304 TODD ROAD PROJECT
NOISE AND VIBRATION ASSESSMENT

Sonoma County, California

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Introduction

Ghilotti Construction Company, Inc. currently uses the property located at 304 Todd Road, in unincorporated Sonoma County, as a temporary contractor's equipment storage site, stockpile location for rock rip-rap material, and processing site for broken asphalt and concrete materials for recycling and reuse purposes as base rock. There are large stockpiles of soil on the southern half of the property. This application is to bring the current use into compliance pursuant to the Notice of Violation received from the County PRMD dated August 9, 2011.

The purpose of this study is to evaluate noise and vibration levels attributable to project operations with regard to the regulatory criteria established by the Sonoma County General Plan. The report first provides a brief discussion of the fundamentals of environmental noise and vibration to assist those who are not familiar with acoustical terminology or concepts and then provides a summary of the applicable regulatory criteria used in the assessment. Existing noise levels in the project vicinity are then described and an evaluation of project-generated noise and vibration levels is made.

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* (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.

Fundamentals of Groundborne Vibration

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

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

The two primary concerns with construction-induced vibration, the potential to damage a structure and the potential to interfere with the enjoyment of life, are evaluated against different vibration limits. Human perception to vibration varies with the individual and is a function of physical setting and the type of vibration. Persons exposed to elevated ambient vibration levels, such as people in an urban environment, may tolerate a higher vibration level.

Structural damage can be classified as cosmetic only, such as paint flaking or minimal extension of cracks in building surfaces; minor, including limited surface cracking; or major, that may threaten the structural integrity of the building. Safe vibration limits that can be applied to assess the potential for damaging a structure vary by researcher. The damage criteria presented in Table 3 include several categories for ancient, fragile, and historic structures, the types of structures

most at risk to damage. Most buildings are included within the categories ranging from “Historic and some old buildings” to “Modern industrial/commercial buildings”. Construction-induced vibration that can be detrimental to the building is very rare and has only been observed in instances where the structure is at a high state of disrepair and the construction activity occurs immediately adjacent to the structure.

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

TABLE 1 Definition of Acoustical Terms Used in this Report

Term	Definition
Decibel, dB	A unit describing, the amplitude of sound, equal to 20 times the logarithm to the base 10 of the ratio of the pressure of the sound measured to the reference pressure. The reference pressure for air is 20 micro Pascals.
Sound Pressure Level	Sound pressure is the sound force per unit area, usually expressed in micro Pascals (or 20 micro Newtons per square meter), where 1 Pascal is the pressure resulting from a force of 1 Newton exerted over an area of 1 square meter. The sound pressure level is expressed in decibels as 20 times the logarithm to the base 10 of the ratio between the pressures exerted by the sound to a reference sound pressure (e. g., 20 micro Pascals). Sound pressure level is the quantity that is directly measured by a sound level meter.
Frequency, Hz	The number of complete pressure fluctuations per second above and below atmospheric pressure. Normal human hearing is between 20 Hz and 20,000 Hz. Infrasonic sound are below 20 Hz and Ultrasonic sounds are above 20,000 Hz.
A-Weighted Sound Level, dBA	The sound pressure level in decibels as measured on a sound level meter using the A-weighting filter network. The A-weighting filter de-emphasizes the very low and very high frequency components of the sound in a manner similar to the frequency response of the human ear and correlates well with subjective reactions to noise.
Equivalent Noise Level, L_{eq}	The average A-weighted noise level during the measurement period.
L_{max}, L_{min}	The maximum and minimum A-weighted noise level during the measurement period.
L_{02}, L_{08}, L_{25}, L_{50}	The A-weighted noise levels that are exceeded 2%, 8%, 25%, and 50% 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 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 Reaction of People and Damage to Buildings from Continuous or Frequent Intermittent Vibration Levels

Velocity Level, PPV (in/sec)	Human Reaction	Effect on Buildings
0.01	Barely perceptible	No effect
0.04	Distinctly perceptible	Vibration unlikely to cause damage of any type to any structure
0.08	Distinctly perceptible to strongly perceptible	Recommended upper level of the vibration to which ruins and ancient monuments should be subjected
0.1	Strongly perceptible	Threshold at which there is a risk of damage to fragile buildings with no risk of damage to most buildings
0.25	Strongly perceptible to severe	Threshold at which there is a risk of damage to historic and some old buildings.
0.3	Strongly perceptible to severe	Threshold at which there is a risk of damage to older residential structures
0.5	Severe - Vibrations considered unpleasant	Threshold at which there is a risk of damage to new residential and modern commercial/industrial structures

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

Regulatory Criteria

Goals, objectives, and policies designed to protect noise-sensitive uses from exposure to excessive noise are set forth in the Noise Element of the Sonoma County General Plan 2020. The primary goal of the Noise Element is to, "Protect people from the adverse effects of exposure to excessive noise and to achieve an environment in which people and land uses function without impairment from noise."

Objectives and policies of the Noise Element that are applicable in the assessment of the proposed project are as follows:

Objective NE-1.1: Provide noise exposure information so that noise impacts may be effectively evaluated in land use planning and project review.

Objective NE-1.2: Develop and implement measures to avoid exposure of people to excessive noise levels.

Objective NE-1.3: Protect the present noise environment and prevent intrusion of new noise sources which would substantially alter the noise environment.

Policy NE-1c: Control non-transportation related noise from new projects. The total noise level resulting from new sources shall not exceed the standards in Table NE-2 (Table 4 of this report) of the recommended revised policies as measured at the exterior property line of any adjacent noise sensitive land use. Limit exceptions to the following:

(1) If the ambient noise level exceeds the standard in Table NE-2, adjust the standard to equal the ambient level, up to a maximum of 5 dBA above the standard, provided that no measurable increase (i.e. +/- 1.5 dBA) shall be allowed.

(2) Reduce the applicable standards in Table NE-2 by 5 dBA for simple tone noises, noises consisting primarily of speech or music, or for recurring impulsive noises, such as pile drivers and dog barking at kennels.

(3) Reduce the applicable standards in Table NE-2 by 5 decibels if the proposed use exceeds the ambient level by 10 or more decibels.

(4) For short-term noise sources, which are permitted to operate no more than six days per year, such as concerts or race events, the allowable noise exposures shown in Table NE-2 may be increased by 5 dB. These events shall be subject to a noise management plan including provisions for maximum noise level limits, noise monitoring, complaint response and allowable hours of operation. The plan shall address potential cumulative noise impacts from all events in the area.

(5) Noise levels may be measured at the location of the outdoor activity area of the noise sensitive land use, instead of at the exterior property line of the adjacent noise sensitive use where:

(a) The property on which the noise sensitive use is located has already been substantially developed pursuant to its existing zoning, and

(b) There is available open land on these noise sensitive lands for noise attenuation.

This exception may not be used for vacant properties, which are zoned to allow noise sensitive uses.

TABLE 4 Maximum Allowable Exterior Noise Exposures for Non-Transportation Noise Sources (Table NE-2)

Hourly Noise Metric[1], dBA	Daytime 7 a.m. to 10 p.m.	Nighttime 10 p.m. to 7 a.m.
L_{50} (30 minutes in any hour)	50	45
L_{25} (15 minutes in any hour)	55	50
L_{08} (5 minutes in any hour)	60	55
L_{02} (1 minute in any hour)	65	60

[1] The sound level exceeded n% of the time in any hour. For example, the L_{50} is the value exceeded 50% of the time or 30 minutes in any hour; this is the median noise level. The L_{02} is the sound level exceeded 1 minute in any hour.

Existing Noise Environment

Ambient noise levels were measured by Illingworth & Rodkin, Inc. between October 10, 2016 and October 13, 2016 at two locations representative of nearby residential receptors. Figure 1 is an aerial photo of the site showing the long-term noise monitoring locations (LT-1 and LT-2). The nearest receptors include a single-family residence located immediately west of the equipment storage site, represented by noise measurement site LT-1, and six single-family residences located along Langner Avenue west, southwest, and south of the site, represented by noise measurement site LT-2. During the noise monitoring period, Ghilotti Construction used the equipment storage site as normal, but no activities occurred near stockpile location for rock rip-rap material or stockpiles of soil on the southern half of the property.

