Acoustic Assessment

Cranberry Point Energy Storage Project

Cranberry Point Energy Storage, LLC

August 27, 2021

Prepared for:

Cranberry Point Energy Storage, LLC

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Acronyms and Abbreviations

°F	degrees Fahrenheit
BESS	battery energy storage system
contour	sound isopleth
Cranberry Point	Cranberry Point Energy Storage, LLC (the Company)
LT	long term
Lw	sound power level
MassDEP	Massachusetts Department of Environmental Protection
PL	property line
project	Cranberry Point Energy Storage Project
SLM	sound level meter
SPL	sound pressure level

1. Introduction

Cranberry Point Energy Storage, LLC (the “Company” or “Cranberry Point”) proposes to construct a 150 MW/300 MWh battery energy storage system with ancillary structures (e.g., transformers, substation, low voltage/medium voltage equipment), at 31-R Main Street in Carver, Massachusetts. The Cranberry Point Energy Storage Project (project) will store electricity during times of oversupply, and during times of peak demand, will dispatch the electricity onto the electric grid. This function will serve as a valuable addition to the electricity system by using lower-cost energy stored during off-peak periods to meet peak demand, providing flexibility to optimize the use of other clean, intermittent renewable resources and deferring future traditional generation and transmission projects while avoiding and even offsetting their environmental impacts.

1.1 Project Design

The project will use lithium-ion batteries, which will be in approximately 116 above-ground enclosures on an approximately 6-acre parcel of undeveloped land (currently under Option contract with the Company) to be leased by the Company. The project will interconnect directly adjacent to an Eversource substation (No. 276), via a new 115 kV, three-breaker ring station, which will tap into the existing transmission line #127, requiring installation of two new dead-end structures between existing structures. The existing approximately 530-foot-long gravel access driveway from Main Street to the project site will be improved to a width of 20 feet. An existing gravel access road approximately 20 feet wide and 25 feet long will be extended further south on the east side of the project site, to allow emergency vehicle access.

1.2 Nearest Noise-Sensitive Receptors

The acoustic assessment analyzed baseline ambient noise levels and predicted project operational noise levels at the four closest noise-sensitive receptor property lines (PLs) to the project site. The studied receptors are summarized in Table 1.

Table 1. Studied Noise-Sensitive Property Lines

Modeled Receiver ID	Receptor Address	Receptor Type	Distance from Closest Project Noise Source (feet)
PL-1	19 Craig St., Carver, MA	Single-Family Residence	555
PL-2	20 Craig St., Carver, MA	Single-Family Residence	200
PL-3	31 Main St., Carver, MA	Single-Family Residence	485
PL-4	45 Main St., Carver, MA	Single-Family Residence	530

Figure 1 shows the project site layout and studied nearest noise-sensitive property lines overlaid on aerial imagery.

Sources: Google Imagery 2021; MassGIS 2021

Figure 1 Project Site Overview and Nearest Noise-Sensitive Property Lines

1.3 Acoustical Terminology

A summary of relevant fundamental concepts and a glossary of terms related to noise and vibration are provided in Appendix A.

Key acoustical terms used in this report are as follows:

- **dB**: decibels; used to express the sound level magnitude.
- **dBA**: A-weighted decibels; a frequency spectrum filter applied to more closely reflect the sensitivities of the human ear.
- **L_{90}**: A sound level exceeded for 90 percent of a measurement period. The L_{90} commonly is called the "background" level because it typically represents the acoustical contribution from continuous or "steady-state" sound sources and the perceived indistinct din of background sound from the amalgamation of many contributing distant sound sources in the environment.
- **L_w**: sound power level; defined colloquially as the inherent acoustic energy generated by a noise source (e.g., absent of environmental factors, distance).
- **SPL**: sound pressure level, defined colloquially as the actual sound pressure wave measured within a three-dimensional space, capturing the influence of environmental factors, such as acoustical wave propagation and distance from the noise source.

2. Regulatory Setting

2.1 Federal

No federal noise regulations are relevant to the acoustic aspect of the project.

