Appendix F

Environmental Noise Assessment

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TECHNICAL MEMORANDUM

To:	Darin M. Lemire, P.E. HRP Associates, Inc. 197 Scott Swamp Road Farmington, Connecticut 06032
From:	Christopher Bajdek, Emma Butterfield and Tara Cruz
Date:	November 19, 2019
Subject:	Environmental Noise Assessment for the Proposed Old Town Substation Rebuild Project at 280/312/330 Kaechele Place, in Bridgeport, Connecticut for the United Illuminating Company
Reference:	HMMH Project Number 310900.000

Summary of Findings

The United Illuminating Company (UI) proposes to rebuild its existing Old Town Substation, a transmission/ distribution facility located in the northwestern portion of the City of Bridgeport at 280 Kaechele Place. The Old Town Substation will be rebuilt on approximately 2.25 acres of UI-owned property; the site will encompass undeveloped UI land located at 312 and 330 Kaechele Place, as well as the existing substation property. The Project also will involve the installation of transmission line connections to the new substation, involving transmission structure replacements on Eversource's existing transmission line rights-of-way (ROW) immediately adjacent to the site, as well as modifications to certain distribution line connections (typically within local streets). After energization of the new substation, the existing substation will be demolished.

HMMH was retained by HRP Associates, Inc. (HRP) to conduct an environmental noise assessment for the operation of the proposed Old Town substation rebuild project (the “Project”). We evaluated facility noise levels with respect to the sound level limits contained in the State of Connecticut Department of Energy and Environmental Protection (DEEP) noise regulations and the City of Bridgeport noise ordinance.

The noise study included noise measurements to document existing ambient sound levels on the site of the proposed Project and in the surrounding community. The measured ambient sound levels serve as a baseline against which the potential affects of the Project may be evaluated.

HMMH used the ISO-9613 standard for sound propagation with the SoundPLAN® computer noise model to compute operational noise levels from the proposed Project at noise-sensitive receptors located along the north property line and in the surrounding community. Under the assumptions stated in this report, predicted noise levels from the two transformers are expected to be within the allowable sound level limits for adjacent land uses in the surrounding community and at the property line. In addition, when considered in the context of existing ambient sound levels, under certain conditions, the transformers may produce tones as defined by the DEEP noise regulations at sites to the north of the Project along Sequoia Road and to the west at the Greentree townhomes on Frenchtown Road. However, the presence of the tones is not considered excessive as the overall A-weighted levels from the transformers at these locations are more than 5 dB below the noise zone standards established by the regulation.

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1. Introduction

The United Illuminating Company (UI) proposes to rebuild its existing Old Town Substation, a transmission/distribution facility located in the northwestern portion of the City of Bridgeport at 280 Kaechele Place. The Old Town Substation will be rebuilt on approximately 2.25 acres of UI-owned property; the site will encompass undeveloped UI land located at 312 and 330 Kaechele Place, as well as the existing substation property. The Project also will involve the installation of transmission line connections to the new substation, involving transmission structure replacements on Eversource's existing transmission line rights-of-way (ROW) immediately adjacent to the site, as well as modifications to certain distribution line connections (typically within local streets). After energization of the new substation, the existing substation will be demolished.

HMMH was retained by HRP Associates, Inc. (HRP) to conduct an environmental noise assessment for the operation of the proposed Old Town substation rebuild project (the "Project"). This memorandum summarizes the applicable noise ordinances and regulations, presents the results of noise monitoring to document existing conditions, and presents the results of the noise modeling and operational noise assessment. Attached to this memorandum are two appendices. Appendix A contains the figures referenced in the body of this memorandum. Appendix B provides supplemental information about the fundamentals of acoustics.

2. Applicable Noise Ordinances and Regulations

Both the State of Connecticut Department of Energy and Environmental Protection (DEEP)[1] and the City of Bridgeport[2] prescribe the same A-weighted maximum sound pressure levels, based upon land use at the noise emitter and receptor. Table 1 provides a summary of these maximum levels.

