Appendix O.1: Illingworth & Rodkin Noise and Vibration Assessment

BALL ESTATES PROJECT NOISE AND VIBRATION ASSESSMENT

Alamo, California

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INTRODUCTION

The purpose of this report is to assess noise and vibration impacts associated with the proposed parcel subdivision project located at 333 Camille Avenue in Alamo, California. The project would subdivide the existing 60.5-acre site into 35 residential lots and two parcels would be designated as open space/scenic easements. While the project does not request approval to construct any new residences at this time, this assessment assumes the ultimate full build-out of 35 single-family residential lots on the 21.7-acre lower portion of the property.

The report is divided into two sections: 1) the Setting Section provides a brief description of the fundamentals of environmental noise and groundborne vibration, summarizes applicable regulatory criteria, and discusses the results of the ambient noise measurements and modeling completed to document existing and future conditions; and 2) 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 provide a compatible project with respect to adjacent noise and vibration sources and noise-sensitive land uses.

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 p.m. - 10:00 p.m.) and a 10 dB addition to nocturnal (10:00 p.m. - 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. Typically, the highest steady traffic noise level during the daytime is about equal to the DNL and nighttime levels are 10 dBA lower. The standard is designed for sleep and speech protection and most jurisdictions apply the same criterion for all residential uses. Typical structural attenuation is 12-17 dBA with open windows. With closed windows in good condition, the noise attenuation factor is around 20 dBA for an older structure and 25 dBA for a newer dwelling. Sleep and speech interference is therefore possible when exterior noise levels are about 57-62 dBA DNL with open windows and 65-70 dBA DNL if the windows are closed. Levels of 55-60 dBA are common along collector streets and secondary arterials, while 65-70 dBA is a typical value for a primary/major arterial. Levels of 75-80 dBA are normal noise levels at the first row of development outside a freeway right-of-way. In order to achieve an acceptable interior noise environment, bedrooms facing secondary roadways need to be able to have their windows closed, those facing major roadways and freeways typically need special glass windows.

Annoyance

Attitude surveys are used for measuring the annoyance felt in a community for noises intruding into homes or affecting outdoor activity areas. In these surveys, it was determined that the causes for annoyance include interference with speech, radio and television, house vibrations, and interference with sleep and rest. The DNL as a measure of noise has been found to provide a

valid correlation of noise level and the percentage of people annoyed. People have been asked to judge the annoyance caused by aircraft noise and ground transportation noise. There continues to be disagreement about the relative annoyance of these different sources. When measuring the percentage of the population highly annoyed, the threshold for ground vehicle noise is about 50 dBA DNL. At a DNL of about 60 dBA, approximately 12 percent of the population is highly annoyed. When the DNL increases to 70 dBA, the percentage of the population highly annoyed increases to about 25-30 percent of the population. There is, therefore, an increase of about 2 percent per dBA between a DNL of 60-70 dBA. Between a DNL of 70-80 dBA, each decibel increase increases by about 3 percent the percentage of the population highly annoyed. People appear to respond more adversely to aircraft noise. When the DNL is 60 dBA, approximately 30-35 percent of the population is believed to be highly annoyed. Each decibel increase to 70 dBA adds about 3 percentage points to the number of people highly annoyed. Above 70 dBA, each decibel increase results in about a 4 percent increase in the percentage of the population highly annoyed.

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 vibration levels produce.

The annoyance levels shown in Table 3 should be interpreted with care since vibration may be found to be annoying at much 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.

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 induce structural 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. Studies have shown that the threshold of perception for average persons is in the range of 0.008 to 0.012 in/sec PPV. 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 minor cracking of building elements, or may threaten the integrity of the building. Safe vibration limits that can be applied to assess the potential for damaging a structure vary by researcher and there is no general consensus as to what amount of vibration may pose a threat for structural damage to the building. 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.

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 p.m. and 7:00 a.m.
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 p.m. to 10:00 p.m. and after addition of 10 decibels to sound levels measured in the night between 10:00 p.m. and 7:00 a.m.
Ambient Noise Level	The composite of noise from all sources near and far. The normal or existing level of environmental noise at a given location.
Intrusive	That noise which intrudes over and above the existing ambient noise at a given location. The relative intrusiveness of a sound depends upon its amplitude, duration, frequency, and time of occurrence and tonal or informational content as well as the prevailing ambient noise level.

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

TABLE 2 Typical Noise Levels in the Environment

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

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

TABLE 3 Reactions 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	Virtually no risk of damage to normal buildings
0.3	Strongly perceptible to severe	Threshold at which there is a risk of damage to older residential dwellings such as plastered walls or ceilings
0.5	Severe - Vibrations considered unpleasant	Threshold at which there is a risk of damage to newer residential structures

Source: Transportation and Construction Vibration Guidance Manual, California Department of Transportation, September 2013.

Regulatory Background - Noise

The proposed project is located in unincorporated Contra Costa County and would be subject to noise-related regulations, plans, and policies established within documents prepared by the State of California and Contra Cost County. These planning documents are implemented during the environmental review process to limit noise exposure at existing and proposed noise sensitive land uses. Contra Costa County does not have a noise ordinance. Noise complaints within the county are addressed through application of peace disturbance sections of the County Police Code.

Applicable planning documents include: (1) the California Environmental Quality Act (CEQA) Guidelines, Appendix G, (2) California Department of Transportation (Caltrans) Construction Vibration Criteria, and (3) the Contra Costa County General Plan. Regulations, plans, and policies presented within these documents form the basis of the significance criteria used to assess project impacts.

State CEQA Guidelines. The 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) Exposure of persons to or generation of noise levels in excess of standards established in the local General Plan or Noise Ordinance, or applicable standards of other agencies;

(b) Exposure of persons to or generation of excessive groundborne vibration or groundborne noise levels;

(c) A substantial permanent increase in ambient noise levels in the project vicinity above levels existing without the project;

(d) A substantial temporary or periodic increase in ambient noise levels in the project vicinity above levels existing without the project;

(e) For a project located within 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; or

(f) For a project within the vicinity of a private airstrip, if the project would expose people residing or working in the project area to excessive noise levels.

Checklist items (a), (b), (c), (d), and (f) are relevant to the proposed project. The project is not located in the vicinity of a public airport; therefore, checklist item (e) is not carried forward in this analysis.

CEQA does not define what noise level increase would be considered substantial. Typically, project-generated noise level increases of 3 dBA DNL or greater would be considered significant where exterior noise levels would exceed the normally acceptable noise level standard (60 dBA DNL for residential land uses). Where noise levels would remain at or below the normally acceptable noise level standard with the project, noise level increases of 5 dBA DNL or greater would be considered significant.

California Department of Transportation – Construction Vibration. Caltrans recommends a vibration limit of 0.5 in/sec PPV for buildings structurally sound and designed to modern engineering standards. A conservative vibration limit of 0.3 in/sec PPV has been used for older buildings that are found to be structurally sound but cosmetic damage to plaster ceilings or walls is a major concern. For historic 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. All of these limits have been used successfully and compliance to these limits has not been known to result in appreciable structural damage. All vibration limits referred to herein apply on the ground level and take into account the response of structural elements (i.e. walls and floors) to groundborne excitation.

Contra Costa County General Plan. The Contra Costa County 2020 General Plan, contains the following goals and policies applicable to the Project:

11.8 Goals

11-A: To improve the overall environment in the County by reducing annoying and physically harmful levels of noise for existing and future residents and for all land uses.

11-B: To maintain appropriate noise conditions in all areas of the County.

11-C: To ensure that new developments will be constructed so as to limit the effects of exterior noise on the residents.

11.9 Policies

11-1: New projects shall be required to meet acceptable exterior noise level standards as established in the Noise and Land Use Compatibility Guidelines contained in Figure 11-6. These guidelines, along with the future noise levels shown in the future noise contours maps, should be used by the county as a guide for evaluating the compatibility of "noise sensitive" projects in potentially noisy areas.

11-2: The standard for outdoor noise levels in residential areas is a DNL of 60 dB. However, a DNL of 60 dB or less may not be achievable in all residential areas due to economic or aesthetic constraints. One example is small balconies associated with multi-family housing. In this case, second and third story balconies may be difficult to control to the goal. A common outdoor use area that meets the goal can be provided as an alternative.

11-3: If the primary noise source is train passbys, then the standard for outdoor noise levels in residential areas is a DNL of 70 dB. A higher DNL is allowable since the DNL is controlled by a relatively few number of train passbys that are disruptive outdoors only for short periods. Even though the DNL may be high, during the majority of the time the noise level will be acceptable.

11-4: Title 24, Part 2, of the California Code of Regulations requires that new multiple family housing projects, hotels, and motels exposed to a DNL of 60 dB or greater have a detailed acoustical analysis describing how the project will provide an interior DNL of 45 dB or less. The County also shall require new single-family housing projects to provide for an interior DNL of 45 dB or less.

11-6: If an area is currently below the maximum "normally acceptable" noise level, an increase in noise up to the maximum should not be allowed necessarily.

