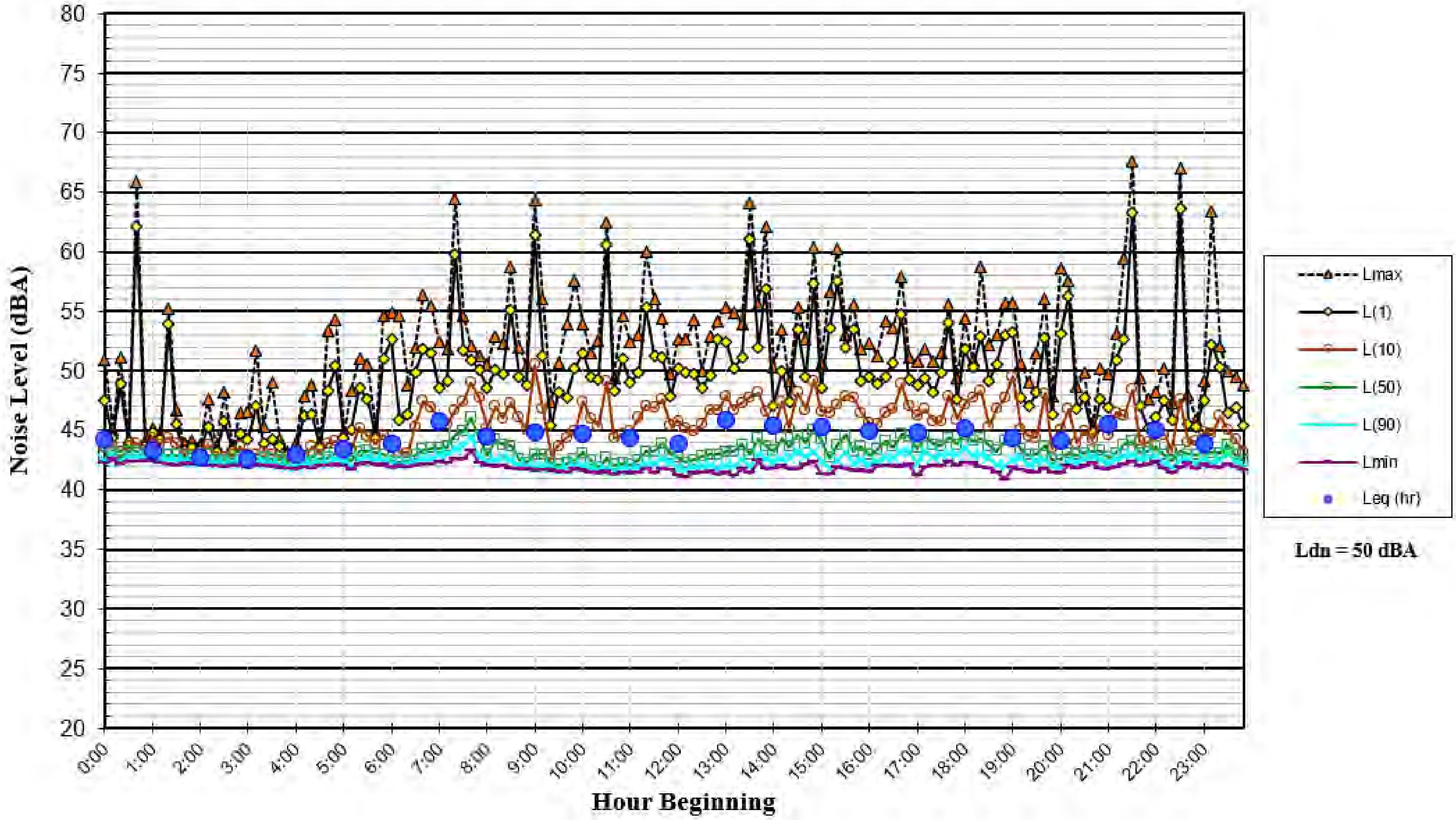


**FIGURE A3 Daily Trend in Noise Levels for