Noise measurements were made with a Larson Davis Model 820 Integrating Sound Level Meters set at "slow" response. The sound level meters were equipped with G.R.A.S. Type 40AQ ½-inch random incidence microphones and fitted with windscreens. The sound level meters were calibrated prior to the noise measurements using a Larson Davis Model CAL200 acoustical calibrator, and the response of each system was checked after the measurement session and was found to be within 0.2 dBA. No calibration adjustments were made to the measured sound levels. Weather conditions during this period were generally good for noise monitoring with clear to partly cloudy skies, calm to light winds, and seasonable temperatures.

Figures 2-5 display the noise data collected at Site LT-1. As noted above, LT-1 was selected to represent the ambient noise environment at the nearest residential land uses located west of the equipment storage site. Intermittent noise produced by activities associated with the equipment storage site (represented by the L_{02} and L_{08} acoustical descriptors) punctuated the background noise environment which was predominantly the result of traffic along Todd Road and other industrial uses in the project vicinity. Existing ambient day-night average noise levels at Site LT-1 were 60 dBA L_{dn} on Tuesday, October 11, 2016, and Wednesday, October 12, 2016. The measured noise data are also summarized in terms of the metrics appropriate for the Sonoma County noise performance standards and for hourly L_{eq} in Table 5. The arithmetic average noise level is given for each L_n descriptor throughout the daytime and nighttime periods.

TABLE 5 Existing Noise Levels at LT-1

Time Period	Average Hourly Noise Level, dBA				
	L_{02}	L_{08}	L_{25}	L_{50}	L_{eq}
Daytime (7 a.m. – 10 p.m.)	61	57	53	50	54
Nighttime (10 p.m. to 7 a.m.)	56	52	47	44	48

Site LT-2 was situated between the six residences located along Langner Avenue west, southwest, and south of the site. Figures 6 - 9 display the measured noise data over a daily basis. In the absence of local traffic along Langner Avenue, the noise environment at this location results primarily from distant traffic and industrial operations. Existing ambient day-night average noise levels at Site LT-2 ranged from 52 to 54 dBA L_{dn}. Table 6 summarizes the

arithmetic average of the noise data in terms of the metrics appropriate for the Sonoma County noise performance standards and for hourly L_{eq}.

TABLE 6 Existing Noise Levels at LT-2

Time Period	Average Hourly Noise Level, dBA				
	L_{02}	L_{08}	L_{25}	L_{50}	L_{eq}
Daytime (7 a.m. – 10 p.m.)	57	50	46	44	50
Nighttime (10 p.m. to 7 a.m.)	48	45	43	41	43

Noise Assessment of Equipment Storage Site

The northernmost portion of the 304 Todd Road property is used by Ghilotti Construction Company, Inc. as a temporary contractor's equipment storage site. Heavy-duty trucks that transport materials and equipment are typically parked along the westernmost boundary of the site and employee autos are typically parked along the northernmost and easternmost boundaries of the equipment storage site. Construction equipment is temporarily stored at the site until the equipment is transported to the next project location. Minor equipment repairs occasionally take place at this location as well.

Noise measurements made at Site LT-1 documented existing noise levels produced by the daily activities occurring at the contractor's equipment storage site. Because the noise produced by the autos, trucks, and construction equipment is intermittent and infrequent in nature, the L_{02} and L_{08} noise levels are the best indicators of the noise produced by these operations. The L_{25} noise level is also assessed, and conservatively assumes that the cumulative noise from the intermittent activities at the equipment storage site could exceed 15 minutes in duration in any hour. A review of the noise data shows that L_{02} noise levels typically ranged from 65 to 68 dBA, but reached 75 dBA during the 9:00 a.m. hour on October 11, 2016. The L_{02} noise data collected during the 9:00 a.m. hour on October 11, 2016 were atypical because L_{02} noise levels were 7 to 8 dBA greater than the next three highest L_{02} noise levels measured during the noise survey (67, 67, and 68 dBA L_{02}). In order to credibly represent L_{02} noise levels produced by equipment storage, and provide for a fair assessment of project-generated L_{02} noise levels, the typical worst-case L_{02} noise level was determined to be 69 dBA when averaging the four loudest L_{02} noise levels measured during the survey. L_{08} noise levels typically ranged from 58 to 66 dBA, and L_{25} noise levels typically ranged from 47 to 57 dBA when including the data collected during the 9:00 a.m. hour on October 11, 2016.

The proposed grading plan (Figure 10) indicates that a 14-foot masonry block noise barrier would be constructed to reduce equipment storage operational noise levels to acceptable levels at the property line of the nearest residence to the west. Calculations were made to estimate the barrier insertion loss provided by the proposed 14-foot masonry block noise barrier. Based on the results of the insertion loss calculations, the proposed 14-foot masonry block noise barrier would provide at least 12 dBA of noise reduction as measured at the nearest residential property line to the west. Tables 7, 8, and 9, following, summarize the assessment of equipment storage site

noise levels assuming the construction of a 14-foot masonry block noise barrier along the westernmost boundary of the equipment storage site.

TABLE 7 Equipment Storage Site Related L_{02} Noise Levels (dBA)

	L_{02} (Noise Level Exceeded 1 Minute in any Hour)	
	Daytime	**Nighttime**
Receptor	Property Line of APN 134-171-051	Property Line of APN 134-171-051
Unadjusted Table NE-2 Limit	65	60
Ambient Noise Levels[1]	57	48
Ambient Exceeds Unadjusted Table NE-2 Limit	No	No
Adjusted Table NE-2 Limits (Ambient)	65	60
Equipment Storage Noise Level with Proposed 14-foot Noise Barrier	53 to 57	53 to 57
Operations Exceed Ambient by 10 dBA?	No	No
NE-2 Adjustment	0	0
Adjusted Table NE-2 Limit (Operations)	65	60
Operations Exceed NE-2?	No	No

TABLE 8 Equipment Storage Site Related L_{08} Noise Levels (dBA)

	L_{08} (Noise Level Exceeded 5 Minutes in any Hour)	
	Daytime	**Nighttime**
Receptor	Property Line of APN 134-171-051	Property Line of APN 134-171-051
Unadjusted Table NE-2 Limit	60	55
Ambient Noise Levels[2]	50	45
Ambient Exceeds Unadjusted Table NE-2 Limit	No	No
Adjusted Table NE-2 Limits (Ambient)	60	55
Equipment Storage Noise Level with Proposed 14-foot Noise Barrier	46 to 54	46 to 54
Operations Exceed Ambient by 10 dBA?	No	No
NE-2 Adjustment	0	0
Adjusted Table NE-2 Limit (Operations)	60	55
Operations Exceed NE-2?	No	No

[1] Ambient L_{02} noise levels documented at LT-2 were used to conservatively represent ambient noise conditions at LT-1 assuming no localized operations at 304 Todd Road.
[2] Ambient L_{08} noise levels documented at LT-2 were used to conservatively represent ambient noise conditions at LT-1 assuming no localized operations at 304 Todd Road.

TABLE 9 Equipment Storage Site Related L_{25} Noise Levels (dBA)

	L_{25} (Noise Level Exceeded 15 Minutes in any Hour)	
	Daytime	**Nighttime**
Receptor	Property Line of APN 134-171-051	Property Line of APN 134-171-051
Unadjusted Table NE-2 Limit	55	50
Ambient Noise Levels[3]	46	43
Ambient Exceeds Unadjusted Table NE-2 Limit	No	No
Adjusted Table NE-2 Limits (Ambient)	55	50
Equipment Storage Noise Level with Proposed 14-foot Noise Barrier	35 to 45	35 to 45
Operations Exceed Ambient by 10 dBA?	No	No
NE-2 Adjustment	0	0
Adjusted Table NE-2 Limit (Operations)	55	50
Operations Exceed NE-2?	No	No

The proposed 14-foot masonry block noise barrier would be solidly constructed over the face and at the base of the barrier from masonry blocks having a minimum surface weight of approximately 30 lbs./sq.ft. The proposed barrier materials would be more than adequate for the desired noise reduction as the minimum surface weight required for barrier materials is 3 lbs./sq.ft. The construction of a 14-foot masonry block noise barrier along the westernmost boundary of the equipment storage site would sufficiently reduce noise levels such that daytime and nighttime L_{02}, L_{08}, and L_{25} noise levels produced by intermittent equipment storage operations would not exceed the Table NE-2 noise level thresholds at the nearest residential property line or the nearest residence. The proposed noise barrier would also provide sufficient noise attenuation for the more distant receptors located to the west along Langner Avenue. No additional mitigation would be required.