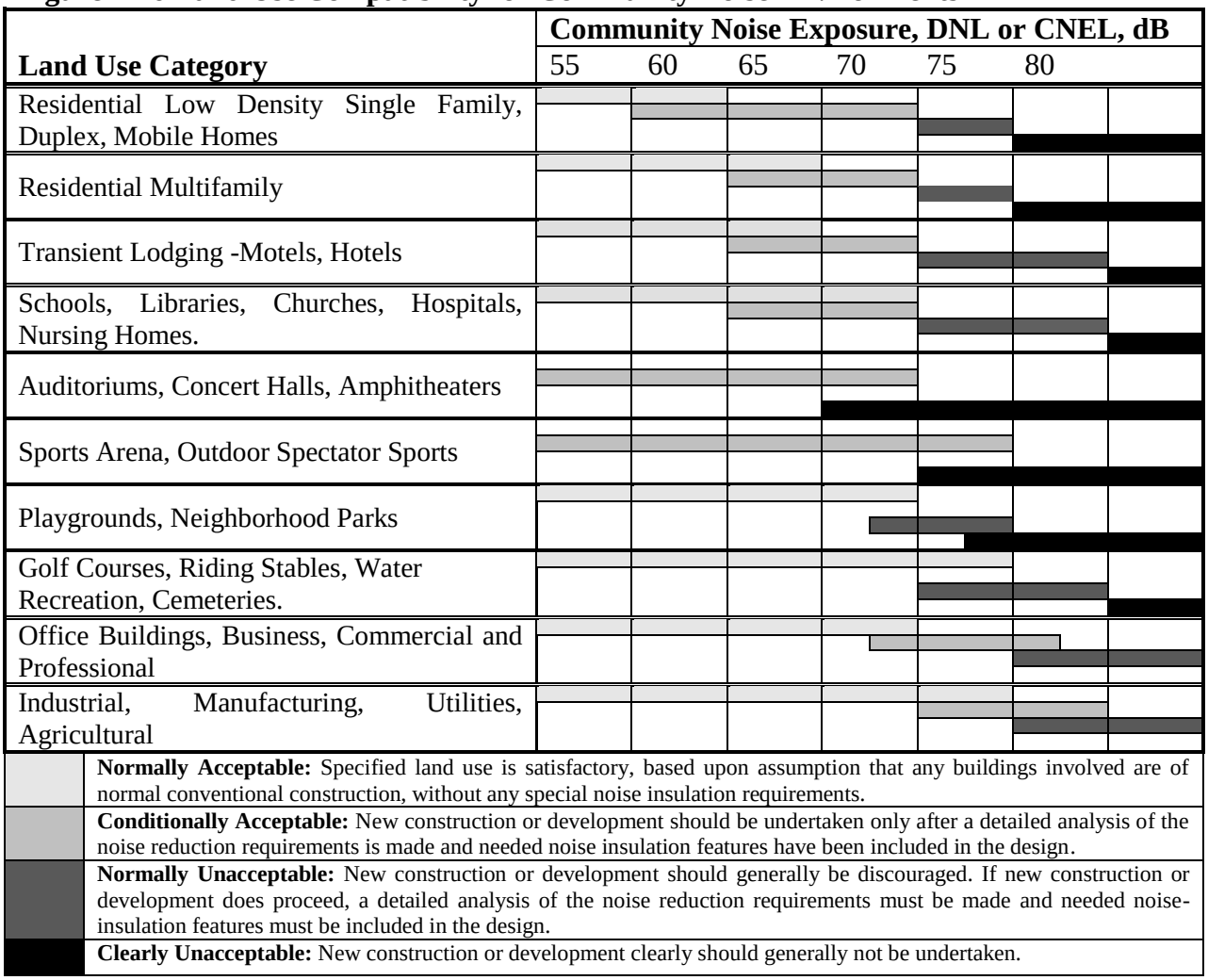
11-8: Construction activities shall be concentrated during the hours of the day that are not noise-sensitive for adjacent land uses and should be commissioned to occur during normal work hours of the day to provide relative quiet during the more sensitive evening and early morning periods.

11-9: Sensitive land use shall be encouraged to be located away from noise areas, or the impacts of noise on these uses shall be mitigated. If residential areas are planned adjacent to industrial noise sources, then a noise study shall be performed to determine the extent of any noise impacts and recommend appropriate noise mitigation measures.

11-10: Development located within 6,000 feet of the Camp Parks Reserve Forces Training Area shall be required to prepare a detailed acoustical analysis. The analysis shall determine if the project will be affected severely by noise and, if so, what noise mitigation measures are available.

11-11: Noise impacts upon the natural environment, including impacts on wildlife, shall be evaluated and considered in review of development projects.

Figure 11-6 Land Use Compatibility for Community Noise Environments



11.10 Implementation Measures: Development Review

11-a Continue to require a review and analysis of noise-related impacts as part of the existing project development review procedures of the County.

11-b Evaluate the noise impacts of a proposed project upon existing land uses in terms of the applicable Federal, State, and local codes, and the potential for adverse community response, based on a significant increase in existing noise levels.

11-c Encourage use of the following mitigation measures to minimize noise impacts of proposed development projects:

1) Site planning. Proper site planning is the first mitigation measure that should be investigated to reduce noise impacts. By taking advantage of the natural shape and terrain of a site, it often is possible to arrange the buildings and other uses in a manner that will reduce and possibly eliminate noise impact. Specific site planning techniques include:

a) Increasing the distance between the noise source and the receiver;

b) Placing non-noise-sensitive land uses such as parking lots, maintenance facilities, and utility areas between the source and the receiver;

c) Using non-noise-sensitive structures such as garages to shield noise-sensitive areas; and

d) Orienting buildings to shield outdoor spaces from a noise source.

2) Architectural layout of buildings. In many cases, noise reduction can be attained by careful layout of noise-sensitive spaces. Bedrooms, for example, should be placed away from freeways. Quiet outdoor spaces can be provided next to a noisy highway by creating a U-shaped development, which faces away from the highway.

3) Noise Barriers: Noise barriers or walls are commonly used to reduce noise levels from ground transportation noise sources and industrial sources. While serving a dual purpose in that they can reduce noise level both outdoors and indoors, to be effective, a barrier must interrupt the line of sight between the noise source and the receiver. A barrier should provide at least 5 dB of noise reduction to achieve a noticeable change in noise levels.

4) Construction modifications: If site planning, architectural layout, noise barriers, or a combination of these measures does not achieve the required noise reduction, then construction modification to walls, roofs, ceilings, doors, windows, and other penetrations may be necessary.

Existing Noise Environment

A noise monitoring survey was performed at the site beginning on Friday, October 23rd, 2015 and concluding on Wednesday, October 28th, 2015. The monitoring survey included two long-term noise measurements and two short-term measurements, as shown in Figure 1. The noise environment at the site and in the surrounding areas are primarily the result of distant traffic and construction and natural noises, such as wind through vegetation and animals. The daily trend in noise levels at LT-1 and LT-2 are shown in Appendix A.

Long-term noise measurement LT-1 was located at the end of Ironwood Place. Hourly average noise levels at this location typically ranged from 40 to 53 dBA L_{eq} during the day and were as low as 34 dBA L_{eq} at night. Occasionally, high maximum instantaneous noise levels, likely due to localized noise sources, raised the average hourly daytime noise levels to between 59 and 63 dBA L_{eq}. The day-night average noise level ranged from 45 to 53 dBA DNL.

Noise measurement LT-2 was made about 60 feet south of Camille Avenue and 80 feet west of the eastern property line of the site. Hourly average noise levels at this location typically ranged from 40 to 48 dBA L_{eq} during the day and were as low as 37 dBA L_{eq} at night. Occasionally, high maximum noise levels, likely due to localized noise sources, raised the average hourly daytime noise levels to between 54 and 65 dBA L_{eq}. The day-night average noise level ranged from 48 to 56 dBA DNL.

The two short-term measurements were made on Friday, October 23rd, 2015 in concurrent intervals to the long-term measurements. These measurements were attended by a noise technician who documented maximum noise levels as they occurred at each measurement location. Table 4 summarizes the short-term measurement results.

