Appendix C Noise Fundamentals

Appendix

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NOISE FUNDAMENTALS

Fundamentals of Noise

NOISE

Noise is most often defined as unwanted sound; whether it is loud, unpleasant, unexpected, or otherwise undesirable. Although sound can be easily measured, the perception of noise and the physical response to sound complicate the analysis of its impact on people. People judge the relative magnitude of sound sensation in subjective terms such as "noisiness" or "loudness."

Noise Descriptors

The following are brief definitions of terminology used in this chapter:

- **Sound.** A disturbance created by a vibrating object, which, when transmitted by pressure waves through a medium such as air, is capable of being detected by a receiving mechanism, such as the human ear or a microphone.
- **Noise.** Sound that is loud, unpleasant, unexpected, or otherwise undesirable.
- **Decibel (dB).** A unitless measure of sound, expressed on a logarithmic scale and with respect to a defined reference sound pressure. The standard reference pressure is 20 micropascals (20 μPa).
- **Vibration Decibel (VdB).** A unitless measure of vibration, expressed on a logarithmic scale and with respect to a defined reference vibration velocity. In the U.S., the standard reference velocity is 1 micro-inch per second ($1x10^{-6}$ in/sec).
- **A-Weighted Decibel (dBA).** An overall frequency-weighted sound level in decibels that approximates the frequency response of the human ear.
- **Equivalent Continuous Noise Level (L_{eq}); also called the Energy-Equivalent Noise Level.** The value of an equivalent, steady sound level which, in a stated time period (often over an hour) and at a stated location, has the same A-weighted sound energy as the time-varying sound. Thus, the L_{eq} metric is a single numerical value that represents the equivalent amount of variable sound energy received by a receptor over the specified duration.
- **Statistical Sound Level (L_n).** The sound level that is exceeded "n" percent of time during a given sample period. For example, the L_{50} level is the statistical indicator of the time-varying noise signal that is exceeded 50 percent of the time (during each sampling period); that is, half of the sampling time, the changing noise levels are above this value and half of the time they are below it. This is called the "median sound level." The L_{10} level, likewise, is the value that is exceeded 10 percent of the time (i.e., near the maximum) and this is often known as the "intrusive sound level." The L_{90} is the sound level exceeded 90 percent of the time and is often considered the "effective background level" or "residual noise level."

- **Maximum Sound Level (L_{max}).** The highest RMS sound level measured during the measurement period.
- **Root Mean Square Sound Level (RMS).** The square root of the average of the square of the sound pressure over the measurement period.
- **Day-Night Sound Level (L_{dn} or DNL).** The energy-average of the A-weighted sound levels occurring during a 24-hour period, with 10 dB added to the sound levels occurring during the period from 10:00 PM to 7:00 AM.
- **Community Noise Equivalent Level (CNEL).** The energy average of the A-weighted sound levels occurring during a 24-hour period, with 5 dB added from 7:00 PM to 10:00 PM and 10 dB from 10:00 PM to 7:00 AM. NOTE: For general community/environmental noise, CNEL and L_{dn} values rarely differ by more than 1 dB (with the CNEL being only slightly more restrictive – that is, higher than the L_{dn} value). As a matter of practice, L_{dn} and CNEL values are interchangeable and are treated as equivalent in this assessment.
- **Peak Particle Velocity (PPV).** The peak rate of speed at which soil particles move (e.g., inches per second) due to ground vibration.
- **Sensitive Receptor.** Noise- and vibration-sensitive receptors include land uses where quiet environments are necessary for enjoyment and public health and safety. Residences, schools, motels and hotels, libraries, religious institutions, hospitals, and nursing homes are examples.

Characteristics of Sound

When an object vibrates, it radiates part of its energy in the form of a pressure wave. Sound is that pressure wave transmitted through the air. Technically, airborne sound is a rapid fluctuation or oscillation of air pressure above and below atmospheric pressure that creates sound waves.

Sound can be described in terms of amplitude (loudness), frequency (pitch), or duration (time). Loudness or amplitude is measured in dB, frequency or pitch is measured in Hertz [Hz] or cycles per second, and duration or time variations is measured in seconds or minutes.

Amplitude

Unlike linear units such as inches or pounds, decibels are measured on a logarithmic scale. Because of the physical characteristics of noise transmission and perception, the relative loudness of sound does not closely match the actual amounts of sound energy. Table 1 presents the subjective effect of changes in sound pressure levels. Ambient sounds generally range from 30 dBA (very quiet) to 100 dBA (very loud). Changes of 1 to 3 dB are detectable under quiet, controlled conditions, and changes of less than 1 dB are usually not discernible (even under ideal conditions). A 3 dB change in noise levels is considered the minimum change that is detectable with human hearing in outside environments. A change of 5 dB is readily discernible to most people in an exterior environment, and a 10 dB change is perceived as a doubling (or halving) of the sound.

Table 1 Noise Perceptibility

Change in dB	Noise Level
± 3 dB	Barely perceptible increase
± 5 dB	Readily perceptible increase
± 10 dB	Twice or half as loud
± 20 dB	Four times or one-quarter as loud

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

Frequency

The human ear is not equally sensitive to all frequencies. Sound waves below 16 Hz are not heard at all, but are "felt" more as a vibration. Similarly, though people with extremely sensitive hearing can hear sounds as high as 20,000 Hz, most people cannot hear above 15,000 Hz. In all cases, hearing acuity falls off rapidly above about 10,000 Hz and below about 200 Hz.