Noise Assessment of Material Processing

The central portion of the property is used by Ghilotti Construction Company, Inc. for material processing. Storage of rock rip-rap for reuse on projects will take place from time to time as will trucking off-haul of the rock rip-rap to project sites. Stockpiling and processing of asphalt grindings, concrete and base rock materials will occur from time to time and is a use that will coincide primarily with the construction season, from spring to early winter. Processing of these materials will be for trucking to and re-use in on-going countywide projects. Both stockpiling and processing of materials is on an as needed basis. Stockpiling of the materials on site will occur during the week and on Saturdays between the hours of 7:00 AM to 6:00 PM. Processing of materials will be performed during the week and on Saturdays between the hours of 7:00 AM

[3] Ambient L_{25} noise levels documented at LT-2 were used to conservatively represent ambient noise conditions at LT-1 assuming no localized operations at 304 Todd Road.

to 6:00 PM. Processing of the materials will involve the use of two operated pieces of equipment and an operated portable crushing plant.

The major noise sources associated with the material processing component of the project would be the concrete and asphalt recycling crushing plant and secondary noise sources such as a front loader or excavator that would be necessary feed materials into the plant, as well as trucks operating on the site when loading or unloading materials. Noise measurements were made by Illingworth & Rodkin, Inc. at 670 S. Napa Junction Road in American Canyon in order to quantify source noise levels produced by this operation utilizing the actual crushing plant that would be periodically located on the site to process materials. The equipment measured included a Terex rock crusher, a CAT 972 G wheel loader, and conveyors. Since noise from this operation is continuous, the L_{50} noise level is the best indicator of the noise and would represent the lowest noise level threshold applicable to the project. Under typical operating conditions, the L_{50} noise level was measured to be 85 dBA on the front side of the crushing plant where the radiator was located. On the opposite side, away from the radiator, the L_{50} noise level was measured to be 75 dBA.

Given the directionality of the noise emanating from the material processing operation, Ghilotti Construction Company, Inc. has confirmed that the front side of the crushing plant would be oriented to the east and away from nearby receptors. The grading plan indicates that the material processing area would be shielded by a minimum 25-foot earth berm, as measured above the height of the crusher pad, which would extend a minimum distance of 1,060 feet along the west boundary of the site and return along the south boundary of the site over an approximate distance of 250 feet. Calculations were made to estimate the barrier insertion loss provided by the proposed 25-foot noise barrier. Based on the results of the insertion loss calculations, the proposed 25-foot noise barrier would provide approximately 18 dBA of noise reduction. The crusher would be located no closer than 140 feet from the nearest residential property line, resulting in an additional 9 dBA of attenuation due to increased distance from the noise source. Table 10 summarizes the assessment of material processing noise levels assuming the construction of a 25-foot earth berm along the westernmost and southernmost site boundaries and that the front side of the crushing plant would be oriented to the east and away from nearby receptors.

TABLE 10 Material Processing Related L_{50} Noise Levels (dBA)

	L_{50} (Noise Level Exceeded 30 Minutes in any Hour)	
	Daytime	**Daytime**
Receptor	Property Line of APN 134-171-051	Residence APN 134-171-051
Unadjusted Table NE-2 Limit	50	50
Ambient Noise Levels[4]	44	44
Ambient Exceeds Unadjusted Table NE-2 Limit	No	No
Adjusted Table NE-2 Limits (Ambient)	50	50
Material Processing Noise Level with Proposed 25-foot Earth Berm	48	43
Operations Exceed Ambient by 10 dBA?	No	No
NE-2 Adjustment	0	0
Adjusted Table NE-2 Limit (Operations)	50	50
Operations Exceed NE-2?	No	No

The construction of the proposed 25-foot earth berm along the westernmost and southernmost boundaries of the site area would sufficiently reduce noise levels such that daytime L_{50} noise levels produced by material processing operations would not exceed the Table NE-2 noise level threshold of 50 dBA L_{50} at the nearest residential property lines. The calculated noise level at the residence during material processing operations would be 43 dBA L_{50} or less assuming the acoustical shielding provided by the earth berm and 14-foot masonry block noise barrier proposed along the westernmost boundary of the site. The proposed noise barriers would also provide sufficient noise attenuation for the more distant receptors located to the west along Langner Avenue. No additional mitigation would be required.

[4] Ambient L_{50} noise levels documented at LT-2 were used to conservatively represent ambient noise conditions at LT-1 assuming no localized operations at 304 Todd Road.

Noise Assessment of Temporary Stockpile Operations

Large stockpiles of soil exist on the southern half of the property. Heavy-duty trucks transport the soil to and from the site depending on the needs of the job. Soil importation could occur at night depending on the requirements of the job at hand, and up to 15 trucks per hour would be expected under credible worst-case conditions.

Noise data collected by Illingworth & Rodkin, Inc. indicate that temporary stockpile operations, assuming up to 15 trucks per hour, would produce noise levels of 77 dBA L_{02}, 72 dBA L_{08}, 66 dBA L_{25}, and 62 dBA L_{50} as measured at a distance of 125 feet.

The proposed grading plan indicates that a 25-foot earth berm would be constructed along the west and south property boundaries. Calculations were made to estimate the barrier insertion loss provided by the proposed 25-foot earth berm. The analysis assumed that the top of the earth berm would be at least 14 feet higher than the maximum elevation of the stockpile (i.e., the stockpile would be maintained at a height of 11 feet or less). Based on the results of the insertion loss calculations, the proposed 25-foot earth berm would provide approximately 17 to 21 dBA of noise reduction as measured at the nearest residential property line to the west or south. Tables 11, 12, 13, and 14 summarize the assessment of noise levels produced by temporary stockpile operations assuming the construction of a 25-foot earth berm along the westernmost and southernmost boundaries of the site.

TABLE 11 Temporary Stockpile Operations L_{02} Noise Levels (dBA)

	L_{02} (Noise Level Exceeded 1 Minute in any Hour)	
	Daytime	**Nighttime**
Receptor	Property Line of APN 134-171-051	Property Line of APN 134-171-051
Unadjusted Table NE-2 Limit	65	60
Ambient Noise Levels[5]	57	48
Ambient Exceeds Unadjusted Table NE-2 Limit	No	No
Adjusted Table NE-2 Limits (Ambient)	65	60
Temporary Stockpile Operations Noise Level with Proposed 25-foot Earth Berm	56-60	56-60
Operations Exceed Ambient by 10 dBA?	No	Yes
NE-2 Adjustment	0	-5
Adjusted Table NE-2 Limit (Operations)	65	55
Operations Exceed NE-2?	No	**Yes**

[5] Ambient L_{02} noise levels documented at LT-2 were used to conservatively represent ambient noise conditions at LT-1 assuming no localized operations at 304 Todd Road.