FIGURE 1 Noise and Vibration Measurement Locations

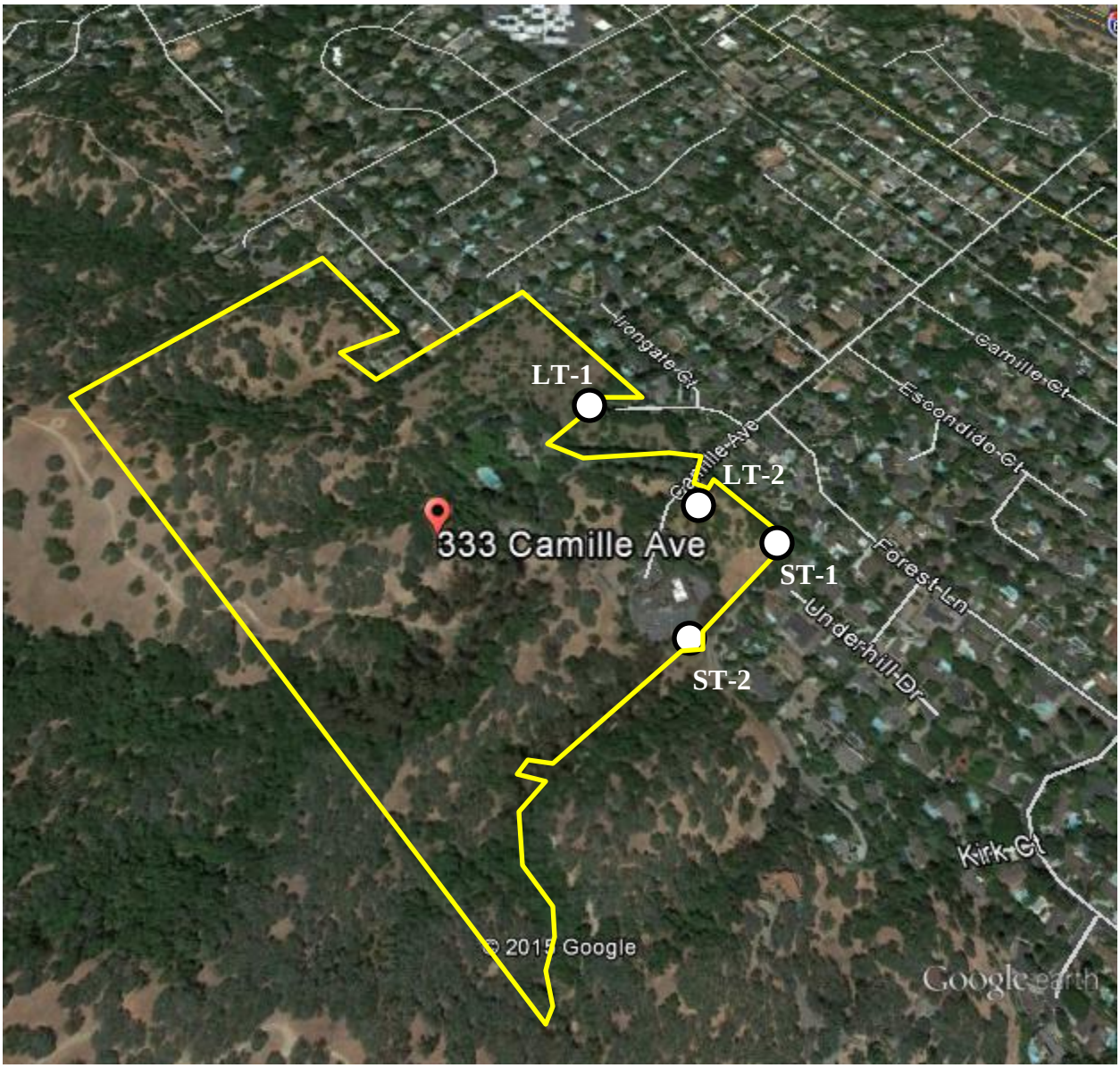


TABLE 4 Summary of Short-Term Noise Measurement Results, October 23rd, 2015

Location (Time)	Measured Daytime Noise Levels, dBA					Primary Noise Sources
	L_{eq}	L_1	L_{10}	L_{50}	L_{90}	
ST-1: Path on eastern corner of site, 11:10 a.m. to 11:20 a.m.	40	61	47	41	39	Distant traffic and construction, occasional local traffic, hikers, natural noises
ST-2: Path on southern portion of site, 11:30 a.m. to 11:40 a.m.	44	54	46	42	40	Distant traffic and construction, natural noises

NOISE IMPACTS AND MITIGATION MEASURES

Significance Criteria

Paraphrasing from Appendix G of the CEQA Guidelines, a project would normally result in significant noise impacts if noise levels generated by the project conflict with adopted environmental standards or plans, if the project would expose people to or generate excessive groundborne vibration levels, or if ambient noise levels at sensitive receivers would be substantially increased over a permanent, temporary, or periodic basis. The following criteria were used to evaluate the significance of environmental noise and vibration resulting from the project:

1. **Noise and Land Use Compatibility:** A significant noise impact would be identified if the project would expose persons to or generate noise levels that would exceed applicable noise standards.
    a) *Exterior Noise Levels:* Residential uses would be considered "normally acceptable" where exterior noise exposures in outdoor use areas are 60 dBA DNL or less.
    b) *Interior Noise Levels:* Noise levels inside residences shall be maintained at or below 45 dBA DNL.

2. **Groundborne Vibration:** A significant impact would be identified if the construction of the project would expose persons to excessive vibration levels. Groundborne vibration levels exceeding 0.3 in/sec PPV would have the potential to result in "architectural" damage to normal buildings.

3. **Permanent Increase in Noise Levels:** A significant noise impact would be identified if traffic generated by the project would increase noise levels at noise sensitive receptors by 5 dBA DNL or greater and the resulting noise levels would continue to be 60 dBA DNL or if traffic generated by the project would increase noise levels at noise sensitive receptors by 3 dBA DNL or greater and the resulting noise levels would exceed 60 dBA DNL at noise sensitive residential areas.

4. **Aircraft Noise Impacts:** An aircraft noise impact would be identified if aircraft noise levels at the site exceed 60 dBA DNL.

Impact 1: **Noise and Land Use Compatibility.** Future noise levels at the project site would be considered compatible with the site's proposed usage. **This is a less-than-significant impact.**

The project proposes to subdivide an existing 60.5-acre site into 35 residential lots and two parcels designated as open space. While the project does not request approval to construct any new residences at this time, this assessment assumes the ultimate full build-out of 35 single-family residential lots on the 21.7-acre lower portion of the property. A significant noise and land use compatibility impact would be identified if exterior noise levels in residentially designated lots would exceed 60 dBA DNL or if interior noise levels inside potential homes would exceed 45 dBA DNL. A significant noise and land use compatibility impact would be identified if open space designated lots would be exposed to noise levels exceed 75 dBA DNL.

As described in the Setting Section, existing ambient noise levels at the easternmost portion of the site range from 45 to 56 dBA DNL. The western portion of the site is located further from area noise sources (traffic and residential noise) and would be exposed to lower noise levels. Noise levels throughout the project site are below 60 dBA DNL and would be considered to be compatible with residential and open space land uses.

A typical residential structure would provide about 15 dBA of noise reduction from exterior noise sources with windows open and 20 to 25 dBA of noise reduction with windows in the closed position. As a result, any residences built on the site under a future development plan would be anticipated to meet the interior noise level standard of 45 dBA DNL.

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

Mitigation Measures: None Needed.

Impact 2: **Exposure to Excessive Groundborne Vibration due to Construction.** Construction-related vibration would not be excessive at nearby residential land uses. **This is a less-than-significant impact.**

Construction would occur over a period of 16 to 18 months and would include demolition, site preparation, grading and excavation, trenching, construction of the residential units, and paving. A significant impact would be identified if the construction of the project would generate groundborne vibration levels at adjacent structures exceeding 0.3 in/sec PPV because these levels would have the potential to result in "architectural" damage to normal buildings.

Project construction activities, such as drilling, the use of jackhammers, rock drills and other high-power or vibratory tools, and rolling stock equipment (tracked vehicles, compactors, etc.) may generate substantial vibration in the immediate vicinity of the work area. Vibration levels would vary depending on soil conditions, construction methods, and equipment used. Table 5 presents typical vibration levels that could be expected from construction equipment at a distance of 25 feet.

TABLE 5 Vibration Source Levels for Construction Equipment

Equipment		PPV at 25 ft. (in/sec)	Approximate L_v at 25 ft. (VdB)
Pile Driver (Impact)	upper range	1.158	112
	typical	0.644	104
Pile Driver (Sonic)	upper range	0.734	105
	typical	0.170	93
Clam shovel drop		0.202	94
Hydromill (slurry wall)	in soil	0.008	66
	in rock	0.017	75
Vibratory Roller		0.210	94
Hoe Ram		0.089	87
Large bulldozer		0.089	87
Caisson drilling		0.089	87
Loaded trucks		0.076	86
Jackhammer		0.035	79
Small bulldozer		0.003	58

Source: Transit Noise and Vibration Impact Assessment, United States Department of Transportation, Office of Planning and Environment, Federal Transit Administration, May 2006.

The nearest existing structures to project construction areas include existing residences that back or side onto the northern and eastern portions of the site. These residential structures are located as close as 40 to 70 feet from the shared property lines.

Impact or vibratory pile driving is not anticipated as part of project construction activities. Based on the levels shown in Table 5, vibration could exceed 0.3 in/sec PPV when located within about 20 feet of existing structures. Vibration levels produced by heavy equipment (vibratory rollers, clam shovel drops) during construction are calculated to be 0.13 in/sec PPV or less at a distance of 40 feet and 0.07 in/sec PPV or less at a distance of 70 feet.[1] Vibration levels would be lower at structures located further from the project site and as construction moves away from the eastern and northern property lines of the site. Vibration levels during heavy construction may occasionally be perceptible at the nearest residences when construction is located directly adjacent to these areas, but would not approach the 0.3 in/sec PPV threshold for architectural damage.

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

Mitigation Measures: None Needed.

Impact 3: **Project-Generated Traffic Noise.** The proposed project would not result in a permanent noise level increase at the existing residential land uses in the project vicinity. **This is a less-than-significant impact.**

[1] These levels are calculated assuming normal propagation conditions and a conservative assumption of hard soil conditions, using a standard equations of PPV_{eqmt}-PPV_{ref} * $(25/D)^{1.1}$.

Traffic noise levels at residences in the vicinity of the project are currently below 60 dBA DNL (the normally acceptable noise level standard for residences). As a result, a significant noise impact would be identified if traffic generated by the project would increase noise levels at noise sensitive receptors by 5 dBA DNL or greater or if traffic generated by the project would increase noise levels at noise sensitive receptors by 3 dBA DNL or greater and the resulting noise levels would exceed 60 dBA DNL at noise sensitive residential areas.

Traffic volumes were prepared for the project by *Abrams Associates Traffic Engineering, Inc*[2] for five intersections in the vicinity of the project and include traffic generated by potential residences constructed at the site under future development plans. Traffic volumes under the Existing Plus Project scenario were compared to the Existing scenario to calculate the relative increase in traffic noise attributable to the proposed project. The comparison of the traffic volumes under these scenario indicates that traffic noise levels are calculated to increase by less than 1 dBA at all study intersections as a result of the project. Noise levels would not be substantially increased (i.e., by 3 or 5 dBA or more) as a result of the project, and the impact would be **less-than-significant**.