Table 1. Maximum Allowable Sound Pressure Levels based on the City Ordinance and State Regulations

Emitter Land Use	Receptor Land Use			
	Industial (All Times)	Commercial (All Times)	Residential (Day)*	Residential (Night)*
Residential	62 dBA	55 dBA	55 dBA	45 dBA
Commercial	62 dBA	62 dBA	55 dBA	45 dBA
Industrial	70 dBA	66 dBA	61 dBA	51 dBA

Source: Regulations of Connecticut State Agencies, TITLE 22a: Environmental Protection, Control of Noise, 22a-69-1 to 22a-69-7.4, 2015.
Notes:
*The State of Connecticut defines "day" as the hours from 7 a.m. to 10 p.m. (and night as 10 p.m. to 7 a.m.) for all days of the week. In comparison, the City of Bridgeport defines "day" as 7 a.m. to 6 p.m. (and "night" as 6 p.m. to 7 a.m.) from Monday through Friday. On Saturday and Sunday, the City defines "day" as 9 a.m. to 6 p.m. (and "night" as 6 p.m. to 9 a.m.).

Based on a review of the City's Zoning Map,[3] much of the land use surrounding the site of the proposed project, particularly abutting property, is zoned "residential – single family." To the east, the condominiums on Frenchtown Road are zoned "residential – multi-family." Properties along Main Street are primarily zoned "office – retail," although properties to the west of Main Street across from Hillview Street and the north end of Kaechele Place are zoned "mixed use – educational/medical." Consequently, all of the noise-sensitive properties potentially affected by the project are either classified as "Residential" or "Commercial" receptors under the Connecticut State Code. The Project as it is proposed will constitute an industrial emitter even though the parcel is zoned as "residential – single family." Using these criteria, the maximum permissible

[1] Regulations of Connecticut State Agencies, TITLE 22a: Environmental Protection, Control of Noise, 22a-69-1 to 22a-69-7.4, 2015.
[2] City of Bridgeport, Code of Ordinances, Chapter 8.80 – Noise Control Regulations.
[3] Available at: https://www.bridgeportct.gov/filestorage/341650/341652/345965/343658/Zoning_Map.pdf

levels for the Project are 61 dBA during the day, and 51 dBA during the night at residential receptors and 66 dBA for all times of the day for commercial receptors.

The state ordinance also provides specific criteria defining prominent discrete tones for each one third octave band from 100 Hz to 20 kHz, based upon each band level's relation to its upper and lower neighboring band levels. Where a discrete tone exists, it is considered excessive noise, if its level exceeds 5 dBA below the criteria in Table 1, or 56 dBA during the day and 46 dBA at night.

3. Existing Noise Conditions

HMMH performed sound level measurements at several sites to document existing conditions at noise-sensitive land use in the surrounding community. The measured sound levels summarized in this section serve as a baseline against which the Project's impact on ambient sound levels may be determined. These ambient measurements include noise from the existing substation, which will be demolished as a result of the proposed Project. The following subsections describe the measurement methods and procedures, and also summarize the measured sound levels at both the short-term and long-term measurement sites.

3.1 Noise Measurement Methods and Procedures

On August 12, 2019, HMMH personnel conducted short-term attended measurements at four locations in the surrounding community. The objective of the short-term noise measurements was to characterize existing sound levels at noise-sensitive land use for both daytime (between 7 a.m. to 10 p.m.) and nighttime (between 10 p.m. and 7 a.m.) periods. Short-term measurements of 20 to 30 minutes duration were taken at all four sites. In total, eight short-term measurement samples were taken.

Figure 1 in Appendix A provides a map of the study area that shows the locations of the four short-term sites in relation to the proposed Project. Figures 2 through 5 provide photographs that show the position of the microphone at each short-term noise measurement site. (Note that all of the referenced figures are included in Appendix A of this memorandum.) Table 1 provides a summary of each short-term site, including observed sources of sound.