When describing sound and its effect on a human population, A-weighted (dBA) sound levels are typically used to approximate the response of the human ear. The A-weighted noise level has been found to correlate well with people's judgments of the "noisiness" of different sounds and has been used for many years as a measure of community and industrial noise. Although the A-weighted scale and the energy-equivalent metric are commonly used to quantify the range of human response to individual events or general community sound levels, the degree of annoyance or other response also depends on several other perceptibility factors, including:

- Ambient (background) sound level
- General nature of the existing conditions (e.g., quiet rural or busy urban)
- Difference between the magnitude of the sound event level and the ambient condition
- Duration of the sound event
- Number of event occurrences and their repetitiveness
- Time of day that the event occurs

Duration

Time variation in noise exposure is typically expressed in terms of a steady-state energy level equal to the energy content of the time varying period (called L_{eq}), or alternately, as a statistical description of the sound level that is exceeded over some fraction of a given observation period. For example, the L_{50} noise level represents the noise level that is exceeded 50 percent of the time; half the time the noise level exceeds this level and half the time the noise level is less than this level. This level is also representative of the level that is exceeded 30 minutes in an hour. Similarly, the L_2, L_8 and L_{25} values represent the noise levels that are exceeded 2, 8, and 25 percent of the time or 1, 5, and 15 minutes per hour, respectively. These "n" values are typically used to demonstrate compliance for stationary noise sources with many cities' noise ordinances. Other values typically noted during a noise survey are the L_{min} and L_{max}. These values represent the minimum and maximum root-mean-square noise levels obtained over the measurement period, respectively.

Because community receptors are more sensitive to unwanted noise intrusion during the evening and at night, state law and many local jurisdictions use an adjusted 24-hour noise descriptor called the Community Noise Equivalent Level (CNEL) or Day-Night Noise Level (L_{dn}). The CNEL descriptor requires that an artificial increment (or "penalty") of 5 dBA be added to the actual noise level for the hours from 7:00 PM to 10:00

PM and 10 dBA for the hours from 10:00 PM to 7:00 AM. The L_{dn} descriptor uses the same methodology except that there is no artificial increment added to the hours between 7:00 PM and 10:00 PM. Both descriptors give roughly the same 24-hour level, with the CNEL being only slightly more restrictive (i.e., higher). The CNEL or L_{dn} metrics are commonly applied to the assessment of roadway and airport-related noise sources.

Sound Propagation

Sound dissipates exponentially with distance from the noise source. This phenomenon is known as "spreading loss." For a single-point source, sound levels decrease by approximately 6 dB for each doubling of distance from the source (conservatively neglecting ground attenuation effects, air absorption factors, and barrier shielding). For example, if a backhoe at 50 feet generates 84 dBA, at 100 feet the noise level would be 79 dBA, and at 200 feet it would be 73 dBA. This drop-off rate is appropriate for noise generated by on-site operations from stationary equipment or activity at a project site. If noise is produced by a line source, such as highway traffic, the sound decreases by 3 dB for each doubling of distance over a reflective ("hard site") surface such as concrete or asphalt. Line source noise in a relatively flat environment with ground-level absorptive vegetation decreases by an additional 1.5 dB for each doubling of distance.

Psychological and Physiological Effects of Noise

Physical damage to human hearing begins at prolonged exposure to noise levels higher than 85 dBA. Exposure to high noise levels affects the entire system, with prolonged noise exposure in excess of 75 dBA increasing body tensions, thereby affecting blood pressure and functions of the heart and the nervous system. Extended periods of noise exposure above 90 dBA results in permanent cell damage, which is the main driver for employee hearing protection regulations in the workplace. For community environments, the ambient or background noise problem is widespread, through generally worse in urban areas than in outlying, less-developed areas. Elevated ambient noise levels can result in noise interference (e.g., speech interruption/masking, sleep disturbance, disturbance of concentration) and cause annoyance. Since most people do not routinely work with decibels or A-weighted sound levels, it is often difficult to appreciate what a given sound pressure level number means. To help relate noise level values to common experience, Table 2 shows typical noise levels from familiar sources.

Table 2 Typical Noise Levels

Common Outdoor Activities	Noise Level (dBA)	Common Indoor Activities
Onset of physical discomfort	120+	
	110	Rock Band (near amplification system)
Jet Flyover at 1,000 feet		
	100	
Gas Lawn Mower at three feet		
	90	
Diesel Truck at 50 feet, at 50 mph		Food Blender at 3 feet
	80	Garbage Disposal at 3 feet
Noisy Urban Area, Daytime		
	70	Vacuum Cleaner at 10 feet
Commercial Area		Normal speech at 3 feet
Heavy Traffic at 300 feet	60	
		Large Business Office
Quiet Urban Daytime	50	Dishwasher Next Room
Quiet Urban Nighttime	40	Theater, Large Conference Room (background)
Quiet Suburban Nighttime		
	30	Library
Quiet Rural Nighttime		Bedroom at Night, Concert Hall (background)
	20	
		Broadcast/Recording Studio
	10	
Lowest Threshold of Human Hearing	0	Lowest Threshold of Human Hearing