Mitigation Measure 3: None required.

Impact 4: **Aircraft Noise.** Aircraft noise levels at the site would be compatible with the proposed residential land uses. **This is a less-than-significant impact**.

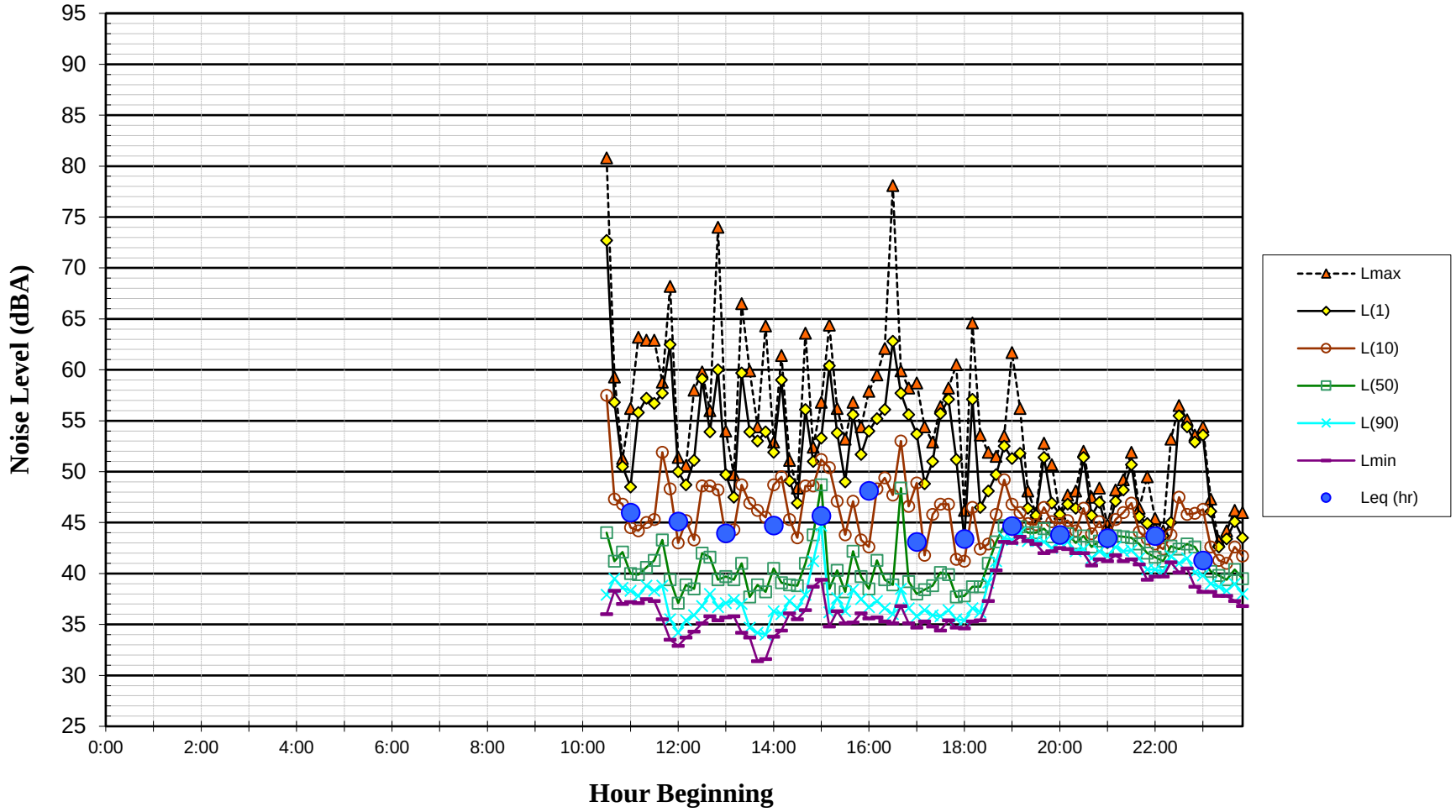
The project is proposed within two miles of the Little Hands Airport, a private airstrip located in San Ramon, California. Aircraft noise exposure would be considered significant if the project site were exposed to aircraft noise levels exceeding 60 dBA DNL. As described in the Environmental Setting Section and under Impact 1, existing ambient noise levels at the site range from less than 45 dBA DNL up to 56 dBA DNL. Noise levels throughout the project site are below 60 dBA DNL and would be considered to be compatible with residential and open space land use.

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

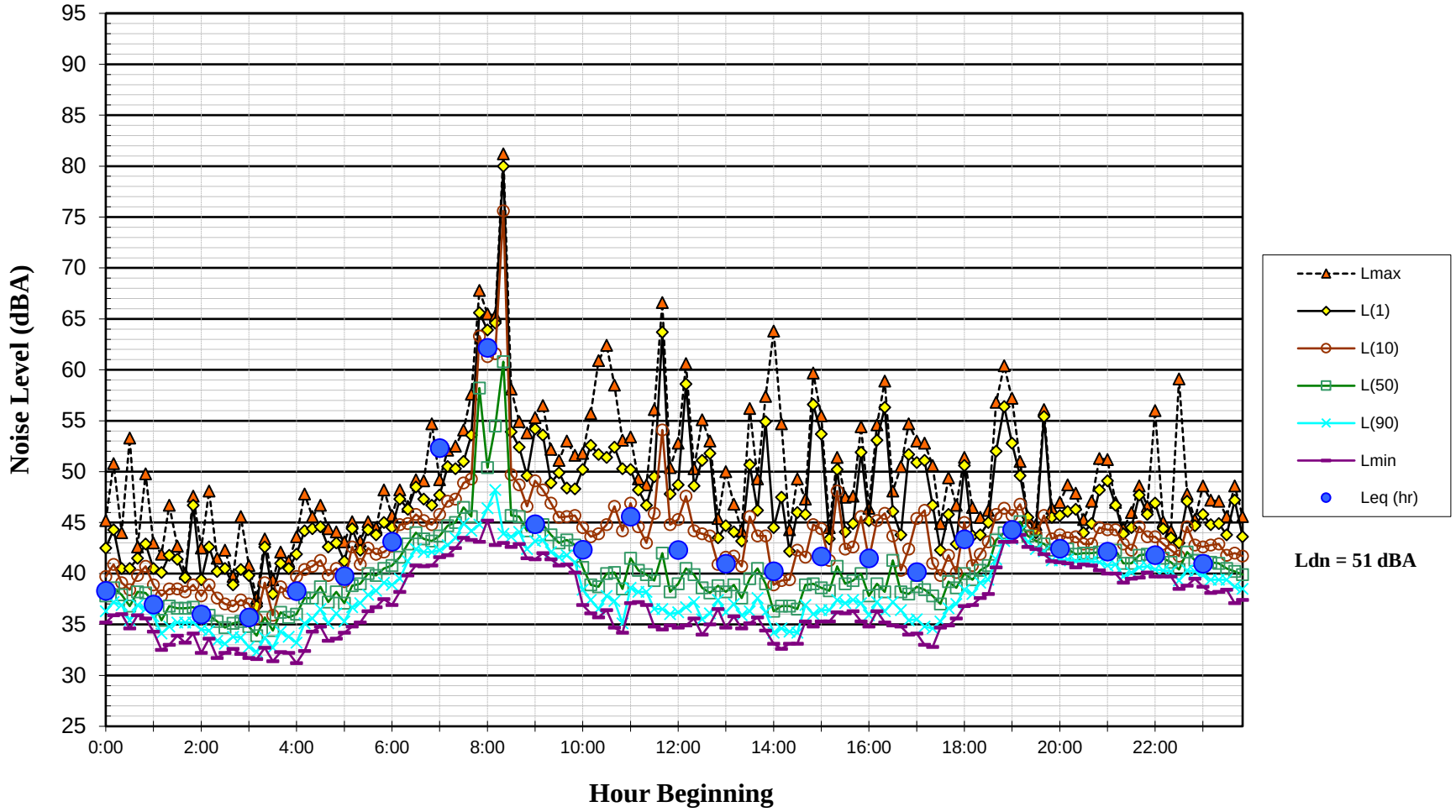
Mitigation Measure 4: None required.

[2] Transportation Impact Study, Ball Property, Prepared for Aliquot Associates, Prepared by Abrams Associates Traffic Engineering, Inc., July 7, 2015.