TABLE 12 Temporary Stockpile Operations L_{08} Noise Levels (dBA)

	L_{08} (Noise Level Exceeded 5 Minutes in any Hour)	
	Daytime	**Nighttime**
Receptor	Property Line of APN 134-171-051	Property Line of APN 134-171-051
Unadjusted Table NE-2 Limit	60	55
Ambient Noise Levels[6]	50	45
Ambient Exceeds Unadjusted Table NE-2 Limit	No	No
Adjusted Table NE-2 Limits (Ambient)	60	55
Temporary Stockpile Operations Noise Level with Proposed 25-foot Earth Berm	51-55	51-55
Operations Exceed Ambient by 10 dBA?	No	Yes
NE-2 Adjustment	0	-5
Adjusted Table NE-2 Limit (Operations)	60	50
Operations Exceed NE-2?	No	**Yes**

TABLE 13 Temporary Stockpile Operations L_{25} Noise Levels (dBA)

	L_{25} (Noise Level Exceeded 15 Minutes in any Hour)	
	Daytime	**Nighttime**
Receptor	Property Line of APN 134-171-051	Property Line of APN 134-171-051
Unadjusted Table NE-2 Limit	55	50
Ambient Noise Levels[7]	46	43
Ambient Exceeds Unadjusted Table NE-2 Limit	No	No
Adjusted Table NE-2 Limits (Ambient)	55	50
Temporary Stockpile Operations Noise Level with Proposed 25-foot Earth Berm	45-49	45-49
Operations Exceed Ambient by 10 dBA?	No	No
NE-2 Adjustment	0	0
Adjusted Table NE-2 Limit (Operations)	55	50
Operations Exceed NE-2?	No	No

[6] Ambient L_{08} noise levels documented at LT-2 were used to conservatively represent ambient noise conditions at LT-1 assuming no localized operations at 304 Todd Road.
[7] Ambient L_{25} noise levels documented at LT-2 were used to conservatively represent ambient noise conditions at LT-1 assuming no localized operations at 304 Todd Road.

TABLE 14 Temporary Stockpile Operations L_{50} Noise Levels (dBA)

	L_{50} (Noise Level Exceeded 30 Minutes in any Hour)	
	Daytime	**Nighttime**
Receptor	Property Line of APN 134-171-051	Property Line of APN 134-171-051
Unadjusted Table NE-2 Limit	50	45
Ambient Noise Levels[8]	44	41
Ambient Exceeds Unadjusted Table NE-2 Limit	No	No
Adjusted Table NE-2 Limits (Ambient)	50	45
Temporary Stockpile Operations Noise Level with Proposed 25-foot Earth Berm	41-45	41-45
Operations Exceed Ambient by 10 dBA?	No	No
NE-2 Adjustment	0	0
Adjusted Table NE-2 Limit (Operations)	50	45
Operations Exceed NE-2?	No	No

The construction of a 25-foot earth berm along the westernmost and southernmost boundaries of the temporary stockpile would sufficiently reduce noise levels such that the daytime L_{02}, L_{08}, L_{25} and L_{50} thresholds would be met at the property lines of the nearest parcels. Nighttime L_{02} and L_{08} noise levels would exceed the Table NE-2 noise level thresholds at the nearest residential property lines by up to 5 dBA. Therefore, it is recommended that nighttime trucks be limited to areas on the site located more than 225 feet from the western or southern site boundaries. The proposed noise barrier, in combination with the nighttime truck restriction above, would be sufficient to reduce noise levels to acceptable levels at the nearest residential property line and at more distant receptors located to the west along Langner Avenue assuming daytime or nighttime operations.

Construction Noise Assessment

Sonoma County does not establish thresholds of significance for construction noise, however, construction noise must be considered in the noise analysis in some cases, and is required for any construction activity that extends for more than one year. Although there is often little that can be done to reduce noise levels generated by construction equipment, this study recommends measures that should be considered to reduce noise levels during site remediation.

Noise impacts generated by project-related construction activities would be a function of the noise levels generated by individual pieces of construction equipment, the type and amount of equipment operating at any given time, the timing and duration of construction activities, the proximity of nearby sensitive land uses, and the presence or lack of shielding at these sensitive

[8] Ambient L_{50} noise levels documented at LT-2 were used to conservatively represent ambient noise conditions at LT-1 assuming no localized operations at 304 Todd Road.

land uses. Construction noise levels would vary on a day-to-day basis during each phase of construction depending on the specific task being completed. Each construction phase would require a different combination of construction equipment necessary to complete the task and differing usage factors for such equipment. Construction noise would primarily result from the operation of heavy construction equipment and the arrival and departure of heavy-duty trucks.

Table 15 presents the typical range of hourly average noise levels generated by different phases of construction measured at a distance of 50 feet from a busy construction site. Typical hourly average construction-generated noise levels are about 79 to 88 dBA L_{eq} for similar type projects as measured at a distance of 50 feet. Large pieces of earth-moving equipment, such as graders, scrapers, and dozers, generate maximum noise levels of 85 to 90 dBA L_{max} at a distance of 50 feet. Construction noise levels drop off at a rate of about 6 dBA per doubling of distance between the noise source and receptor. Intervening structures or terrain would result in lower noise levels at distant receivers.

The potential for the highest noise levels would occur at the residence immediately west of the site. This residence would be located approximately 120 feet from the nearest areas proposed for construction and would at times be exposed to construction noise levels ranging from 71 to 80 dBA L_{eq}. Langner Avenue receptors would be located approximately 365 feet from the nearest areas proposed for construction and would at times be exposed to construction noise levels ranging from 62 to 71 dBA L_{eq}. Although there is no County established threshold for construction noise, these noise levels can be considered a nuisance to nearby land uses, and measures to reduce the noise levels are identified below.

TABLE 15 Typical Ranges of Noise Levels at 50 Feet from Construction Sites (dBA L_{eq})

	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: United States Environmental Protection Agency, 1973, Legal Compilation on Noise, Vol. 1, p. 2-104.

To reduce the potential for noise impacts resulting from the construction of the project, the following measures should be implemented during all project construction activities:

- A detailed construction plan that identifies the schedule for major noise-generating construction activities shall be prepared and distributed to adjacent noise-sensitive receptors. The construction plan should also list the construction noise reduction measures identified in this study.

- Noise-generating construction activities should be restricted to between the hours of 8:00 a.m. to 6:00 p.m. Monday through Friday. No construction activities should occur on weekends or holidays.

- Equip all internal combustion engine driven equipment with intake and exhaust mufflers that are in good condition and appropriate for the equipment.

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

- Locate stationary noise generating equipment as far as possible from sensitive receptors when sensitive receptors adjoin or are near a construction project area.

- Utilize "quiet" air compressors and other "quiet" equipment where such technology exists.

Vibration Assessment

Sonoma County does not establish thresholds of significance for vibration resulting from the construction or operation of projects. 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. For the purposes of this analysis, the 0.3 in/sec PPV vibration limit would be applicable to residential buildings near the project site.

Table 16 presents typical vibration levels that could be expected from construction equipment operating at 25 feet. Impact or vibratory pile driving would not be necessary to construct the project; therefore, the highest potential for groundborne vibration would result from the use of high-power vibratory tools and rolling stock equipment (tracked vehicles, compactors, etc.). Vibration levels would vary depending on soil conditions, construction methods, and equipment used.

The nearest residential structure is approximately 80 feet west of the project site. At 80 feet, vibration levels produced by heavy construction equipment operating near the site's westernmost property line could reach 0.058 in/sec PPV. Worst-case vibration levels resulting from the construction and operation of the project would be well below the 0.3 in/sec PPV used to assess the potential for cosmetic damage to structures (e.g., minor cracking to plastered walls or ceilings in older residential dwellings).

TABLE 16 Vibration Source Levels for Construction Equipment

Equipment		PPV at 25 ft. (in/sec)	PPV at 50 ft. (in/sec)	PPV at 80 ft. (in/sec)
Clam shovel drop		0.202	0.094	0.056
Hydromill (slurry wall)	in soil	0.008	0.004	0.002
	in rock	0.017	0.008	0.005
Vibratory Roller		0.210	0.098	0.058
Hoe Ram		0.089	0.042	0.025
Large bulldozer		0.089	0.042	0.025
Caisson drilling		0.089	0.042	0.025
Loaded trucks		0.076	0.035	0.021
Jackhammer		0.035	0.016	0.010
Small bulldozer		0.003	0.001	0.001

Source: Transit Noise and Vibration Impact Assessment, United States Department of Transportation, Office of Planning and Environment, Federal Transit Administration, May 2006, as modified by Illingworth & Rodkin, Inc., September 2018.