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

Vibration Fundamentals

Vibration is an oscillatory motion through a solid medium in which the motion's amplitude can be described in terms of displacement, velocity, or acceleration. Vibration is normally associated with activities stemming from operations of railroads or vibration-intensive stationary sources, but can also be associated with construction equipment such as jackhammers, pile drivers, and hydraulic hammers. As with noise, vibration can be described by both its amplitude and frequency. Vibration displacement is the distance that a point on a surface moves away from its original static position; velocity is the instantaneous speed that a point on a surface moves; and acceleration is the rate of change of the speed. Each of these descriptors can be used to correlate vibration to human response, building damage, and acceptable equipment vibration levels. During construction, the operation of construction equipment can cause groundborne vibration. During the operational phase of a project, receptors may be subject to levels of vibration that can cause annoyance due to noise generated from vibration of a structure or items within a structure.

Vibration amplitudes are usually described in terms of either the peak particle velocity (PPV) or the root mean square (RMS) velocity. PPV is the maximum instantaneous peak of the vibration signal and RMS is the square root of the average of the squared amplitude of the signal. PPV is more appropriate for evaluating potential building damage and RMS is typically more suitable for evaluating human response.

As with airborne sound, annoyance with vibrational energy is a subjective measure, depending on the level of activity and the sensitivity of the individual. To sensitive individuals, vibrations approaching the threshold of perception can be annoying. Persons accustomed to elevated ambient vibration levels, such as in an urban environment, may tolerate higher vibration levels. Table 3 displays the human response and the effects on buildings resulting from continuous vibration (in terms of various levels of PPV).

Table 3 Human Reaction to Typical Vibration Levels

Vibration Level, PPV (in/sec)	Human Reaction	Effect on Buildings
0.006–0.019	Threshold of perception, possibility of intrusion	Vibrations unlikely to cause damage of any type
0.08	Vibrations readily perceptible	Recommended upper level of vibration to which ruins and ancient monuments should be subjected
0.10	Level at which continuous vibration begins to annoy people	Virtually no risk of “architectural” (i.e. not structural) damage to normal buildings
0.20	Vibrations annoying to people in buildings	Threshold at which there is a risk to “architectural” damage to normal dwelling – houses with plastered walls and ceilings
0.4–0.6	Vibrations considered unpleasant by people subjected to continuous vibrations and unacceptable to some people walking on bridges	Vibrations at a greater level than normally expected from traffic, but would cause “architectural” damage and possibly minor structural damage

Source: California Department of Transportation (Caltrans). 2020, April. *Transportation and Construction Vibration Guidance Manual.* Prepared by ICF International.

NOISE MONITORING DATA

Measurement Report

Report Summary

Meter's File Name	LxT_Data.064.s	Computer's File Name	LxT_0005424-20250319 163353-LxT_Data.064.ldbin
Meter	LxT1 0005424	Firmware	2.404
User	AC	Location	ST-1
Job Description	HBCS-7.0		
Note			

Start Time	2025-03-19 17:33:53	Duration	0:15:00.0		
End Time	2025-03-19 17:48:53	Run Time	0:15:00.0	Pause Time	0:00:00.0
Pre-Calibration	2025-03-19 14:46:02	Post-Calibration	None	Calibration Deviation	---

Results

Overall Metrics

LA_{eq}	55.2 dB		
LAE	84.7 dB	SEA	--- dB
EA	33.1 µPa²h		
EA8	1.1 mPa²h		
EA40	5.3 mPa²h		
LAS_{peak}	92.6 dB	2025-03-19 17:34:46	
LAS_{max}	72.5 dB	2025-03-19 17:34:46	
LAS_{min}	48.6 dB	2025-03-19 17:44:27	
LA_{eq}	55.2 dB		
LC_{eq}	64.3 dB	LC_{eq} - LA_{eq}	9.1 dB
LAI_{eq}	60.0 dB	LAI_{eq} - LA_{eq}	4.8 dB

Exceedances

	Count	Duration
LAS > 85.0 dB	0	0:00:00.0
LAS > 115.0 dB	0	0:00:00.0
LASpk > 135.0 dB	0	0:00:00.0
LASpk > 137.0 dB	0	0:00:00.0
LASpk > 140.0 dB	0	0:00:00.0

Community Noise

LDN	LDay	LNight	
--- dB	--- dB	0.0 dB	
LDEN	**LDay**	**LEve**	**LNight**
--- dB	--- dB	--- dB	--- dB

Any Data

	A		C		Z	
	Level	Time Stamp	Level	Time Stamp	Level	Time Stamp
L_{eq}	55.2 dB		--- dB		--- dB	
$LS_{(max)}$	72.5 dB	2025-03-19 17:34:46	--- dB	None	--- dB	None
$LS_{(min)}$	48.6 dB	2025-03-19 17:44:27	--- dB	None	--- dB	None
$L_{Peak(max)}$	92.6 dB	2025-03-19 17:34:46	--- dB	None	--- dB	None

Overloads

Count	Duration
0	0:00:00.0

Statistics

LAS 2.0	60.1 dB
LAS 8.0	57.2 dB
LAS 25.0	55.0 dB
LAS 50.0	53.3 dB
LAS 90.0	50.9 dB
LAS 99.0	49.6 dB

*

Project Name: ______

Date: 3/19/25

Project Number: HBCS-7.0

Monitoring Personnel: AC

Monitoring Site #: ST #1

Time Start: 5:34 End: 5:49

Site Location/Address: Rear Alley/acess Road of 8132 ; 8122 Indianapolis Ave.