LT-1, Saturday, April 1, 2023**

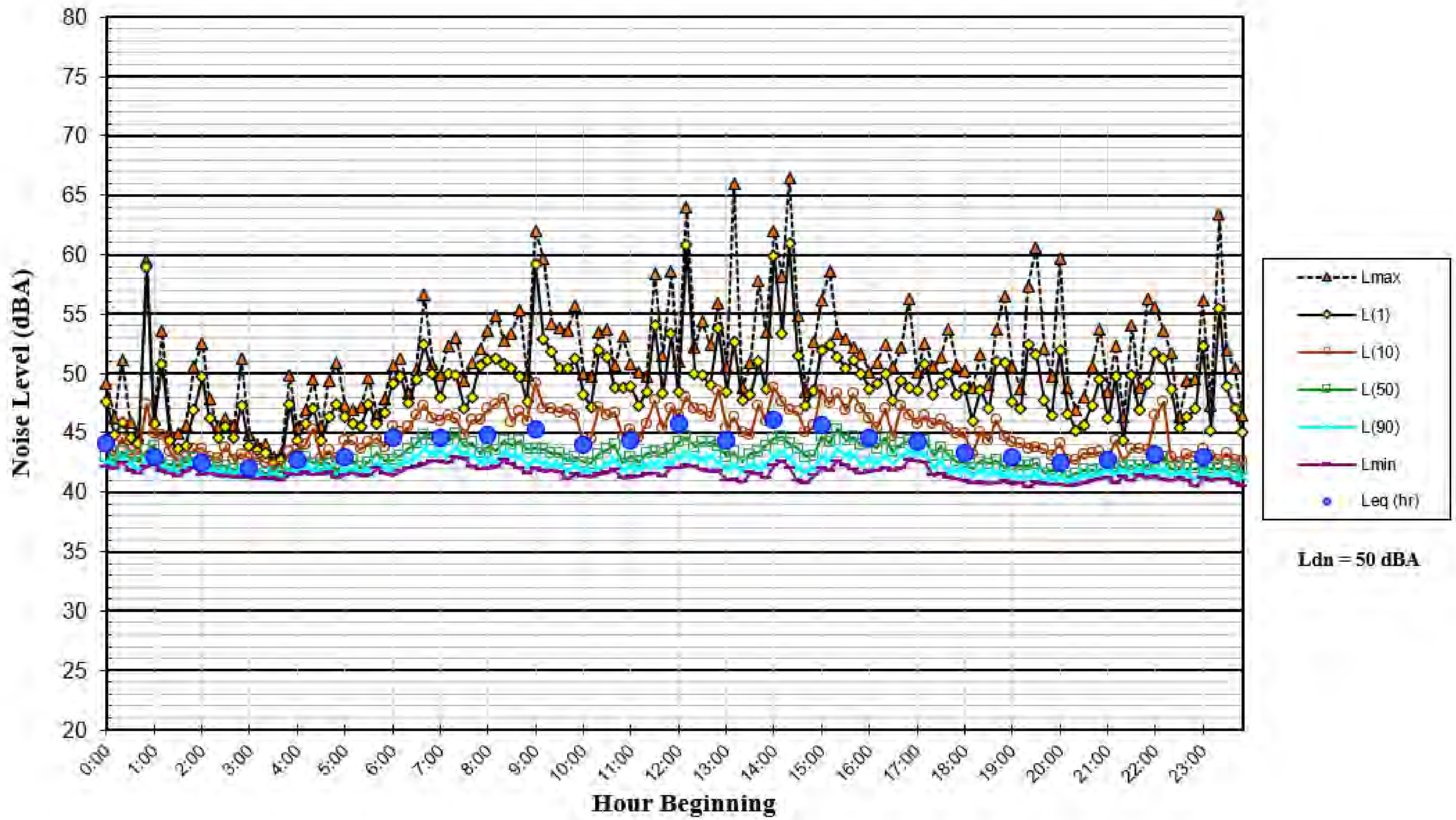


**FIGURE A4 Daily Trend