FIGURE 1 Aerial Image Showing Noise Monitoring Locations and Nearby Residences

Noise Levels at LT-1
West Property Line of Site, 450 feet south of the Todd Road Centerline
Monday, October 10, 2016

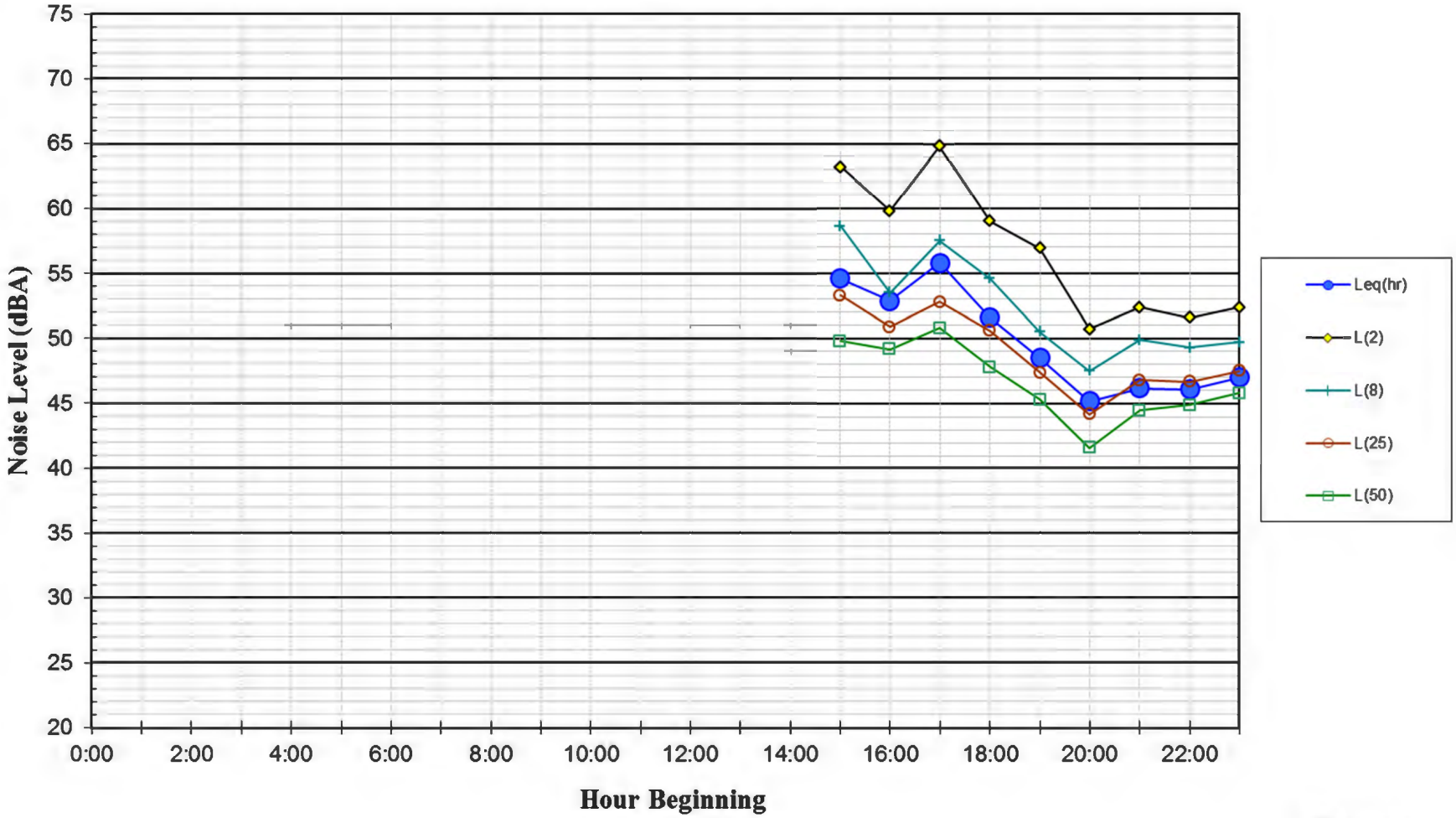
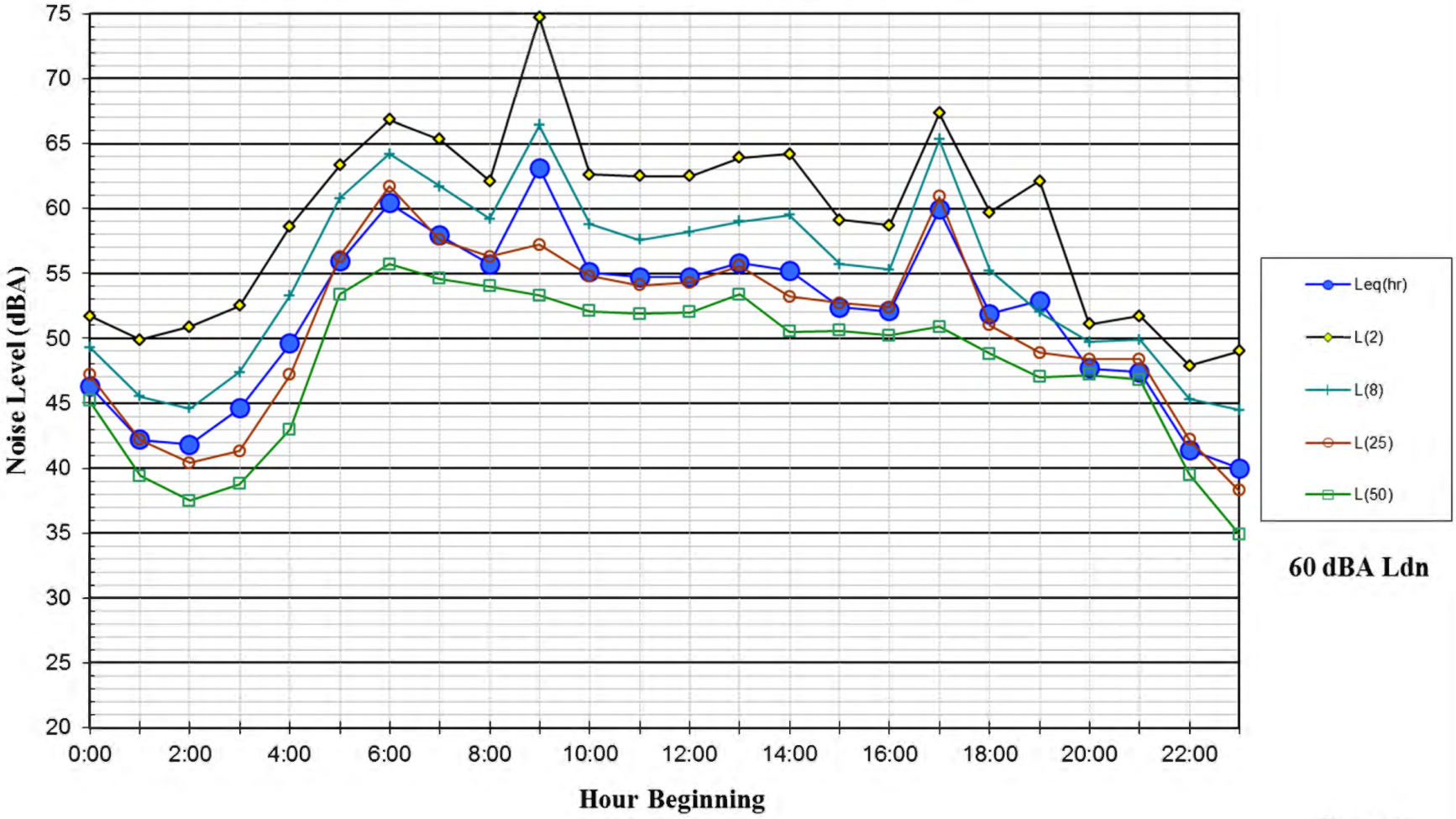