Primary Noise Source: Soccer practice (yelling, whistle, hitting soccer ball), Vehicle ; motorcycle traffic in the distance @ SR-39

Measurement Results	
Percentiles	dBA
Leq	55.2
Lmax	72.5
Lmin	48.6
L2	60.1
L8	57.2
L25	55.0
L50	53.3
Other	-
SEL/CNEL	

Observed Noise Sources/Events		
Time	Noise Source Event	dBA
5:34	Car drove by alley	72

Data File: 64 ☒ Photos: Yes

Comments (sound walls, height, etc..) 6 ft cinder block wall to the rear; 61.8m from 6ft raised walk way / wall (Drainage channel) west with aprox 3ft steel walls

Max Wind Velocity (knots/hr)	Average Wind Velocity (knots/hr)	Temperature (F)	Relative Humidity (%)
	9 mph	68	40%

Traffic counts in both directions:

Roadway	# Lanes	Posted Speed	Autos	MD	HD

Calibration

Note, for ST measurements, calibration is only necessary before and after each monitoring period per day per meter - not before and after every ST measurement in that day. So only fill out calibration info on one ST sheet unless using two different meters for ST's.

LD CAL 200 ☐ SN-14280 ☒ SN-14279

1 kHz Tone Reference Level: ☒ 94 dB ☐ 114 dB

Calibration Offset Prior: -0.73

Offset After: 94 dB

Caltone File Before: File #________

Caltone File Before: File #________

Additional Notes:

Measurement Report

Report Summary

Meter's File Name	LxT_Data.065.s	Computer's File Name	LxT_0005424-20250319 165536-LxT_Data.065.ldbin
Meter	LxT1 0005424	Firmware	2.404
User	AC	Location	ST-2
Job Description	HBCS -7.0		
Note			

Start Time	2025-03-19 17:55:36	Duration	0:15:00.0		
End Time	2025-03-19 18:10:36	Run Time	0:15:00.0	Pause Time	0:00:00.0
Pre-Calibration	2025-03-19 16:46:02	Post-Calibration	None	Calibration Deviation	---

Results

Overall Metrics

LA_{eq}	53.9 dB		
LAE	83.4 dB	SEA	--- dB
EA	24.5 µPa²h		
EA8	785.5 µPa²h		
EA40	3.9 mPa²h		
LAS_{peak}	89.0 dB	2025-03-19 18:06:48	
LAS_{max}	63.7 dB	2025-03-19 18:00:03	
LAS_{min}	47.3 dB	2025-03-19 18:07:21	
LA_{eq}	53.9 dB		
LC_{eq}	66.1 dB	LC_{eq} - LA_{eq}	12.2 dB
LAI_{eq}	56.0 dB	LAI_{eq} - LA_{eq}	2.1 dB

Exceedances

	Count	Duration
LAS > 85.0 dB	0	0:00:00.0
LAS > 115.0 dB	0	0:00:00.0
LASpk > 135.0 dB	0	0:00:00.0
LASpk > 137.0 dB	0	0:00:00.0
LASpk > 140.0 dB	0	0:00:00.0

Community Noise

LDN	LDay	LNight	
--- dB	--- dB	0.0 dB	
LDEN	**LDay**	**LEve**	**LNight**
--- dB	--- dB	--- dB	--- dB

Any Data

	A		C		Z	
	Level	Time Stamp	Level	Time Stamp	Level	Time Stamp
L_{eq}	53.9 dB		--- dB		--- dB	
$L_{S(max)}$	63.7 dB	2025-03-19 18:00:03	--- dB	None	--- dB	None
$L_{S(min)}$	47.3 dB	2025-03-19 18:07:21	--- dB	None	--- dB	None
$L_{Peak(max)}$	89.0 dB	2025-03-19 18:06:48	--- dB	None	--- dB	None

Overloads

Count	Duration
0	0:00:00.0

Statistics

LAS 2.0	60.4 dB
LAS 8.0	56.9 dB
LAS 25.0	54.6 dB
LAS 50.0	52.1 dB
LAS 90.0	49.4 dB
LAS 99.0	47.9 dB

Project Name: ______

Date: 3/19/25

Project Number: HBCS - 7.0

Monitoring Personnel: [illegible]C

Monitoring Site #: ST-2

Time Start: 5:55 End: 6:10

Site Location/Address: At the end of the Driftwood Drive cul-de-sac

Primary Noise Source: Distant Vehicle noise on Beach Boulevard/State Route 39 (SR39); nearby house work (hammer hitting/Drill (etc))