2.2 State

The Massachusetts Department of Environmental Protection (MassDEP) administers its noise regulation, 310 Code of Massachusetts Regulations 7.10, through a Noise Policy, Division of Air Quality Control Policy 90-001. MassDEP regulates any source of "sound of sufficient intensity and/or duration as to cause a condition of air pollution." The MassDEP Noise Policy typically is used as a basis for review by the Energy Facilities Siting Board and may be used in other state or regional reviews. The Noise Policy states the following:

> A source of sound will be considered to be violating the MassDEP's noise regulation if the source:
>
> 1. Increases the broadband sound level by more than 10 dBA above ambient; or
> 2. Produces a "pure tone" condition – when any octave band center frequency sound pressure level exceeds the two adjacent center frequency sound pressure levels by 3 decibels or more.

These conditions are for both the PL and the closest inhabited residence to the sound source, with the ambient being defined as the lowest hourly L_{90} (in dBA) measured during the period of source operation.

2.3 Local

No local noise regulations are relevant to the project.

3. Existing Baseline Conditions

Sound pressure level (SPL) measurements were performed with one Larson Davis Model 831C and two Model LxT sound level meters (SLMs), all rated by the American National Standards Institute as Class 1. The SLM microphones were fitted with open-cell foam windscreens, positioned roughly 5 feet above-grade, and placed at least 10 feet from any acoustically reflecting surfaces. The SLMs were set using slow time response and the A-weighting scale. SLM calibration was field-checked before and after the measurement period with a Larson Davis Model CAL200 acoustic calibrator. In addition, all SLMs and the handheld acoustic calibrator were laboratory-calibrated with passing marks within 1 year of the noise measurement dates (calibration certificates are available on request).

SPL measurements were conducted at three representative nearest noise-sensitive receptor (NNSR) locations. Figure 2 shows the three long-term (LT) measurement locations, superimposed on aerial imagery. Photos of the deployments are provided in Appendix B.

Sources: Google Imagery 2021; MassGIS 2021

Figure 2 Long-Term (LT) Ambient Noise Monitoring Locations

3.1 Baseline Noise Level Results

Noise monitoring deployments were left unattended for a 5-day (120-hour) period, from 12 a.m. on August 11 to 12 a.m. on August 16, 2021.

Sources of noise in the survey vicinity included frequent aircraft flyovers, a continuous hum from the existing substation facility, buzzing noise (“corona” noise) from overhead high-voltage transmission lines, insects, intermittent bird call, and vehicle traffic. Table 2 broadly summarizes the data collected at each monitoring location. Detailed interval-data plots across all five survey days at the three deployment locations are provided in Appendix B.

Table 2. Noise Monitoring Survey Results Summary

ID	Duration (hours)	Lowest Measured 1-hour L_{90} (dBA)	Highest Measured 1-hour L_{90} (dBA)
LT1	120	38	52
LT2	120	38	55
LT3	120	34	54

4. Noise Prediction Modeling

The CadnaA® Noise Prediction Model (Version 2021 MR1) was used to estimate the propagation of sound from aggregate project operations, and thereby to predict SPLs at various distances from the project site, including representative noise-sensitive receptor locations selected for the ambient sound survey. CadnaA is a Windows-based software program that predicts and assesses SPLs near industrial sound sources and is based on International Organization of Standardization 9613-2 algorithms for sound propagation calculations. The software can accept sound power levels (L_W) (in dB referenced to 1 picowatt) in octave-band center frequency resolution to describe the multiple sound propagation sources of the site processes or activity to be modeled. The calculations account classical sound wave divergence plus attenuation factors resulting from air absorption, basic ground effects, and barrier/shielding. The advantage of using CadnaA is that it can handle the three-dimensional sound propagation complexity of considering realistic intervening natural and human-made topographical barrier effects, including those resulting from terrain features and structures, such as multi-story buildings.

4.1 Modeled Sound Sources

The battery energy storage system (BESS) modules and substation transformers were modeled as point sources at 8.5 feet and 10 feet above ground level, respectively. Reference sound levels for the proposed BESS modules and the main site transformer were provided by their respective manufacturers. The BESS units generate noise primarily through their cooling system, which features a set of six rooftop fans that pull fresh air through louvered openings and exhaust it upward through a grill. These cooling systems are designed for use in desert climates with temperatures above 120 degrees Fahrenheit (°F). In temperate climates, the duty cycle of these fans is reduced significantly and results in a reduction in potential noise generation. The duty cycle of the fans at the project site is expected to be capped at roughly 40 percent, during the hottest summer months. To be conservative, this analysis assumed a duty cycle of 50 percent. Equipment reference sound power levels for the main site transformer and the BESS module at 50 percent duty cycle are shown in Table 3.