Noise Levels at Noise Measurement Site LT-1
~60 feet from Camile Drive
Friday, October 23, 2015

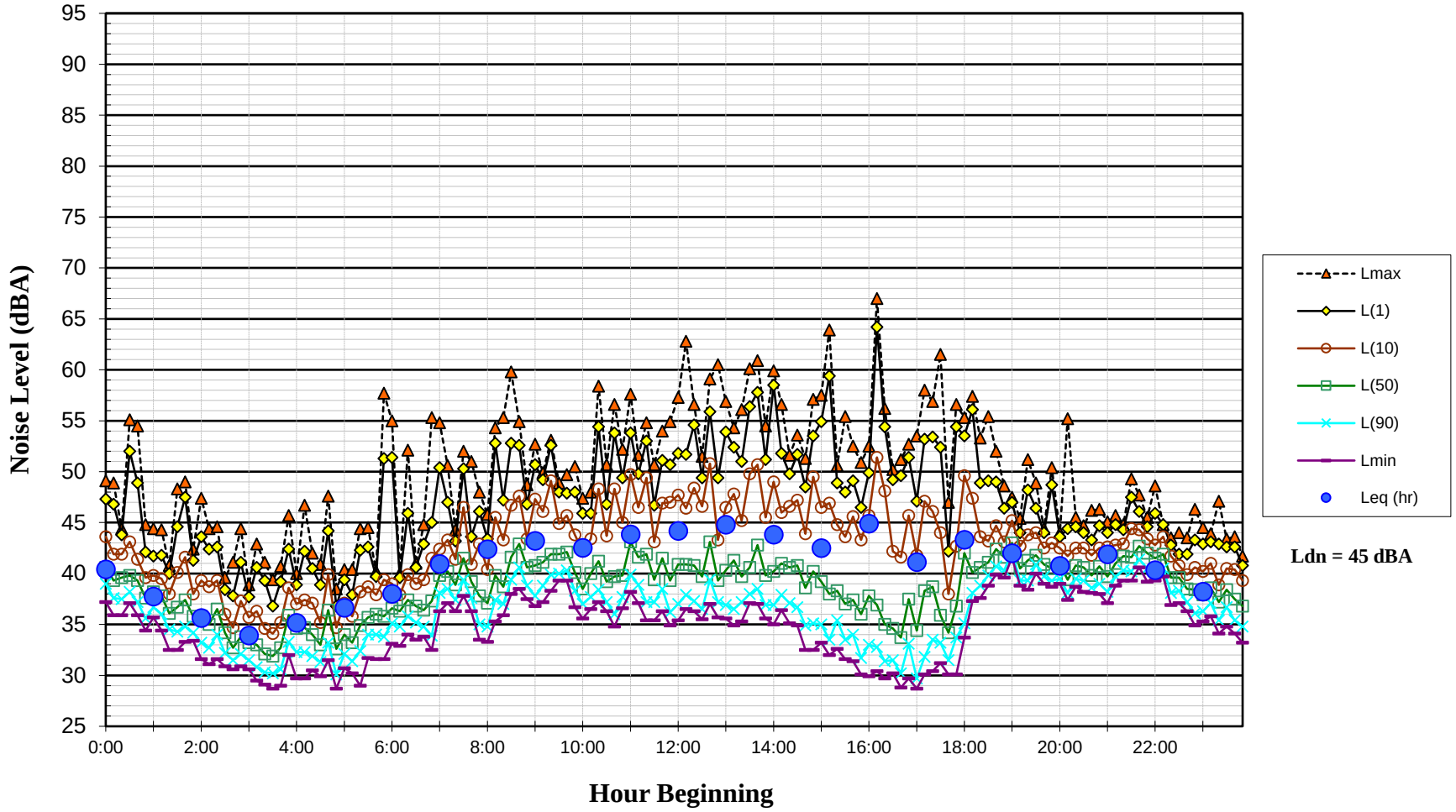


Noise Levels at Noise Measurement Site LT-1
~60 feet from Camile Drive
Saturday, October 24, 2015



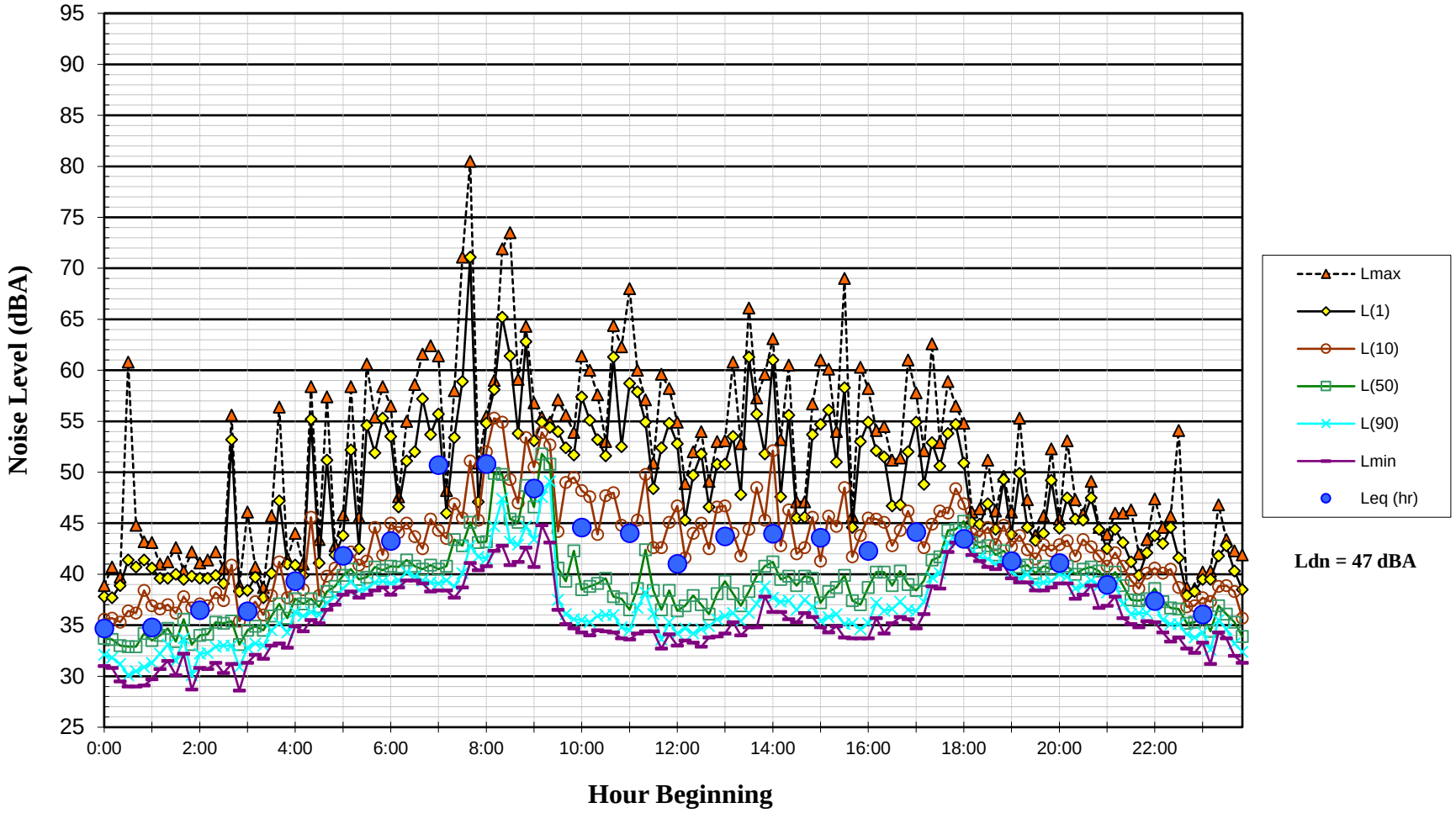
Ldn = 51 dBA

Noise Levels at Noise Measurement Site LT-1
~60 feet from Camile Drive
Sunday, October 25, 2015



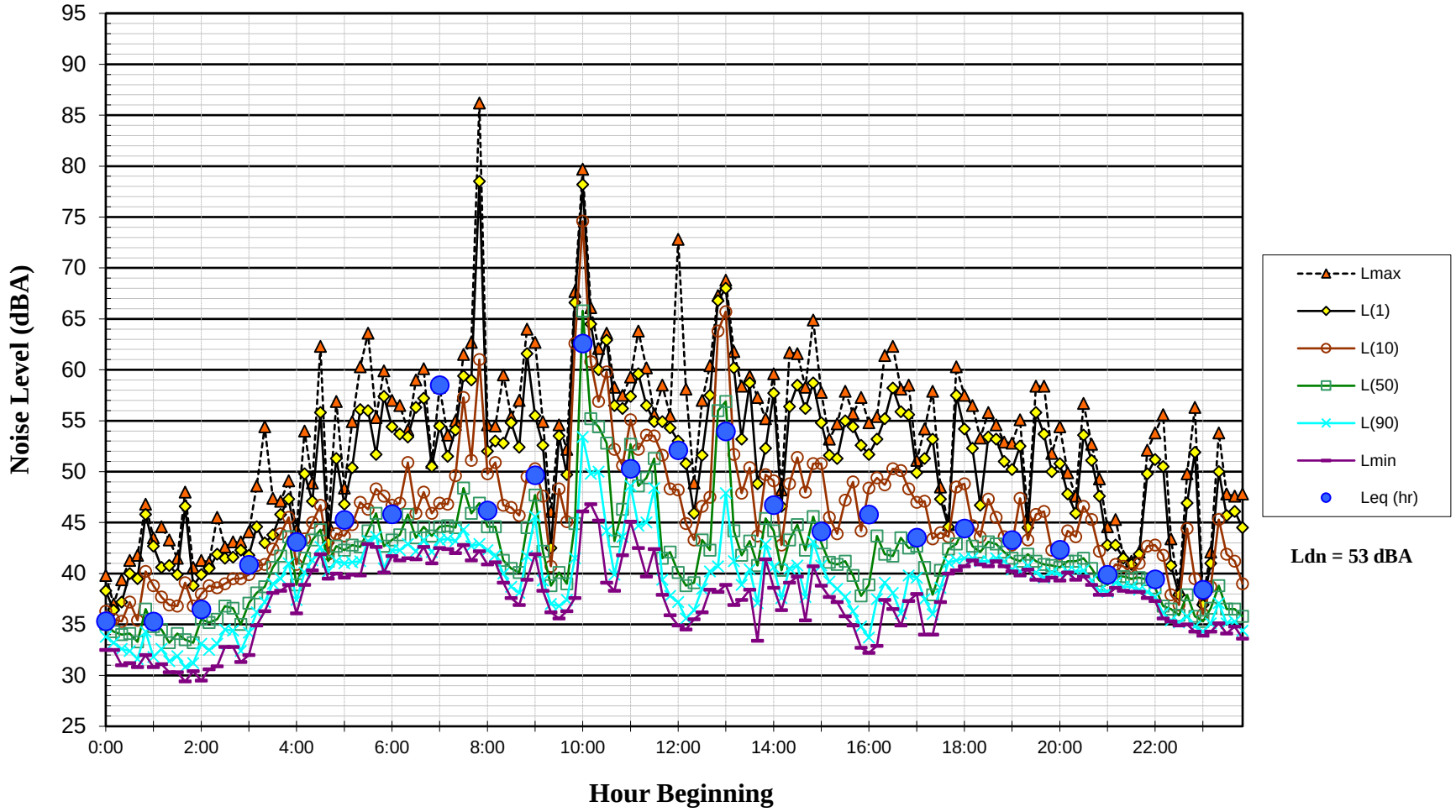
Ldn = 45 dBA

Noise Levels at Noise Measurement Site LT-1
~60 feet from Camile Drive
Monday, October 26, 2015