Measurement Results	
Percentiles	dBA
Leq	53.9
Lmax	63.7
Lmin	47.3
L2	60.4
L8	56.9
L25	54.6
L50	52.1
Other	
SEL/CNEL	

Observed Noise Sources/Events		
Time	Noise Source Event	dBA
6:00 pm	Small plane overhead	63

Data File: 65 ☒ Photos: yes

Comments (sound walls, height, etc..) 6 ft raised walkway / wall on drainage channel

Max Wind Velocity (knots/hr)	Average Wind Velocity (knots/hr)	Temperature (F)	Relative Humidity (%)
	9mph	68	40%

Traffic counts in both directions:

Roadway	# Lanes	Posted Speed	Autos	MD	HD

Calibration

Note, for ST measurements, calibration is only necessary before and after each monitoring period per day per meter - not before and after every ST measurement in that day. So only fill out calibration info on one ST sheet unless using two different meters for ST's.

LD CAL 200 ☐ SN-14280 ☒ SN-14279

1 kHz Tone Reference Level: ☒ 94 dB ☐ 114 dB

Calibration Offset Prior: -0.73

Offset After: 94dB

Caltone File Before: File #________

Caltone File Before: File #________

Additional Notes:

Measurement Report

Report Summary

Meter's File Name	LxT_Data.062.s	Computer's File Name	LxT_0005424-20250319 155351-LxT_Data.062.ldbin
Meter	LxT1 0005424	Firmware	2.404
User	AC	Location	ST-3
Job Description	HBCS-7.0		
Note			

Start Time	2025-03-19 16:53:51	Duration	0:15:00.0		
End Time	2025-03-19 17:08:51	Run Time	0:15:00.0	Pause Time	0:00:00.0
Pre-Calibration	2025-03-19 16:46:22	Post-Calibration	None	Calibration Deviation	---

Results

Overall Metrics

LA_{eq}	56.8 dB		
LAE	86.3 dB	SEA	--- dB
EA	47.9 µPa²h		
EA8	1.5 mPa²h		
EA40	7.7 mPa²h		
LAS_{peak}	87.3 dB	2025-03-19 16:54:49	
LAS_{max}	68.0 dB	2025-03-19 17:06:55	
LAS_{min}	48.1 dB	2025-03-19 16:56:29	
LA_{eq}	56.8 dB		
LC_{eq}	67.1 dB	LC_{eq} - LA_{eq}	10.3 dB
LAI_{eq}	59.8 dB	LAI_{eq} - LA_{eq}	3.0 dB

Exceedances

	Count	Duration
LAS > 85.0 dB	0	0:00:00.0
LAS > 115.0 dB	0	0:00:00.0
LASpk > 135.0 dB	0	0:00:00.0
LASpk > 137.0 dB	0	0:00:00.0
LASpk > 140.0 dB	0	0:00:00.0

Community Noise

LDN	LDay	LNight	
--- dB	--- dB	0.0 dB	
LDEN	**LDay**	**LEve**	**LNight**
--- dB	--- dB	--- dB	--- dB

Any Data

	A		C		Z	
	Level	Time Stamp	Level	Time Stamp	Level	Time Stamp
L_{eq}	56.8 dB		--- dB		--- dB	
$L_{S(max)}$	68.0 dB	2025-03-19 17:06:55	--- dB	None	--- dB	None
$L_{S(min)}$	48.1 dB	2025-03-19 16:56:29	--- dB	None	--- dB	None
$L_{Peak(max)}$	87.3 dB	2025-03-19 16:54:49	--- dB	None	--- dB	None

Overloads

Count	Duration
0	0:00:00.0

Statistics

LAS 2.0	64.4 dB
LAS 8.0	61.3 dB
LAS 25.0	57.2 dB
LAS 50.0	53.6 dB
LAS 90.0	50.3 dB
LAS 99.0	48.6 dB

Project Name: ____________________

Date: 3/14/2025

Project Number: HBCS-7.0

Monitoring Personnel: AC

Monitoring Site #: ST #3

Time Start: 4:53 End: 5:04

Site Location/Address: At the courner of Reilly & Farnsworth courner of 8231 Reilly Drive

Primary Noise Source: Infrequent vehicle traffic into the campus parking lot for soccer practice; distant children noise, soccer practice, e-bikes

Measurement Results	
Percentiles	dBA
Leq	56.8
Lmax	68.0
Lmin	48.1
L2	64.4
L8	61.3
L25	57.2
L50	53.6
Other	
SEL/CNEL	

Observed Noise Sources/Events		
Time	Noise Source Event	dBA
5:04	Tar Truck drove by	67.9

Data File: 62 ☒ Photos: yes

Comments (sound walls, height, etc..) ____________________

Max Wind Velocity (knots/hr)	Average Wind Velocity (knots/hr)	Temperature (F)	Relative Humidity (%)
	9mph	70°	33%

Traffic counts in both directions:

Roadway	# Lanes	Posted Speed	Autos	MD	HD

Calibration

Note, for ST measurements, calibration is only necessary before and after each monitoring period per day per meter - not before and after every ST measurement in that day. So only fill out calibration info on one ST sheet unless using two different meters for ST's.