Table 3. Major Project Operations Noise Producing Sources

Equipment/Source Type	Individual Reference Sound Power Level (L_W, A-weighted)	Quantity of Equipment or Source
Tesla Megapack 8-Fan BESS module at 50 percent duty cycle	85.9	58
Substation transformer	95.5	1

4.2 Predictive Model Configuration Settings

Additional CadnaA model configuration settings and operations noise analysis assumptions are as follows: 50°F outdoor temperature, 70 percent relative humidity, calm wind conditions (less than 0.5 meters per second), one order of acoustic reflections, and an average acoustical ground absorption coefficient of 0.7 (representing a conservative estimate for the project vicinity). Because of the hilly topography of the project site and surrounding lands, study area topography was imported into the model from the U.S. Geological Survey's National Elevation Dataset.

5. Results and Findings

Table 4 shows the predicted SPL from on-site project operation at the studied noise-sensitive receiver (PL) locations and compares them with the measured existing baseline ambient sound level (all values rounded to the closest whole dBA).

Table 4. Existing Ambient Sound Levels and Predicted Project Operations Sound Levels at Nearest Property Lines

Receiver ID	Existing Ambient Noise Level (lowest measured hourly L_{90})	MassDEP Noise Level Limit (existing + 10 dBA)	Predicted Noise Generated by Project Operations (dBA)	Compliant with MassDEP Noise Limit?
PL-1	38	48	39	**Yes**
PL-2	38	48	47	**Yes**
PL-3	34	44	42	**Yes**
PL-4	34	44	39	**Yes**

Table 4 shows that predicted project-only noise levels ranged from 39 to 47 dBA at the studied receiver locations. These predicted levels are all below the MassDEP performance requirements, and thus the future project operations are expected to be compliant with applicable regulations. Figure 3 shows predicted project operation sound isopleths (also known as “contours”) generated by the project design.

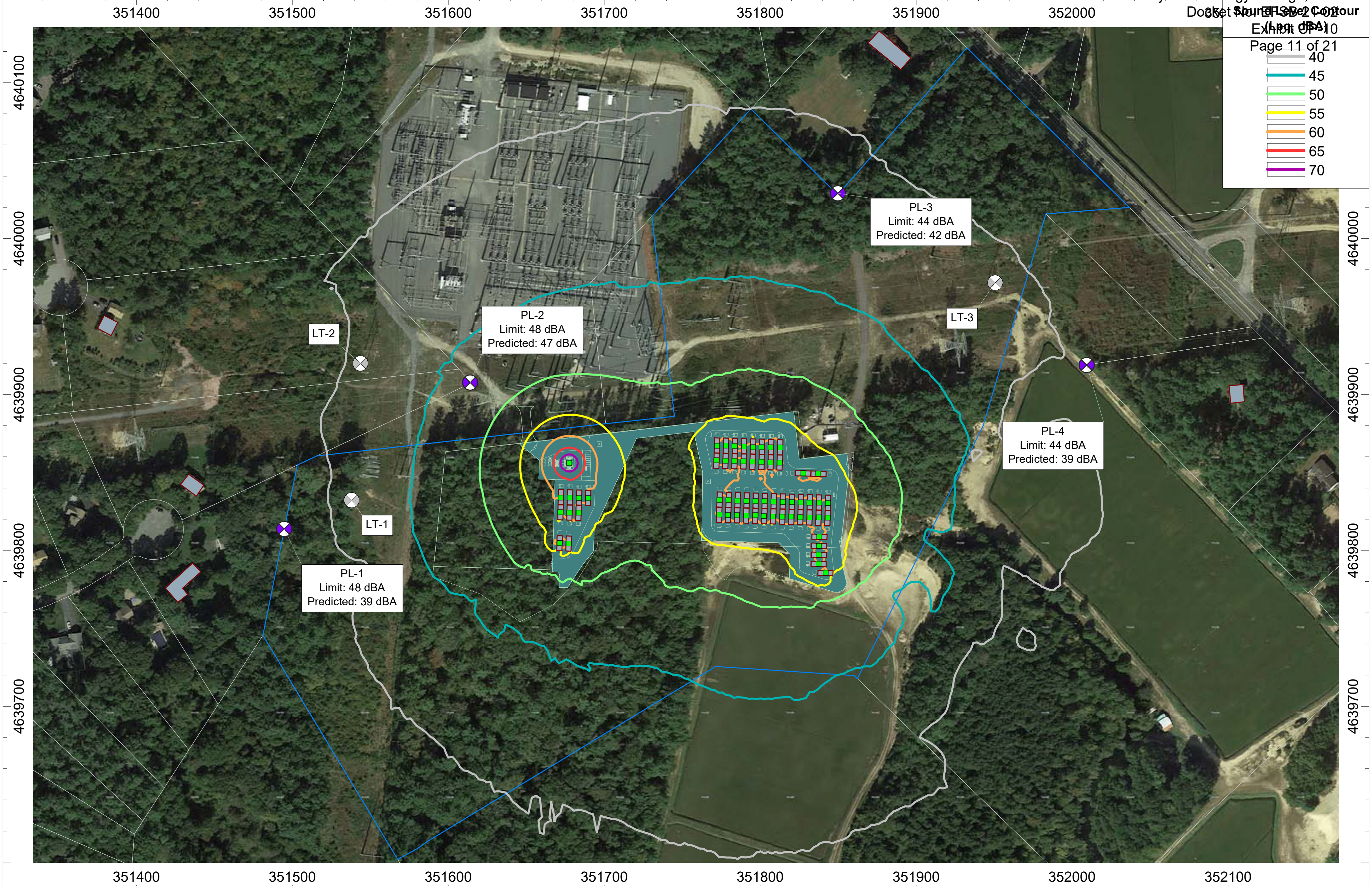
In several cases, the actual residential structure on the studied noise-sensitive properties is notably further from the project than the nearest PL analyzed above. For reference, Table 5 shows the predicted sound levels near the residential structures within each receptor property.