in Noise Levels for LT-1, Sunday, April 2, 2023**

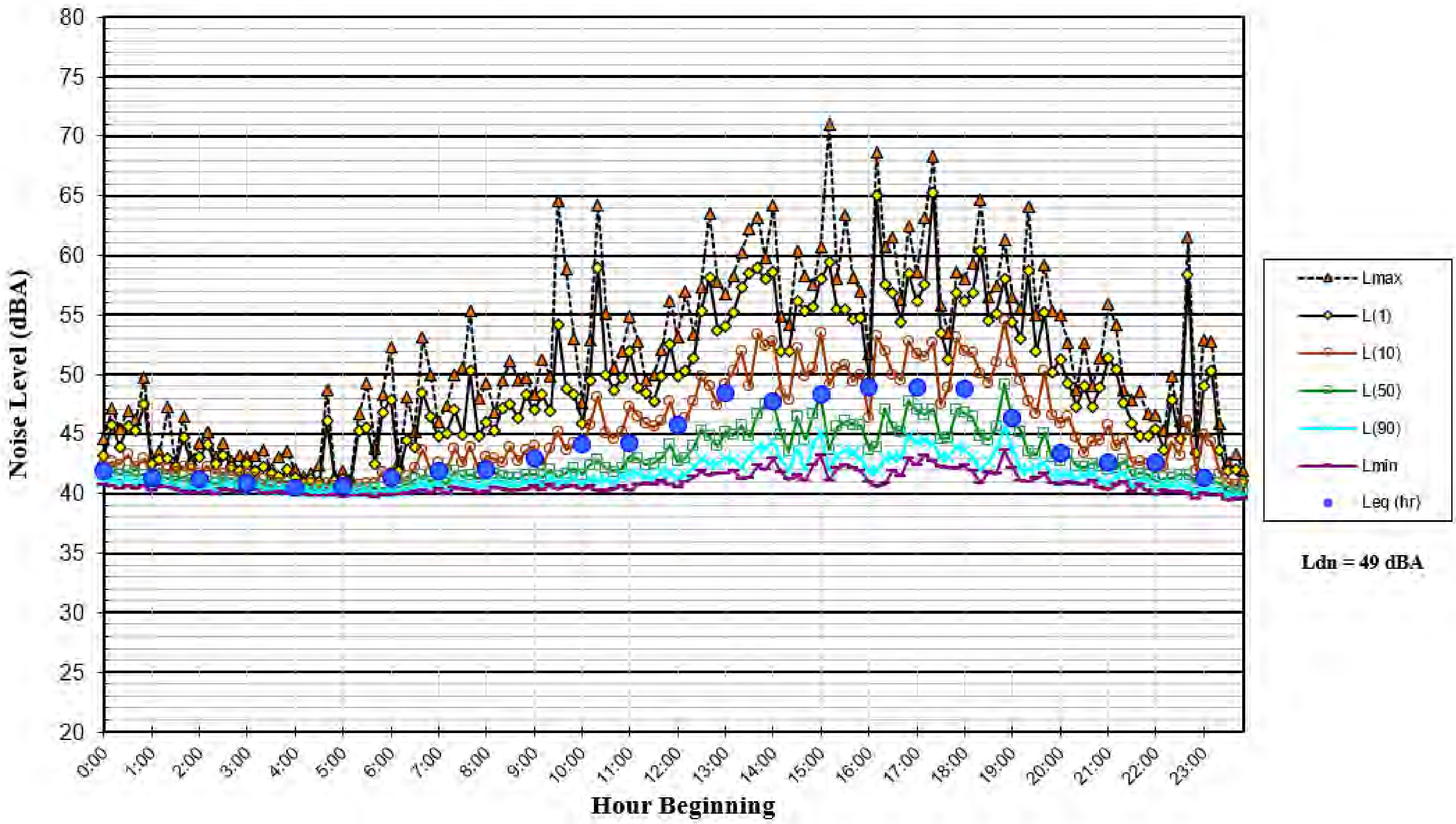