LD CAL 200 ☐ SN-14280 ☒ SN-14279

1 kHz Tone Reference Level: ☒ 94 dB ☐ 114 dB

Calibration Offset Prior: -0.73

Offset After: 94 dB

Caltone File Before: File #________

Caltone File Before: File #________

Additional Notes:

HBCS-07.0- Construction Noise Modeling Attenuation Calculations

		Levels in dBA Leq			
Phase	**RCNM Reference Noise Level**	**Receptor to North**	**Receptor to East**	**Receptor to South**	**Receptor to West**
Distance in feet	*50*	*180*	*600*	*800*	*240*
Site Prep	80	69	58	56	66
Distance in feet	*50*	*30*	*425*	*740*	*95*
Light Pole Installation	73	77	54	50	67
Paving	77	81	58	54	71
Distance in feet	*50*	*30*	*420*	*740*	*95*
Utility Trenching	77	81	59	54	71

Attenuation calculated through Inverse Square Law: Lp(R2) = Lp(R1) - 20Log(R2/R1)

HBCS-07.0 - Vibration Annoyance Attenuation Calculations

Levels in VdB

Equipment *Distance in feet*	Vibration @ 25 ft	Receptor to North *50*	Receptor to East *440*	Receptor to South *780*	Receptor to West *115*
Large Bulldozer	87	78	50	42	67
Caisson Drilling	87	78	50	42	67
Loaded Trucks	86	77	49	41	66
Jackhammer	79	70	42	34	59
Small Bulldozer	58	49	21	13	38

HBCS-07.0 - Vibration Damage Attenuation Calculations

		Levels, PPV (in/sec)			
	Vibration Reference Level	**Receptor to North**	**Receptor to East**	**Receptor to South**	**Receptor to West**
Distance in feet	**at *25 feet***	*50*	*440*	*780*	*115*
Large Bulldozer	0.089	0.031	0.001	0.001	0.009
Caisson Drilling	0.089	0.031	0.001	0.001	0.009
Loaded Trucks	0.076	0.027	0.001	0.000	0.008
Jackhammer	0.035	0.012	0.000	0.000	0.004
Small Bulldozer	0.003	0.001	0.000	0.000	0.000

Roadway Construction Noise Model (RCNM),Version 1.1

Report date: 07/21/2025
Case Description: HBCS-07.0 Site Preparation

**** Receptor #1 ****

		Baselines (dBA)		
Description	Land Use	Daytime	Evening	Night
Receptor at 50 ft	Residential	55.0	55.0	50.0

Equipment

Description	Impact Device	Usage (%)	Spec Lmax (dBA)	Actual Lmax (dBA)	Receptor Distance (feet)	Estimated Shielding (dBA)
Scraper	No	40		83.6	50.0	0.0

Results

	Calculated (dBA)		Noise Limits (dBA)						Noise Limit Exceedance (dBA)					
			Day		Evening		Night		Day		Evening		Night	
Equipment	Lmax	Leq	Lmax	Leq	Lmax	Leq	Lmax	Leq	Lmax	Leq	Lmax	Leq	Lmax	Leq
Scraper	83.6	79.6	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Total	83.6	79.6	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

Roadway Construction Noise Model (RCNM),Version 1.1

Report date: 07/21/2025
Case Description: HBCS-07.0 Utility Trenching

**** Receptor #1 ****

Description	Land Use	Baselines (dBA) Daytime	Evening	Night
Receptor at 50 ft	Residential	70.0	65.0	60.0

Equipment

Description	Impact Device	Usage (%)	Spec Lmax (dBA)	Actual Lmax (dBA)	Receptor Distance (feet)	Estimated Shielding (dBA)
Drill Rig Truck	No	20		79.1	50.0	0.0
Front End Loader	No	40		79.1	50.0	0.0

Results

	Calculated (dBA)		Noise Limits (dBA)						Noise Limit Exceedance (dBA)					
			Day		Evening		Night		Day		Evening		Night	
Equipment	Lmax	Leq	Lmax	Leq	Lmax	Leq	Lmax	Leq	Lmax	Leq	Lmax	Leq	Lmax	Leq
Drill Rig Truck	79.1	72.2	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Front End Loader	79.1	75.1	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Total	79.1	76.9	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

Roadway Construction Noise Model (RCNM),Version 1.1

Report date: 07/21/2025
Case Description: HBCS-07.0 Field Lighting

**** Receptor #1 ****

Description	Land Use	Baselines (dBA) Daytime	Evening	Night
Receptor at 50 ft	Residential	65.0	60.0	55.0

Equipment

Description	Impact Device	Usage (%)	Spec Lmax (dBA)	Actual Lmax (dBA)	Receptor Distance (feet)	Estimated Shielding (dBA)
Crane	No	16		80.6	50.0	0.0

Results

	Calculated (dBA)		Noise Limits (dBA) Day		Evening		Night		Noise Limit Exceedance (dBA) Day		Evening		Night	
Equipment	Lmax	Leq	Lmax	Leq	Lmax	Leq	Lmax	Leq	Lmax	Leq	Lmax	Leq	Lmax	Leq
Crane	80.6	72.6	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Total	80.6	72.6	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