Table 5. Existing Ambient Sound Levels and Predicted Project Operations Sound Levels at Nearest Residential Structure

Receiver ID	Existing Ambient Noise Level (dBA, Lowest Measured Hourly L_{90})	MassDEP Noise Level Limit (Existing + 10 dBA)	Predicted Noise Generated by Project Operations at Residential Structure (dBA)
PL-1 (Home)	38	48	38
PL-2 (Home)	38	48	38
PL-3 (Home)	34	44	38
PL-4 (Home)	34	44	37

5.1 Recommendations

Predicted project operation sound levels appear to be compliant with applicable regulatory criteria, and thus no noise reduction measures are recommended. If the project seeks to exceed the conservatively assumed duty cycle cap on installed BESS modules (50 percent), additional noise compliance modeling will be required.



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8/26/2021

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Figure 3. Typical Site Operations
No Additional Mitigation

Predicted Project Operation Noise Contours
Cranberry Point Energy Storage Project - Carver, MA
Cranberry Point Energy Storage, LLC

Appendix A Glossary of Acoustical Terminology

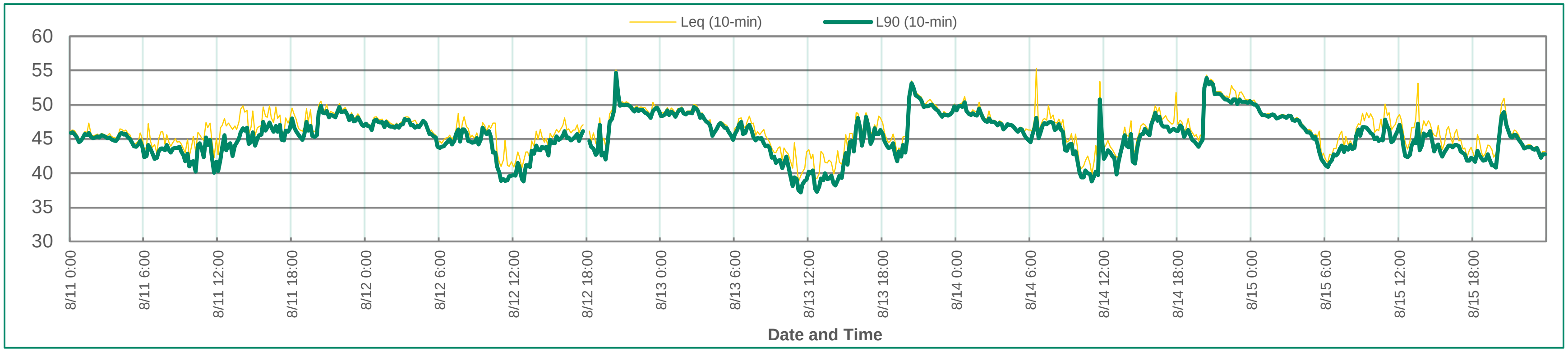
- **Sound** – For this analysis, sound is a physical phenomenon generated by vibrations that result in waves that travel through a medium, such as air, and result in auditory perception by the human brain.
- **Noise** – Noise typically is regarded as unwanted or disruptive sound. Whether something is perceived as a noise event is influenced by the type of sound, the perceived importance of the sound, and its appropriateness in the setting, the time of day, and the type of activity during which the noise occurs and the sensitivity of the listener. Local jurisdictions may have legal definitions of what constitutes "noise" and such environmental parameters to consider.
- **Frequency** – Sound frequency is measured in hertz (Hz), which is a measure of how many times each second the crest of a sound pressure wave passes a fixed point. For example, when a drummer beats a drum, the skin of the drum vibrates a number of times per second. When the drum skin vibrates 100 times per second, it generates a sound pressure wave that is oscillating at 100 Hz, and this pressure oscillation is perceived by the ear/brain as a tonal pitch of 100 Hz. Sound frequencies between 20 and 20,000 Hz are within the range of sensitivity of the best human ear.
- **Amplitude or Level** – Amplitude is measured in decibels (dB), using a logarithmic scale. A sound level of zero dB is approximately the threshold of human hearing and is barely audible under extremely quiet listening conditions. Normal conversational speech has a sound level of approximately 60 dB. Sound levels above approximately 110 dB begin to be felt inside the human ear as discomfort and eventually pain at 120 dB and higher levels. The minimum change in the sound level of individual events that an average human ear can detect is about 1 to 2 dB. A 3 to 5 dB change is readily perceived. A change in sound level of about 10 dB is usually perceived by the average person as a doubling (or if decreasing by 10 dB, halving) of the sound's loudness.