Figure 2

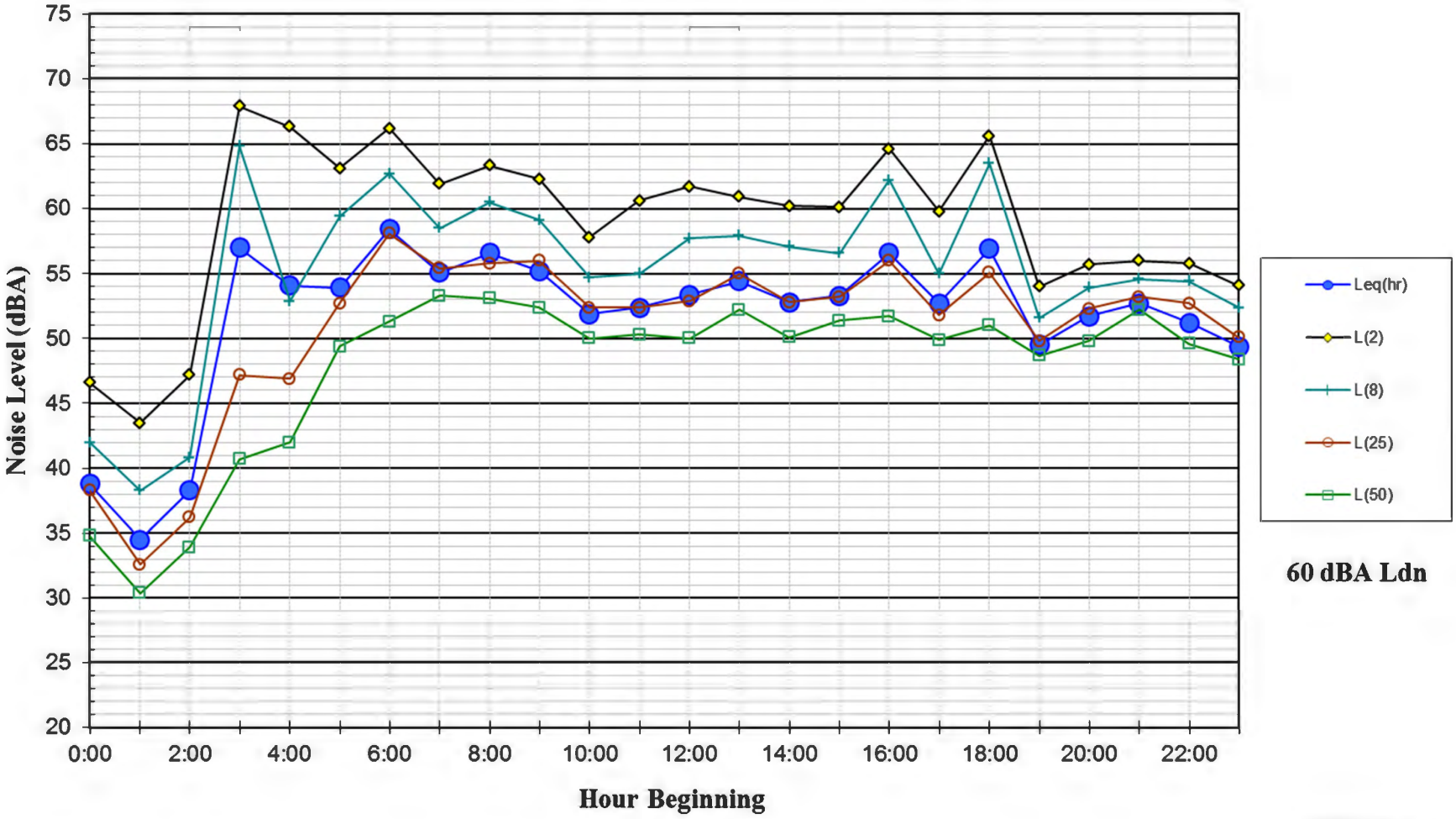
Noise Levels at LT-1
West Property Line of Site, 450 feet south of the Todd Road Centerline
Tuesday, October 11, 2016



60 dBA Ldn

Figure 3

Noise Levels at LT-1
West Property Line of Site, 450 feet south of the Todd Road Centerline
Wednesday, October 12, 2016



60 dBA Ldn

Figure 4

Noise Levels at LT-1
West Property Line of Site, 450 feet south of the Todd Road Centerline
Thursday, October 13, 2016