**FIGURE A5 Daily Trend in Noise Levels for LT-1, Monday, April 3, 2023**

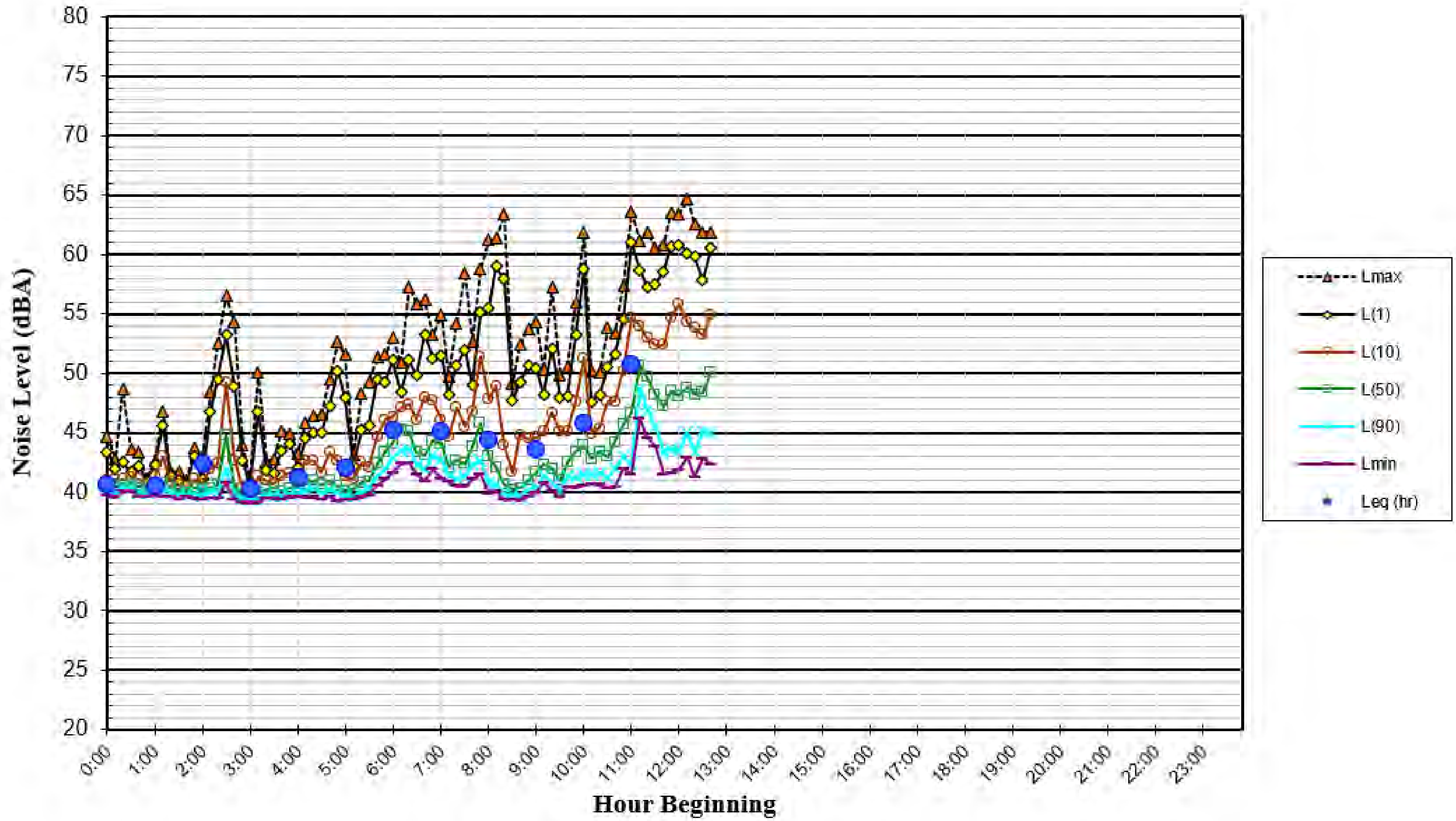


**FIGURE A6 Daily Trend in Noise Levels for LT-2, Thursday, March 30, 