Table 2. Summary of Short-Term Noise Measurement Sites

Site	Location/Address	Observed Source of Sound
ST-1 AM	60 Sequoia Rd. (day)	Traffic on Main St., aircraft, vehicles on Sequoia, insects
ST-1 PM	25/61 Sequoia Rd. (night)	Traffic on Main St., aircraft, vehicles on Sequoia, insects
ST-2	Greentree townhomes on Frenchtown Rd.	Distant traffic, vehicles in lot, aircraft, insects
ST-3	Behind 2 Hillview St. on Kaechele Pl.	Traffic on Main St., vehicles on Kaechele Pl., aircraft, insects, lawn equipment
ST-4	Corner of Main St./Minturn Rd.	Traffic on Main St., aircraft, insects

Source: HMMH, 2019

The short-term sound level measurements were performed with an HMMH-owned Larson Davis 824 sound level meter that meets the requirements of American National Standard S1.4 for Type 1 precision sound measurement instruments. The sound measurement system (comprised of a microphone, preamplifier, and sound level meter) was calibrated at the beginning and end of each measurement period using an acoustic calibrator following procedures that are traceable to the National Institute of Standards and Technology (NIST).

The Larson Davis 824 sound level meter was programmed to collect and store broadband levels and continuous time histories of 1-second sound level data in one-third octave bands. At the conclusion of the measurements, sound level data were downloaded to a personal computer for subsequent analysis.

3.2 Existing Noise Levels from Short-term Measurement Sites

During each short-term measurement, detailed notes were taken on the noise sources audible at each site. These sources were then grouped into three categories: typical, atypical (significant), and insects. Typical noise sources included traffic on Main Street, aircraft, lawn equipment, and birds. These sources would likely be present to a similar degree regardless of measurement date or time period. Atypical noise sources included an occasional loud car exhaust and vehicle pass-bys that were close to the microphone position. Although insects were clearly audible at many sites, insect noise is seasonal and so may not be present in the environment at different times of the year. Both atypical sounds and insect noise were filtered from the ambient sound level data, as described below.

The short-term sites were located in areas with public access, such as on a sidewalk or the shoulder of the road. Measured ambient sound levels were therefore unduly influenced by an occasional vehicle that passed within close proximity to the microphone. To allow effective comparison of ambient levels across measurement periods, we excluded these atypical (significant) events on a second by second basis using the collected time history data, and calculated a "filtered" L_{eq} for each site. The filtered L_{eq} also removed the effects of insect noise and a 125-Hz tone from the measured data, as described in the following paragraphs.

Insect noise was observed at nearly all of the measurement sites during both daytime and nighttime periods. During the day, insect noise was observed primarily in the 1/3 octave bands centered at 6.3 and 8 kHz. However, during the nighttime periods, insects were found to dominate the existing noise environment primarily in the seven 1/3 octave bands from 1.6 to 6.3 kHz. Since insects and similar biogenic sources (e.g. spring peepers) are not active year-round, an ambient A-weighted sound level in the presence of insect sounds is not likely to be an indicator of ambient sound during other periods of the year. Shomer, et al,[4] contend that nighttime insect noise can "distort" ambient sound level data and provide a method to "filter" or remove the contribution of insect noise to the ambient sound level. For the purpose of this study, HMMH filtered the measurement data to effectively remove the effect of insect noise from the ambient sound level, using an approach that is consistent with Schomer, et al.[5]

Figures 6 and 7 in Appendix A provide graphs of the measured ambient sound level spectra (unfiltered) at the short-term sites for daytime and nighttime periods, respectively. These figures convey the frequency characteristics of the ambient sound and clearly show the effect of insect noise, especially at Sites ST-1, ST-2, and ST-3, during both daytime and nighttime periods. These figures also show evidence of transformer noise in the 125-Hz band at Sites ST-2 and ST-3 during the daytime period and at Site ST-3 during the nighttime period. Transformer noise also may be present in the 400-Hz band at Site ST-2 during the day and at Site ST-3 at night.

The ambient sound level, filtered to remove the effects of both insects and the tones due to the transformers, then becomes the baseline against which noise levels due to the Project will be evaluated.

Table 2 shows the unfiltered and filtered measured sound levels for the daytime period, while Table 3 shows the same for the nighttime.