Roadway Construction Noise Model (RCNM),Version 1.1

Report date: 07/21/2025
Case Description: HBCS-07.0 Paving

**** Receptor #1 ****

Description	Land Use	Baselines (dBA) Daytime	Evening	Night
Receptor at 50 ft	Residential	65.0	60.0	55.0

Equipment

Description	Impact Device	Usage (%)	Spec Lmax (dBA)	Actual Lmax (dBA)	Receptor Distance (feet)	Estimated Shielding (dBA)
Drum Mixer	No	50		80.0	50.0	0.0

Results

	Calculated (dBA)		Noise Limits (dBA)						Noise Limit Exceedance (dBA)					
			Day		Evening		Night		Day		Evening		Night	
Equipment	Lmax	Leq	Lmax	Leq	Lmax	Leq	Lmax	Leq	Lmax	Leq	Lmax	Leq	Lmax	Leq
Drum Mixer	80.0	77.0	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Total	80.0	77.0	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

Traffic Noise Calculator: FHWA 77-108 **Peterson School Lighting (HBCS-07) Existing Traffic Noise Traffic Conditions**

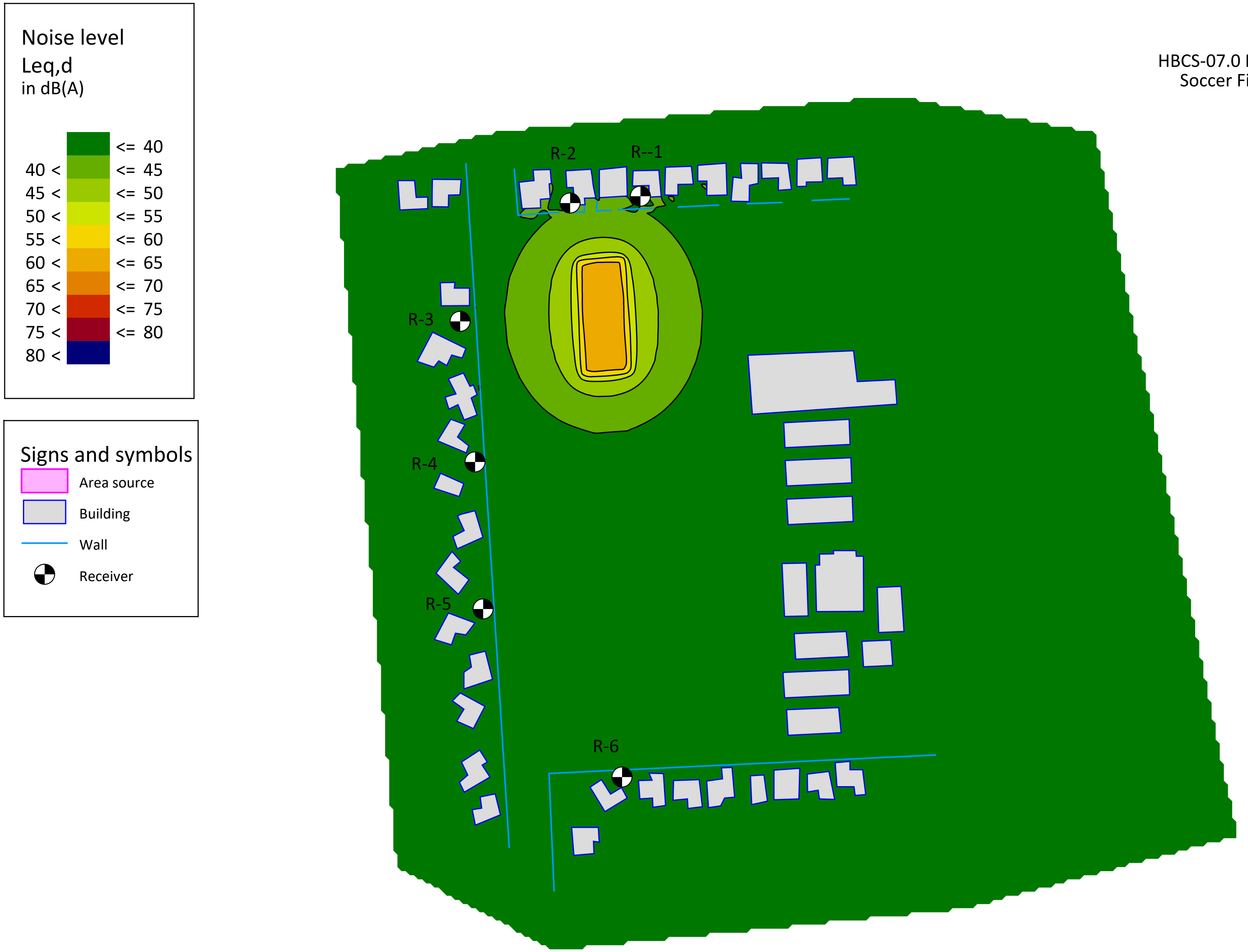
	Output						Inputs															Auto Inputs	
	dBA at 50 feet			Distance to CNEL Contour																			
ID	$L_{eq\text{-}24hr}$	L_{dn}	CNEL	70 dBA	65 dBA	60 dBA	Roadway	Segment From - To		ADT	Posted Speed Limit	Grade	% Autos	% Med Trucks	% Heavy Trucks	% Daytime	% Evening	% Night	Number of Lanes	Site Condition	Distance to Reciever	Ground Absorption	Lane Distance
1	60.9	63.7	64.4	21	45	98	Indinanapolis Ave	Beach Blvd	Farnsworth Lane	6,518	35	0.0%	96.0%	2.5%	1.5%	75.0%	15.0%	10.0%	3	Soft	50	0.5	32
2	60.6	63.4	64.1	20	44	94	Indinanapolis Ave	Kilkenny Lane	Newland Street	6,163	35	0.0%	96.0%	2.5%	1.5%	75.0%	15.0%	10.0%	3	Soft	50	0.5	32
3	52.0	54.8	55.5	5	12	25	Farnsworth Lane	Indianapolis Ave	to the South	1,685	25	0.0%	96.0%	2.5%	1.5%	75.0%	15.0%	10.0%	2	Soft	50	0.5	20