2023**

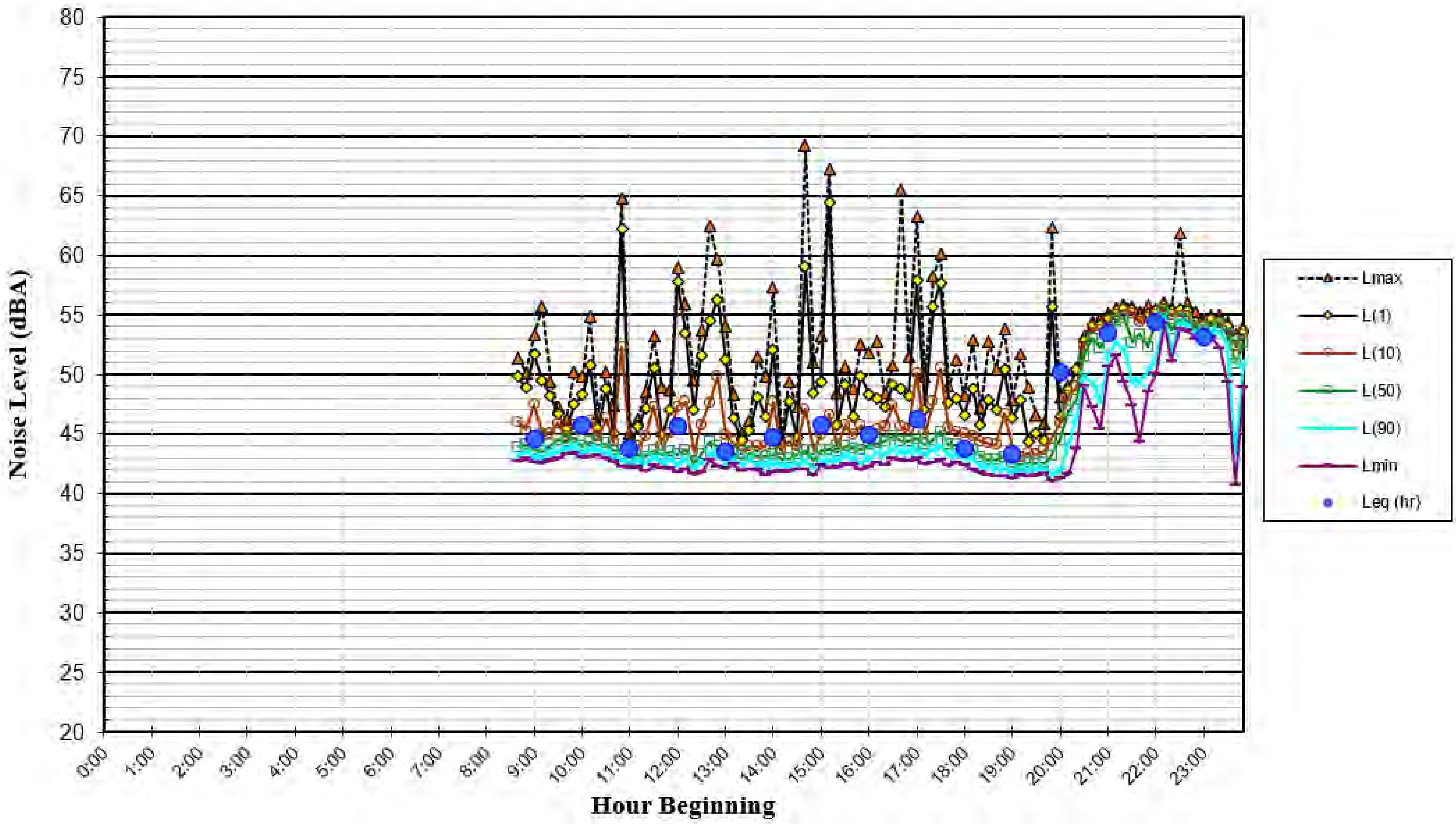
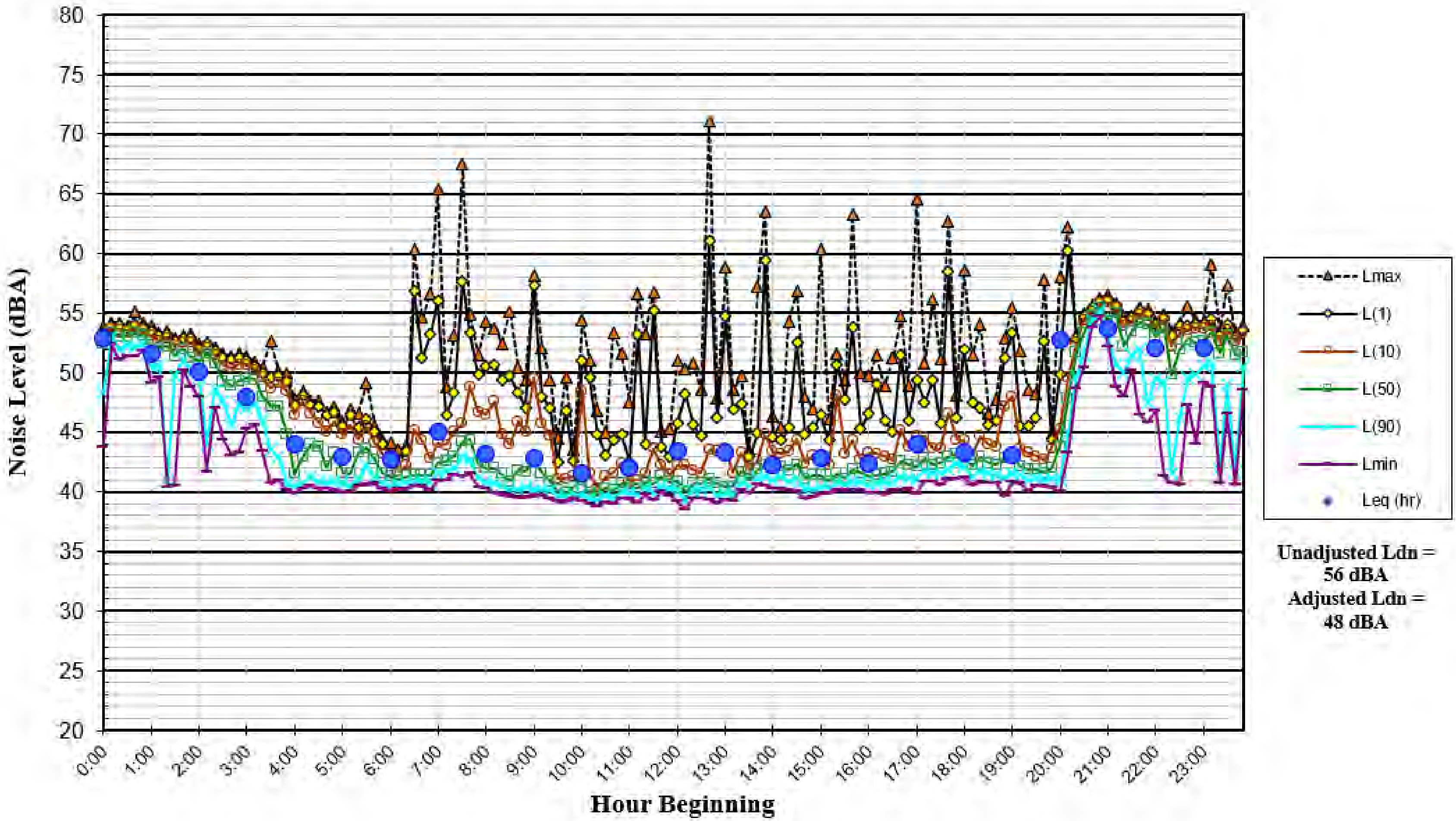