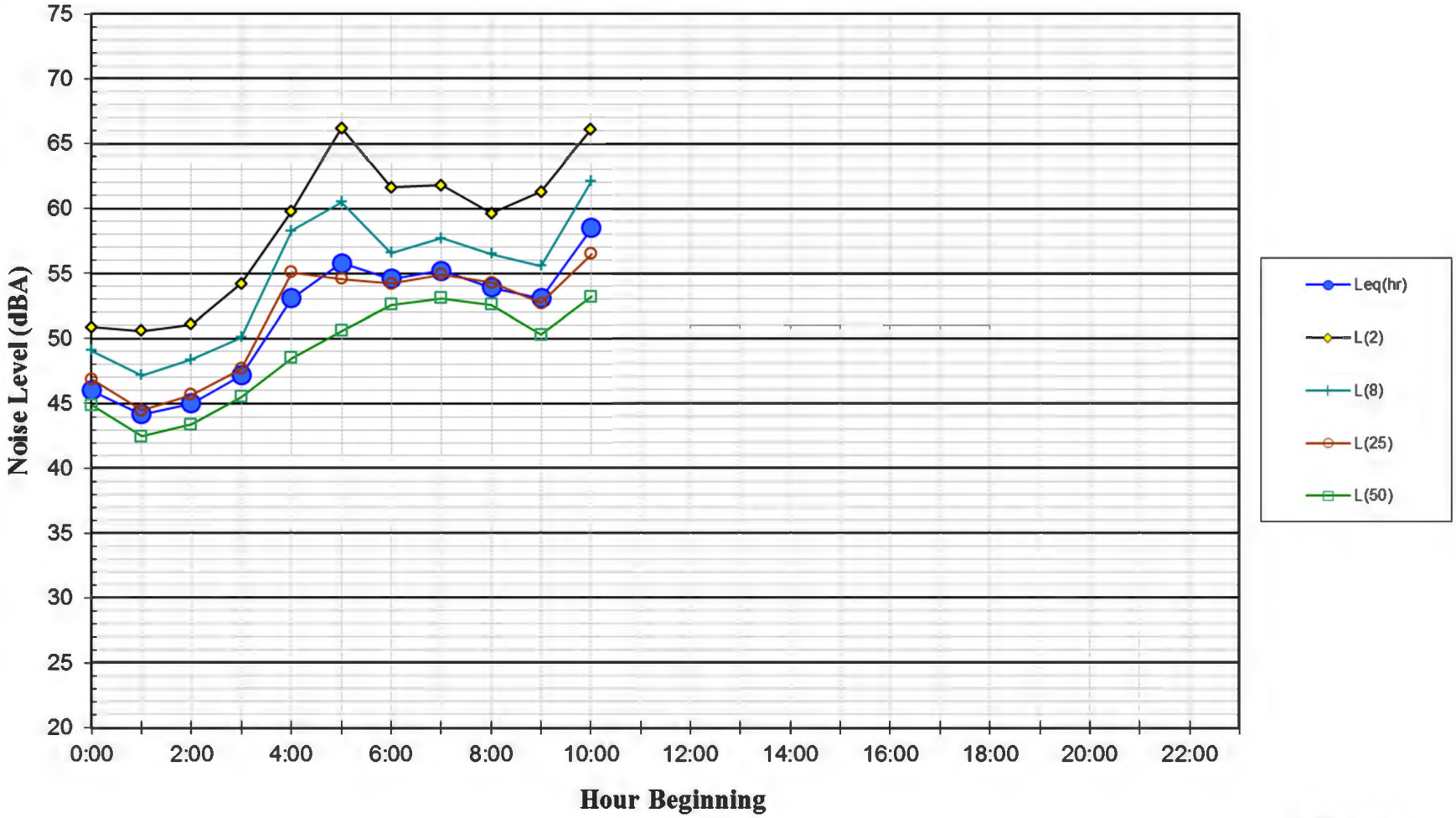


Figure 5

Noise Levels at LT-2
Langner Avenue Residences
Monday, October 10, 2016

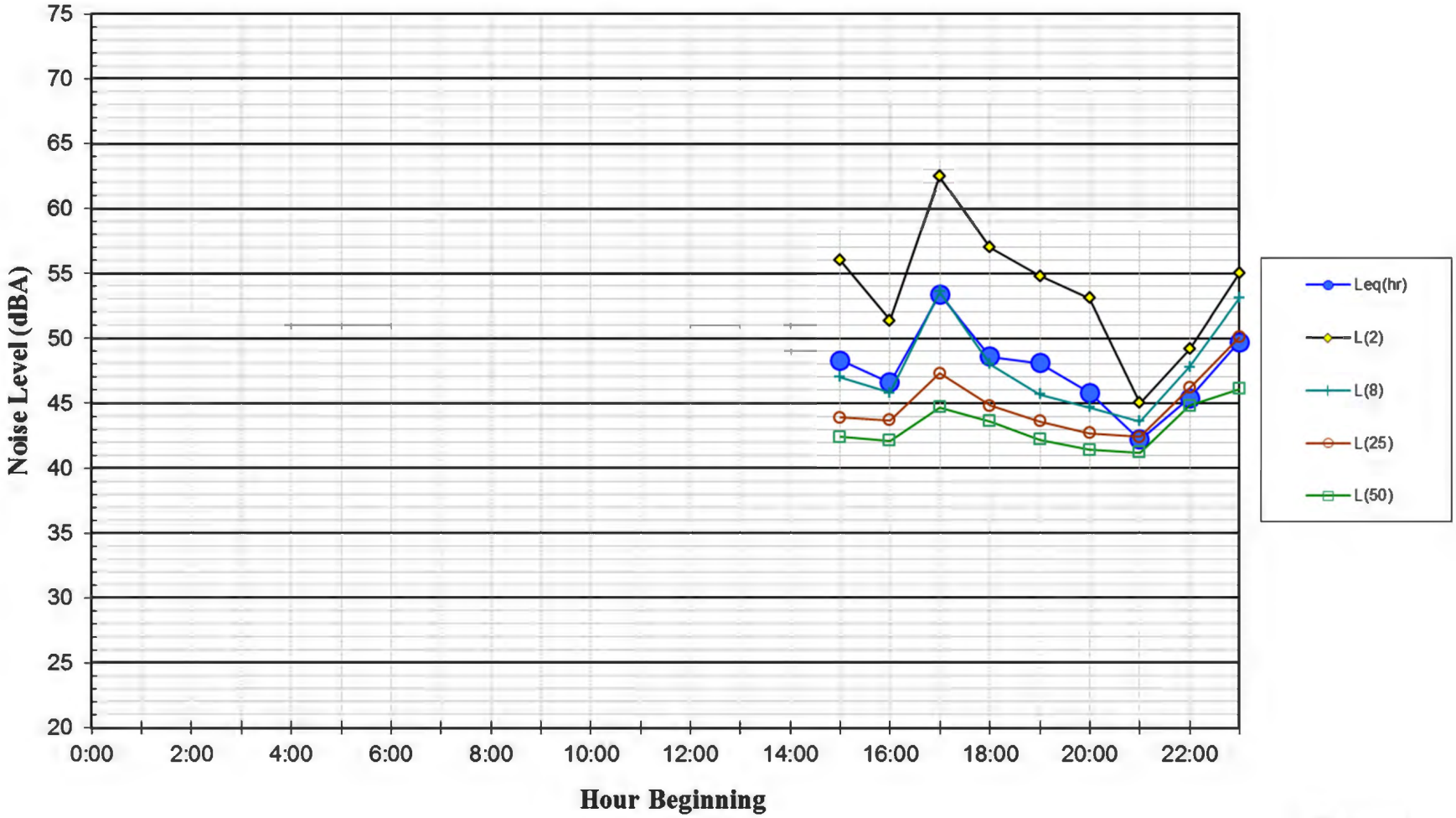
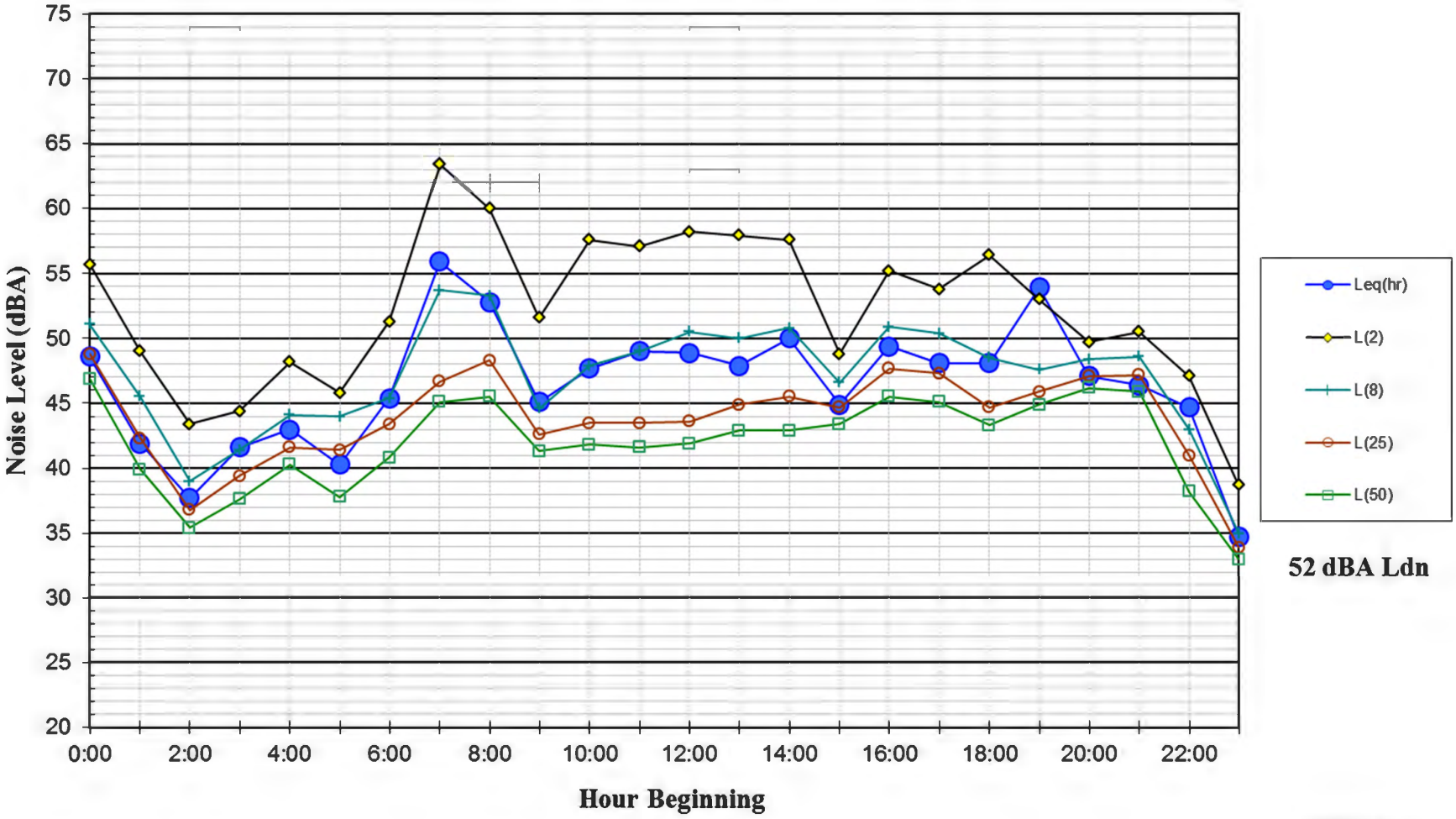