- **Sound pressure** – Sound level is usually expressed by reference to a known standard. This document refers to sound pressure level (SPL), which is expressed on a logarithmic scale with respect to a reference value of 20 micropascals. SPL depends not only on the power of the source, but also on the distance from the source and the acoustical characteristics of the space surrounding the source.
- **Sound power** – Unlike sound pressure, which varies with distance from a source, sound power (and its counterpart sound power level) is the acoustic power of a source, typically expressed in watts.
- **A-weighting** – Sound from a tuning fork contains a single frequency (a pure tone); however most sounds one hears in the environment do not consist of a single frequency. Instead, they are composed of a broad band of frequencies differing in sound level. The method commonly used to quantify environmental sounds consists of evaluating all frequencies of a sound according to a weighting system that reflects the typical frequency-dependent sensitivity of average healthy human hearing at moderate sound levels. This is called "A-weighting," and the decibel level measured is referred to as dBA. In practice, the level of a sound source conveniently is measured using a sound level meter (SLM) that includes a filter corresponding to the dBA "curve" of decibel adjustment per octave band center frequency from a "flat" or unweighted SPL.
- **Equivalent sound level (L_{eq})** – Environmental sound levels vary continuously and include a mixture of sound from near and distant sources. A single descriptor, L_{eq} may be used to describe such sound that is changing in level from one moment to another. L_{eq} is the energy-average sound level during a measured time interval. It is the "equivalent" constant sound level that would have to be produced by a single, steady source to equal the acoustic energy contained in the fluctuating sound level measured over a specified period of time.
- **Statistical sound level (L_n)** – A sound level exceeded for a cumulative "n" percentage of a measurement or studied time period, such as L_{10}, L_{50} or L_{90}. The L_{50} value is often referred to as the "median" sound level, while L_{90} is commonly called the "background" level as it typically represents acoustical contribution from continuous or "steady-state" sound sources and the perceived indistinct din of background sound due to the amalgamation of many contributing distant sound sources in the environment.
- **Day-Night Average Sound Level (L_{dn})** – L_{dn} represents the average sound level for a 24-hour day and is calculated by adding a 10-dB penalty only to sound levels during the nighttime period (10 p.m. to 7 a.m.). This metric commonly is used when assessing noise exposure in communities.