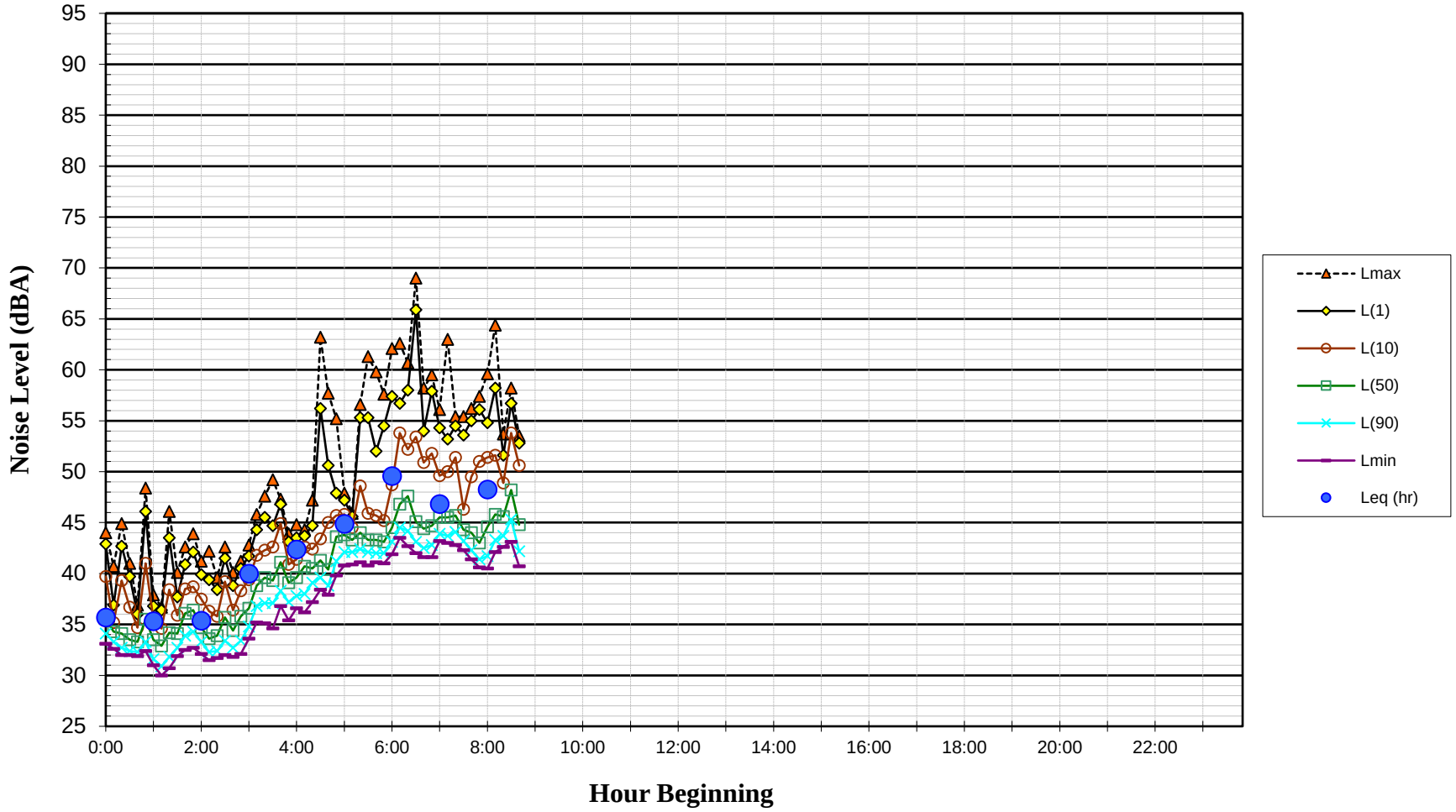
Ldn = 47 dBA

Noise Levels at Noise Measurement Site LT-1
~60 feet from Camile Drive
Tuesday, October 27, 2015