**FIGURE A7 Daily Trend in Noise Levels for LT-2, Friday, March 31, 2023**




**Unadjusted Ldn = 56 dBA**
**Adjusted Ldn = 48 dBA**

FIGURE A8 Daily Trend in Noise Levels for LT-2, Saturday, April 1, 2023

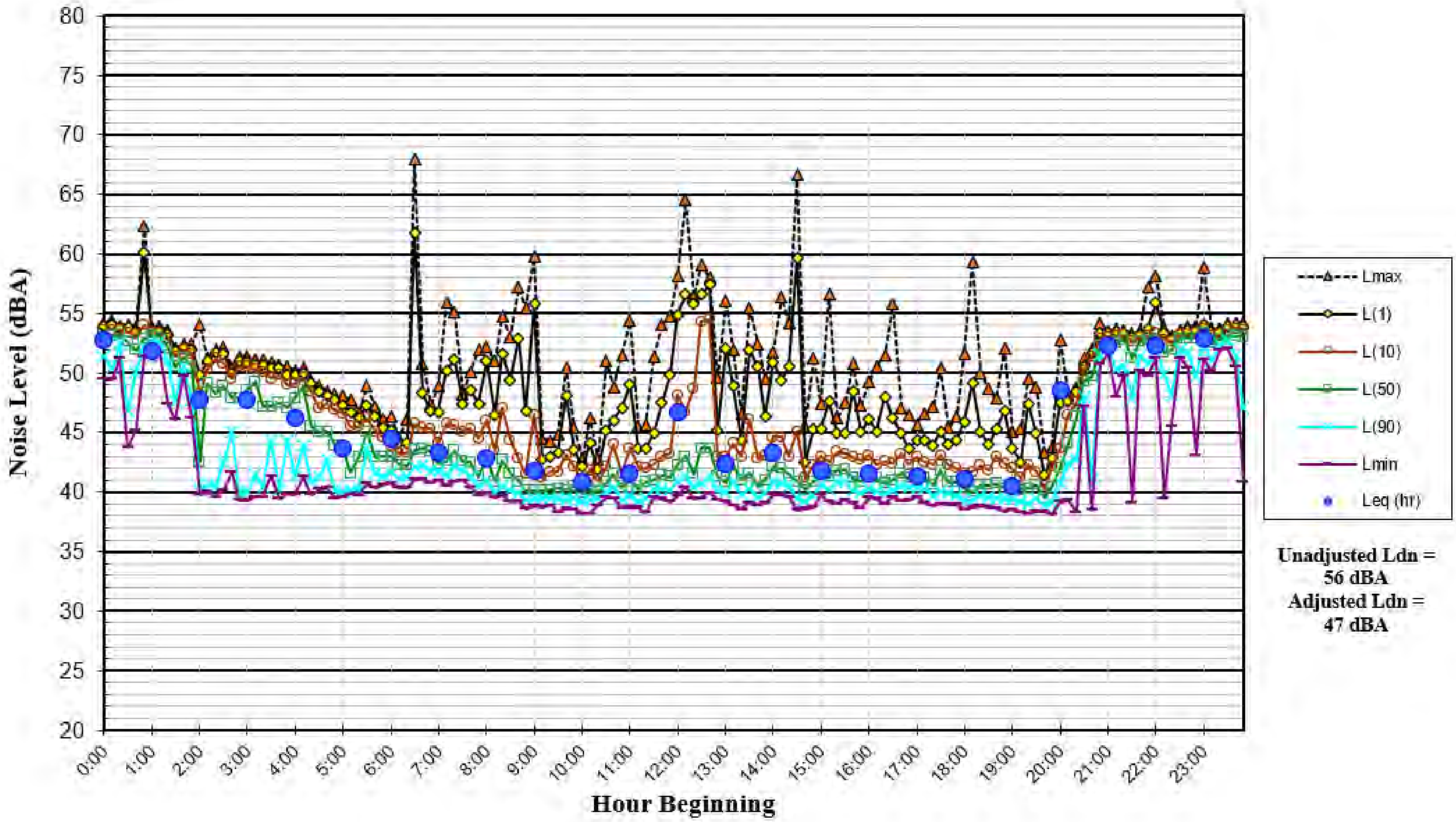


**FIGURE A9 Daily Trend in Noise Levels for LT-2, Sunday, April 2, 2023**

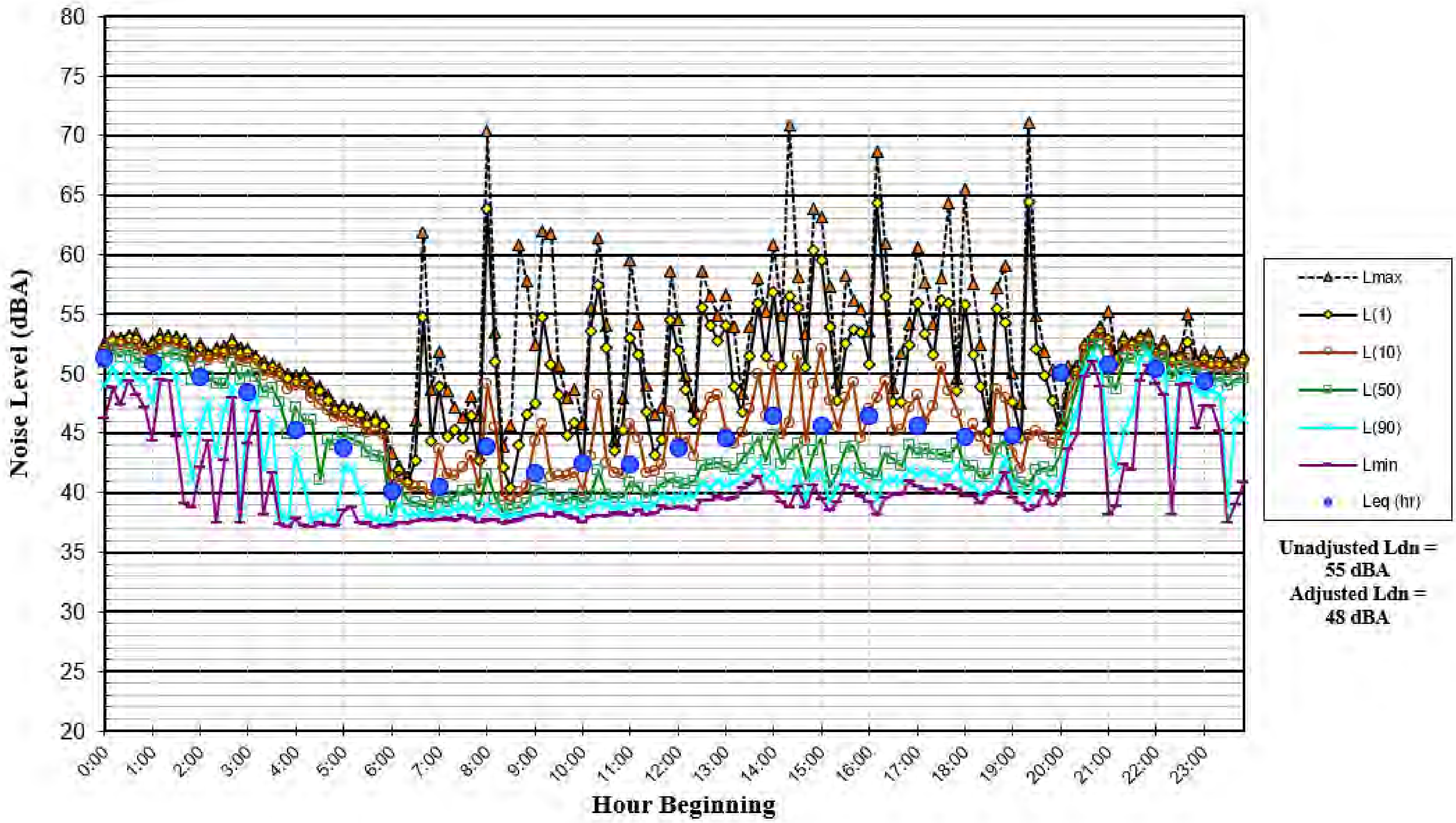


**FIGURE A10 Daily Trend in Noise Levels for LT-2, Monday, April 3, 2023**