Common Outdoor Activities	Noise Level (dBA)	**Common Indoor Activities**
	110	Rock band
Jet flyover at 1,000 feet		
	100	
Gas lawnmower at 3 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		
Gas lawnmower, 100 feet	**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 in 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	
	0	

Appendix B Baseline Survey Data and Photo Log

B.1 Detailed Measurement Plots

LT-1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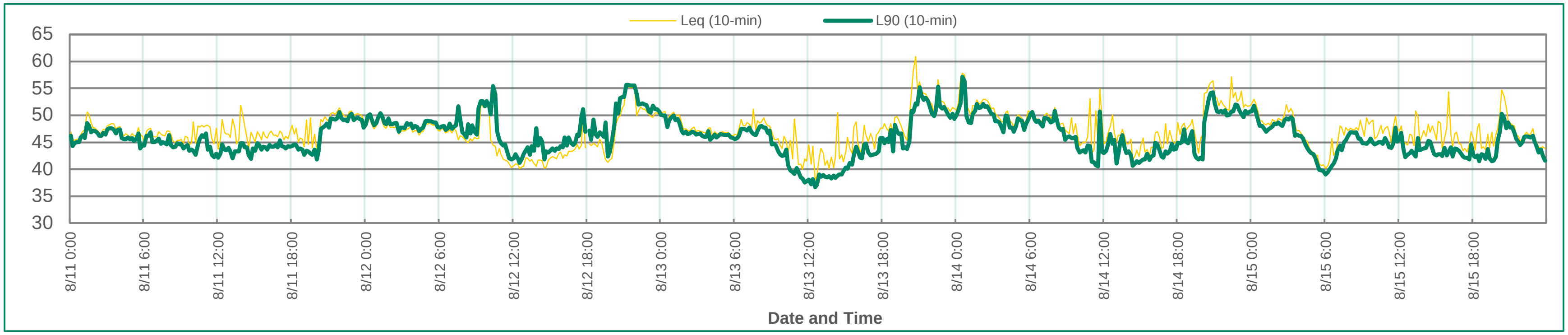
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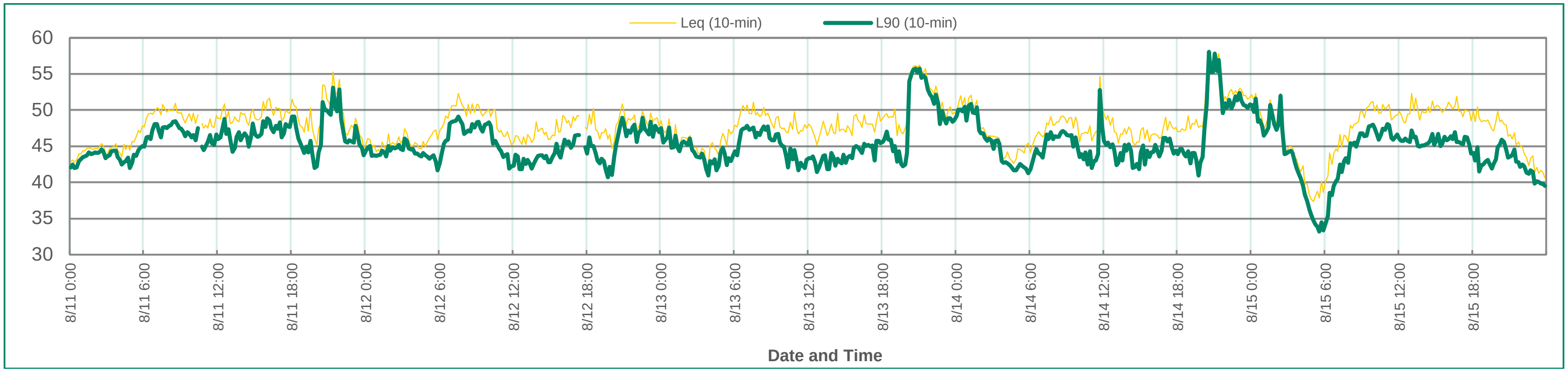
LT-3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Date and Time

B.2 Photo Log

Baseline Ambient Survey Photo Log

	**Photograph 1** **Subject:** LT1 **View:** West **Date Taken:** August 14, 2021
	**Photograph 2** **Subject:** LT1 **View:** North **Date Taken:** August 14, 2021

	**Photograph 3** **Subject:** LT2 **View:** West **Date Taken**: August 14, 2021
	**Photograph 4** **Subject:** LT2 **View:** North **Date Taken**: August 14, 2021

Photograph 5

Subject:
LT3

View:
East

Date Taken:
August 14, 2021

Photograph 6

Subject:
LT3

View:
West

Date Taken:
August 14, 2021