Figure 6

Noise Levels at LT-2
Langner Avenue Residences
Tuesday, October 11, 2016



52 dBA Ldn

Figure 7

Noise Levels at LT-2
Langner Avenue Residences
Wednesday, October 12, 2016

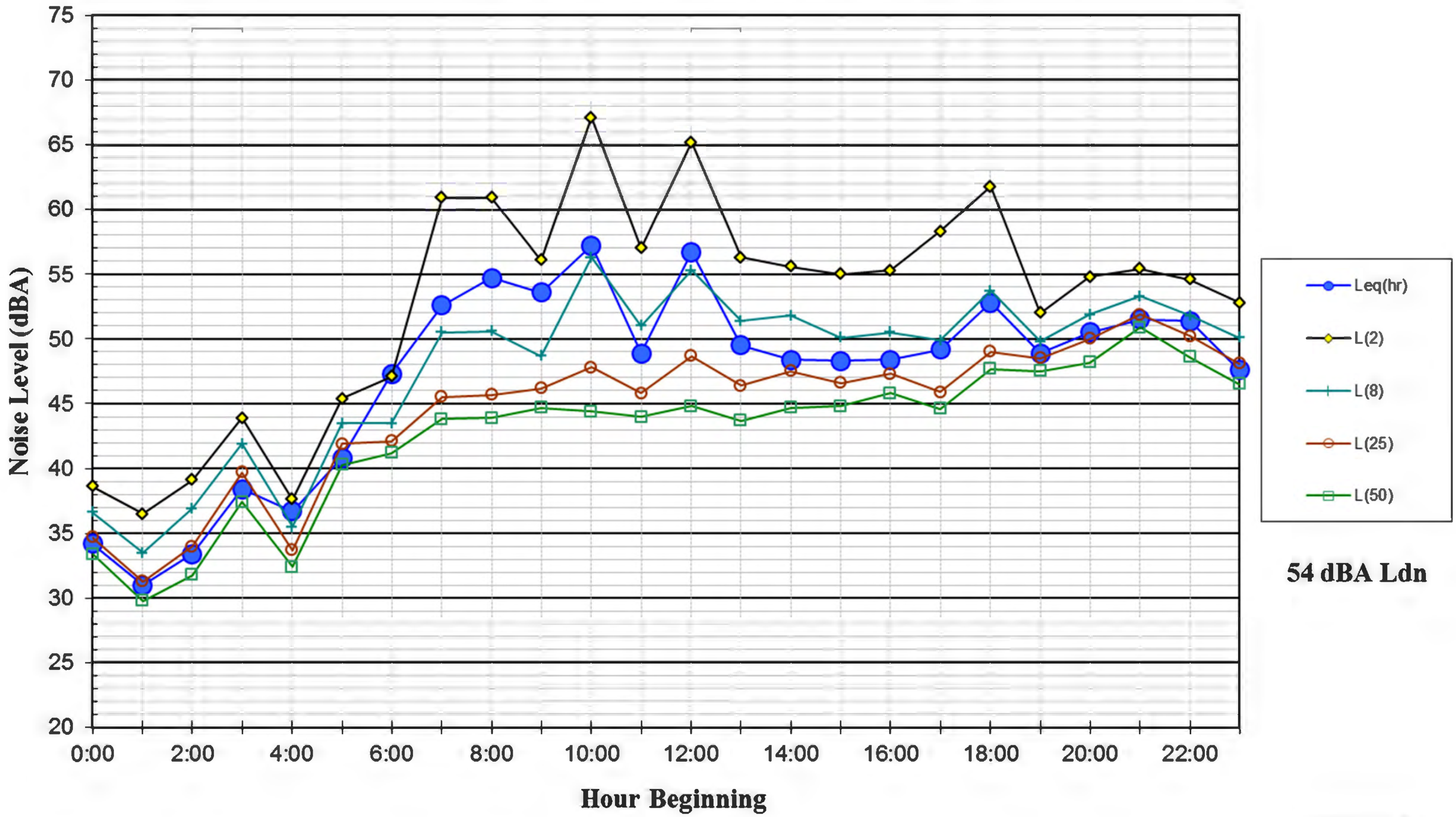


Figure 8

Noise Levels at LT-2
Langner Avenue Residences
Thursday, October 13, 2016

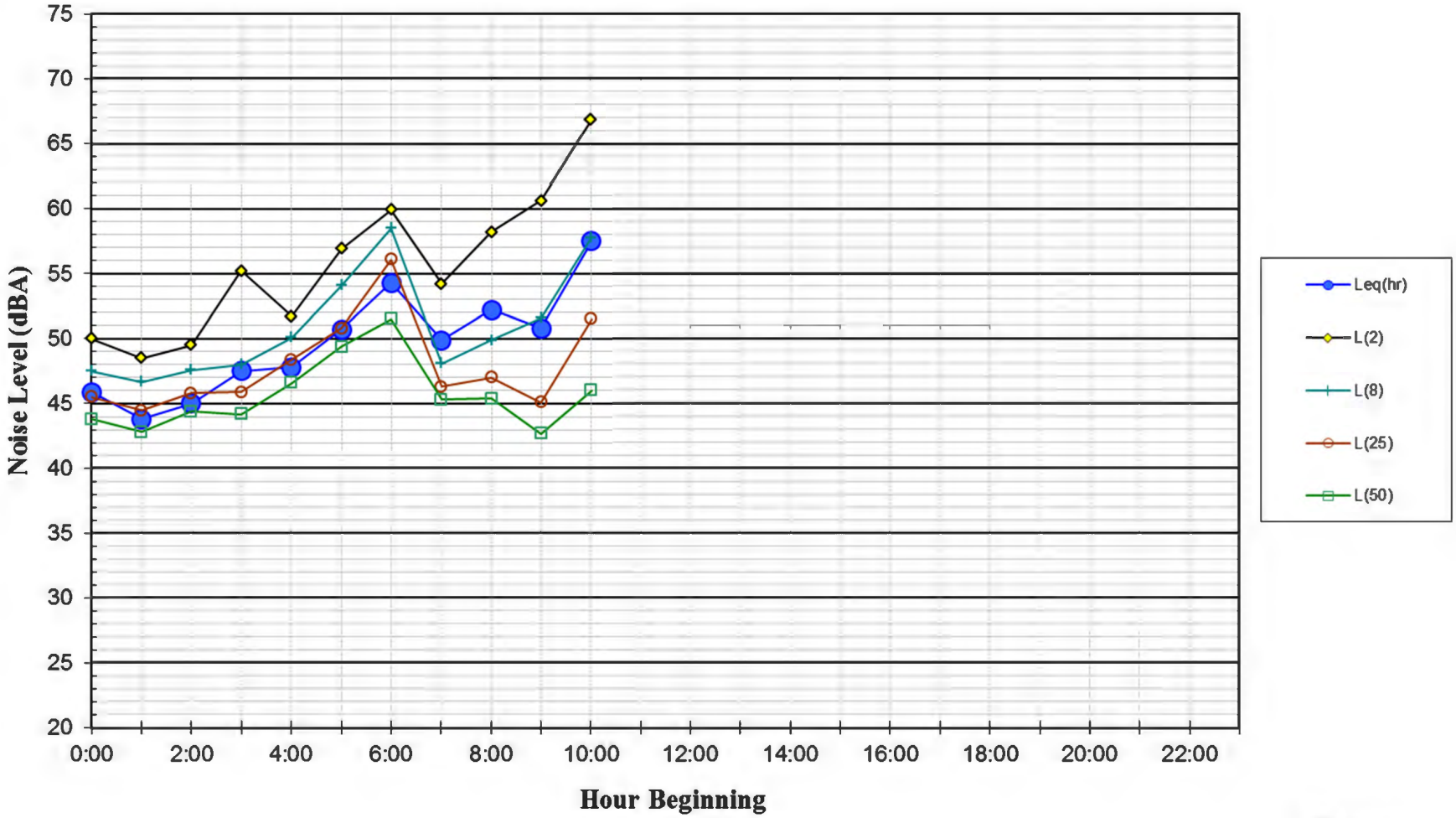


Figure 9

FIGURE 10 Grading Plan