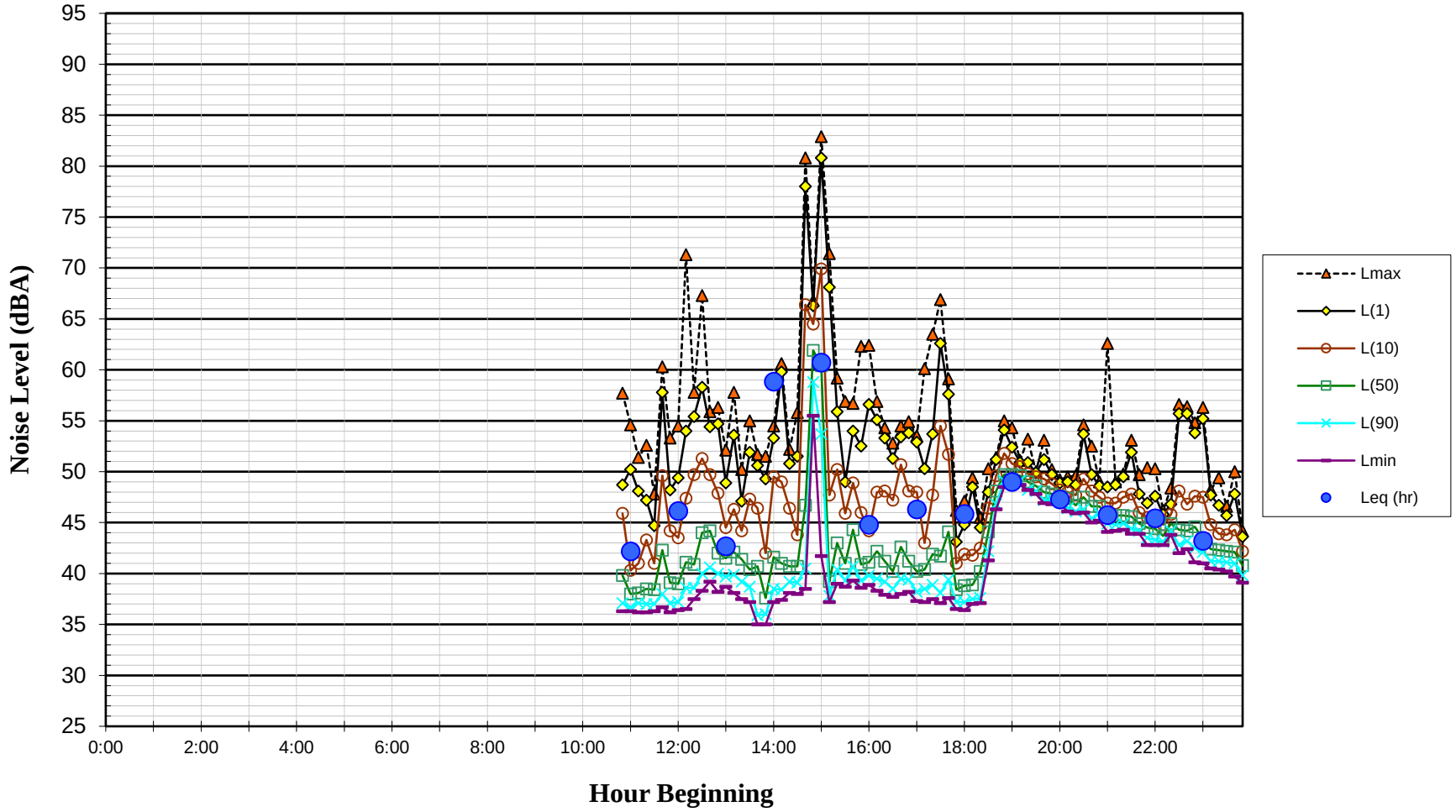


Ldn = 53 dBA

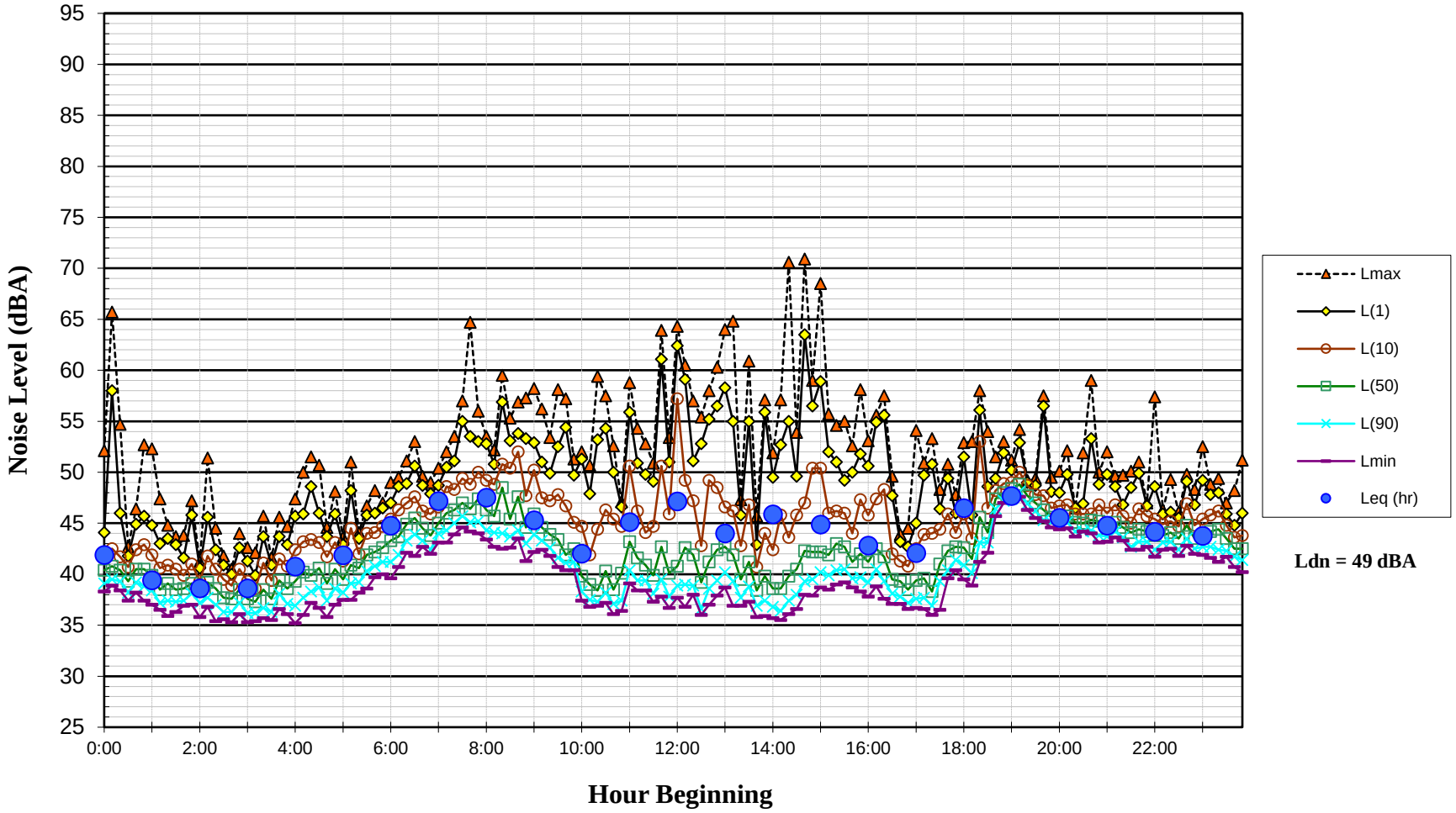
Noise Levels at Noise Measurement Site LT-1
~60 feet from Camile Drive
Wednesday, October 28, 2015



Noise Levels at Noise Measurement Site LT-2
End of Ironwood Place
Friday, October 23, 2015

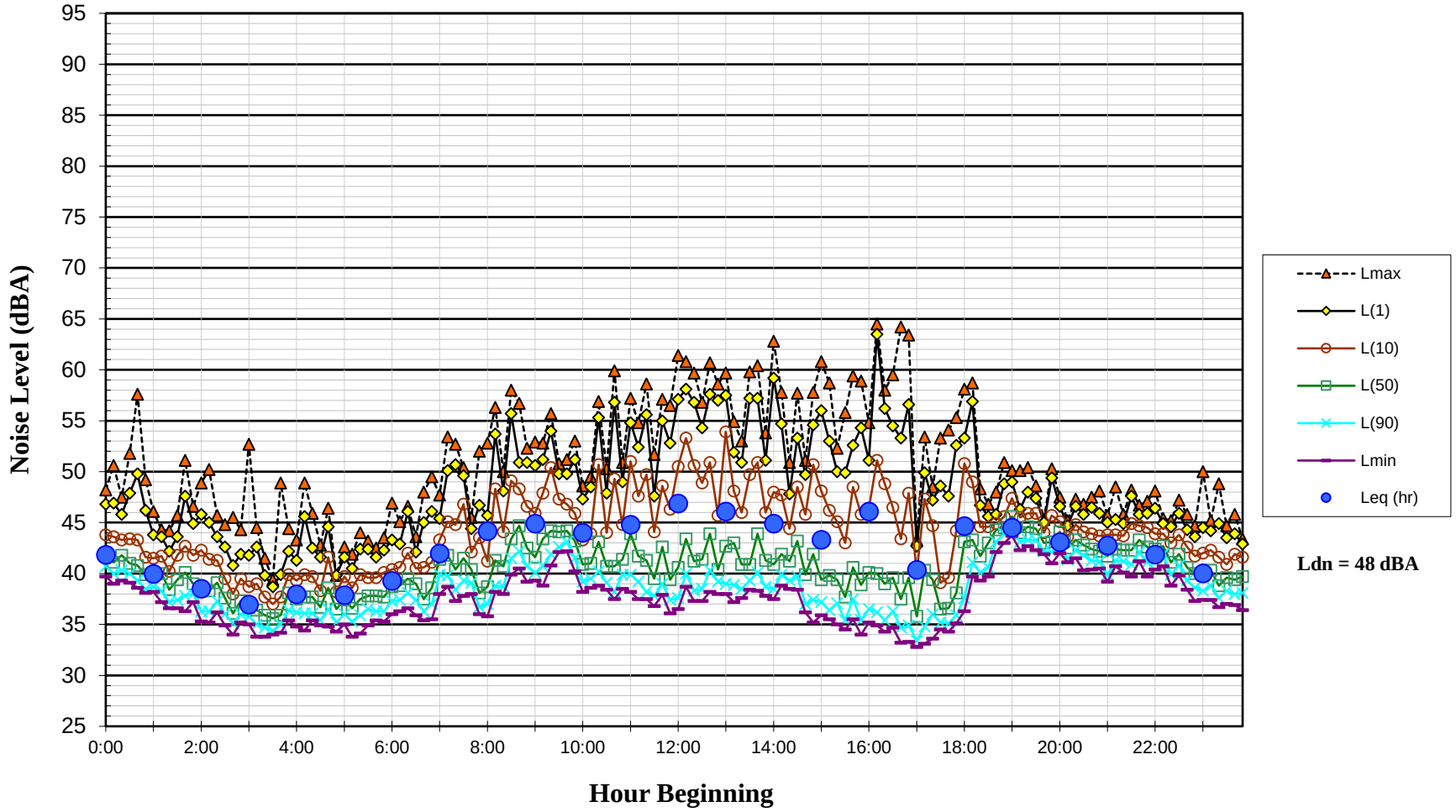


Noise Levels at Noise Measurement Site LT-2
End of Ironwood Place
Saturday, October 24, 2015