Traffic Noise Calculator: FHWA 77-108

Peterson School Lighting (HBCS-07) Existing Traffic Noise With Project Traffic Conditions

	Output						Inputs																Auto Inputs	
	dBA at 50 feet			Distance to CNEL Contour																				
ID	$L_{eq\text{-}24hr}$	L_{dn}	CNEL	70 dBA	65 dBA	60 dBA	Roadway	Segment From - To		ADT	Posted Speed Limit	Grade	% Autos	% Med Trucks	% Heavy Trucks	% Daytime	% Evening	% Night	Number of Lanes	Site Condition	Distance to Reciever		Ground Absorption	Lane Distance
1	61.0	63.7	64.4	21	46	99	Indinanapolis Ave	Beach Blvd	Farnsworth Lane	6,619	35	0.0%	96.0%	2.5%	1.5%	75.0%	15.0%	10.0%	3	Soft	50		0.5	32
2	60.7	63.5	64.2	20	44	95	Indinanapolis Ave	Kilkenny Lane	Newland Street	6,261	35	0.0%	96.0%	2.5%	1.5%	75.0%	15.0%	10.0%	3	Soft	50		0.5	32
3	52.3	55.0	55.7	6	12	26	Farnsworth Lane	Indianapolis Ave	to the South	1,774	25	0.0%	96.0%	2.5%	1.5%	75.0%	15.0%	10.0%	2	Soft	50		0.5	20

HBCS-07.0 Proposed Project
Soccer Field Noise Contours



Peterson Elementary Lighting Project
Assessed receiver levels
HBCS-07.0 Proposed Project

Receiver	Usage	Fl	Leq,d dB(A)	Leq,n dB(A)	
R1	SCR	G	40.6	40.6	
R2	SCR	G	39.5	39.5	
R3	SCR	G	36.6	36.6	
R4	SCR	G	34.1	34.1	
R5	SCR	G	29.2	29.2	
R6	SCR	G	25.2	25.2	

Peterson Elementary Lighting Project
Contribution level - HBCS-07.0 Proposed Project

Source	Source group	Source ty	Leq,d dB(A)	Leq,n dB(A)
Receiver R1 Fl G dB(A) Lr,lim dB(A) Lr,lim dB(A) Ldn 47.0 dB(A) Leq,d 40.6 dB(A) Leq,n 40.6 dB(A)				
Soccer Field 1	Default industrial noise	Area	40.6	40.6
Receiver R2 Fl G dB(A) Lr,lim dB(A) Lr,lim dB(A) Ldn 45.9 dB(A) Leq,d 39.5 dB(A) Leq,n 39.5 dB(A)				
Soccer Field 1	Default industrial noise	Area	39.5	39.5
Receiver R3 Fl G dB(A) Lr,lim dB(A) Lr,lim dB(A) Ldn 43.0 dB(A) Leq,d 36.6 dB(A) Leq,n 36.6 dB(A)				
Soccer Field 1	Default industrial noise	Area	36.6	36.6
Receiver R4 Fl G dB(A) Lr,lim dB(A) Lr,lim dB(A) Ldn 40.5 dB(A) Leq,d 34.1 dB(A) Leq,n 34.1 dB(A)				
Soccer Field 1	Default industrial noise	Area	34.1	34.1
Receiver R5 Fl G dB(A) Lr,lim dB(A) Lr,lim dB(A) Ldn 35.6 dB(A) Leq,d 29.2 dB(A) Leq,n 29.2 dB(A)				
Soccer Field 1	Default industrial noise	Area	29.2	29.2
Receiver R6 Fl G dB(A) Lr,lim dB(A) Lr,lim dB(A) Ldn 31.6 dB(A) Leq,d 25.2 dB(A) Leq,n 25.2 dB(A)				
Soccer Field 1	Default industrial noise	Area	25.2	25.2

Peterson Elementary Lighting Project
Octave spectra of the sources in dB(A) - HBCS-07.0 Proposed Project

3

Name	Source type	I or A m,m²	L'w dB(A)	Lw dB(A)	KI dB	KT dB	Day histogram	Emission spectrum	500Hz dB(A)
Soccer Field 1	Area	31413.90	56.0	101.0	0.0	0.0	100%/24h	Public soccer grounds	101.0