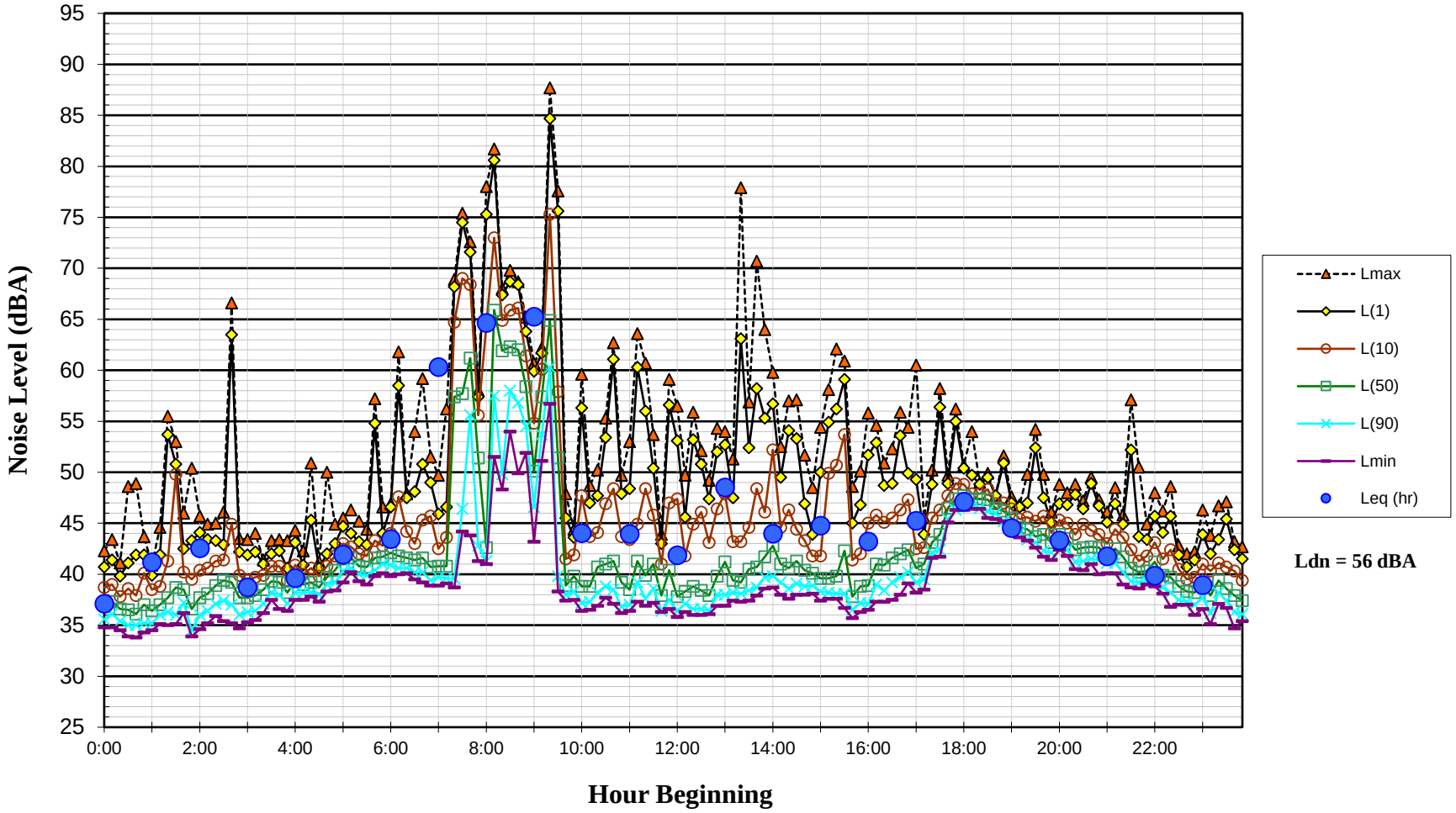
Ldn = 49 dBA

Noise Levels at Noise Measurement Site LT-2
End of Ironwood Place
Sunday, October 25, 2015



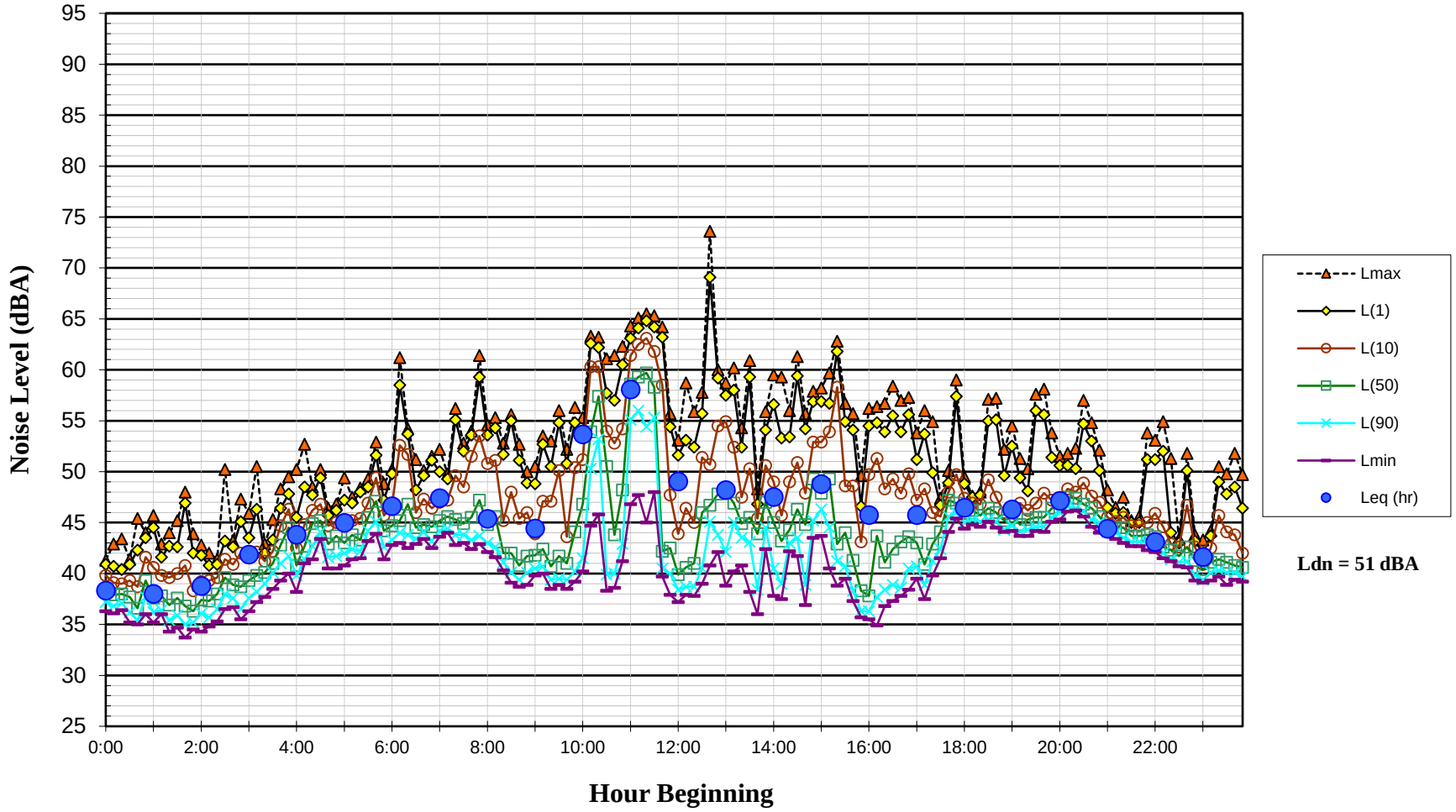
Ldn = 48 dBA

Noise Levels at Noise Measurement Site LT-2
End of Ironwood Place
Monday, October 26, 2015



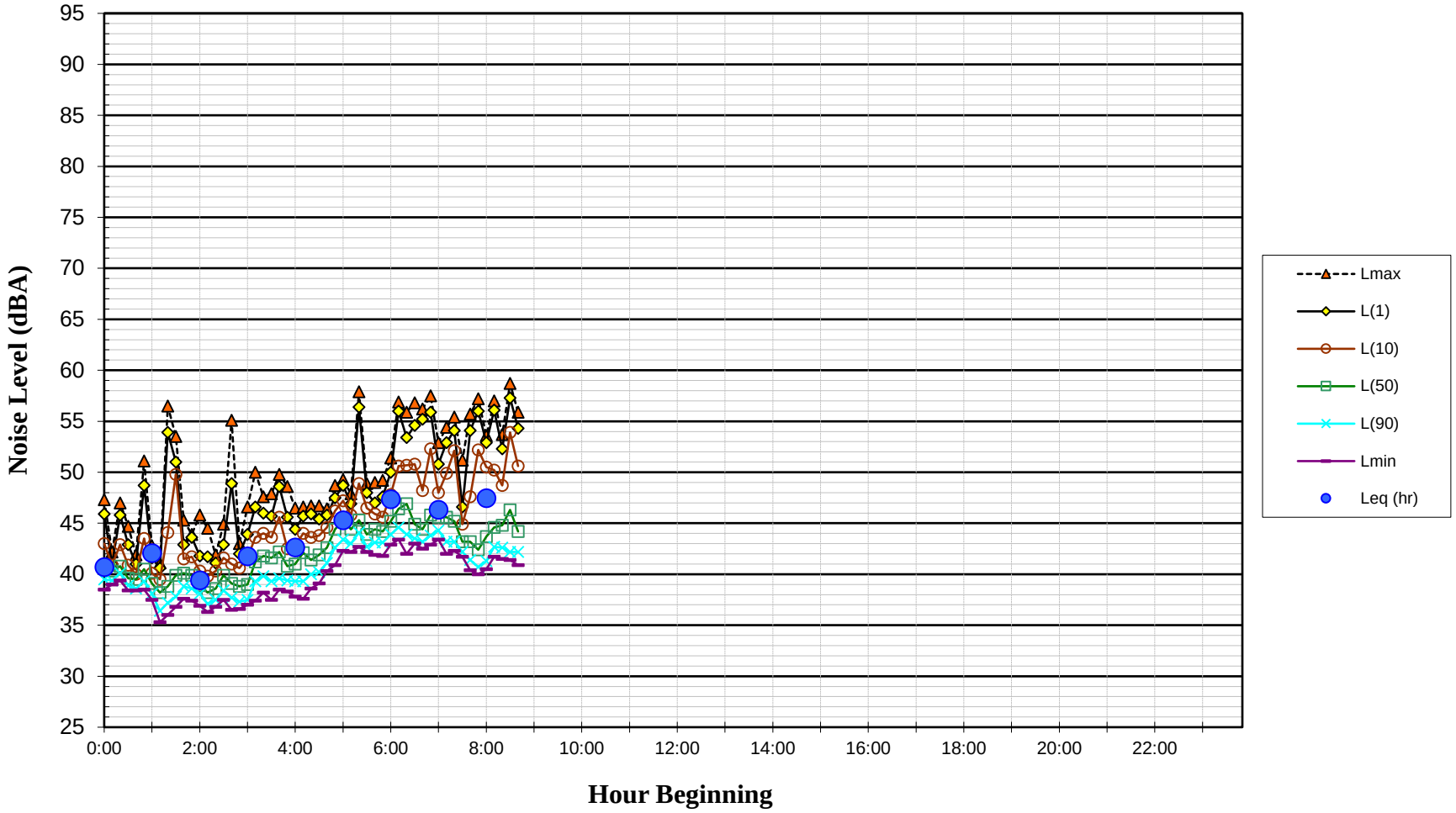
Ldn = 56 dBA

Noise Levels at Noise Measurement Site LT-2
End of Ironwood Place
Tuesday, October 27, 2015



Ldn = 51 dBA

Noise Levels at Noise Measurement Site LT-2
End of Ironwood Place
Wednesday, October 28, 2015



Appendix O.1: Illingworth & Rodkin Noise and Vibration Assessment