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[4] Schomer, Paul D., Slauch, Ian M., and Hessler, George F., "*Proposed 'Ai'-Weighting; a weighting to remove insect noise from A-weighted field measurements*," Proceedings of Inter-Noise 2010, Lisbon, Portugal, 13-16 June 2010.

[5] Schomer's method to remove insects simply ignores all of the sound energy in the bands above, but not including, the 1,250 Hz band. For the high-frequency sounds during the day that are related to insects, we believe Schomer's method is overly conservative as it ignores all of the sound energy in the nine bands above 1,250 Hz, when insect sounds appear to be contained in only two bands. For the daytime measurement data, we only removed sound energy in the 1/3 octave bands centered at 6.3 and 8 kHz .

Table 3. Short-Term Daytime Ambient Level Noise Measurements

Site	Date	Time Start	Duration, Minutes	Unfiltered Leq (dBA)	Filtered Leq (dBA)*	Number of Seconds Excluded	Percent of Time Excluded
ST-1AM	8/12/19	10:34	30	52	49	14	1%
ST-2	8/12/19	11:25	30	50	46	30	2%
ST-3	8/12/19	9:03	30	54	53	0	0%
ST-4	8/12/19	9:49	30	65	64	3	<1%

Source: HMMH, 2019
Notes:
*An insect adjustment was applied to the Filtered L_{eq} that deviated slightly from the methods of Schomer, et al, [2010]. Since insect noise was observed only in the two bands centered at 6.3 and 8 kHz during the daytime period, only the sound energy in each of those two bands was removed. The measured ambient sound level also was filtered to remove the effects of the tones due to the existing transformers at ST-2 and ST-3.

Table 4. Short-Term Nighttime Ambient Level Noise Measurements

Site	Date	Time Start	Duration, Minutes	Unfiltered Leq (dBA)	Filtered Leq (dBA)*	Number of Seconds Excluded	Percent of Time Excluded
ST-1 PM	8/12/19	22:33	20	59	42	0	0%
ST-2	8/12/19	23:37	20	59	44	0	0%
ST-3	8/12/19	22:03	20	57	44	0	0%
ST-4	8/12/19	23:03	20	61	58	13	1%

Source: HMMH, 2019.
Notes:
*An insect adjustment was applied to the Filtered L_{eq} that deviated slightly from the methods of Schomer, et al, [2010]. Since insect noise was observed in the seven bands from 1.6 to 6.3 kHz during the nighttime period, only the sound energy in each of those seven bands was removed. The measured ambient sound level also was filtered to remove the effects of the tones due to the existing transformers at ST-3.

3.3 Existing Noise Levels from the Long-term Measurement Site

Long-term unattended noise monitoring (24 hours in duration) was performed along the northern property line of the proposed Project adjacent to the residences at 60 and 76 Sequoia Road. The objectives of the long-term noise monitoring was to document existing ambient sound levels at the closest residential properties potentially affected by the Project. HMMH installed a Bruel & Kjaer Model 2250 sound level meter at 8:18 AM on August 12, 2019, and retrieved the monitor at 8:50 AM on August 13, 2019. Figure 8 in Appendix A shows a photograph of the noise monitor installed along the north property line on the site of the Project.

The measured sound level data from the long-term site included a tone in the 1/3 octave band centered at 125 Hz, due to the operation of the existing transformers at the Old Town substation. This tone was observed in the 1-second time history for approximately 38% of the duration of the long-term measurement – a cumulative period of approximately nine hours. Filtered ambient sound levels also were established for the long-term site, effectively removing the effects of the existing transformers and the effects of insects, following a method that deviated somewhat from Schomer, et al [2010]. Figure 9 in Appendix A provides a graph of the measured hourly L_{eq}s (unfiltered and filtered) at the long-term site.

Figure 10 in Appendix A provides a graph of the measured 1/3 octave band spectra at the long-term site in terms of the equivalent sound level for the daytime period and the nighttime period. Those data are “unfiltered” and clearly show the effects of both the transformer noise at 125 Hz and insect noise in the bands above 1.6 kHz. Following the same methods used to filter the measurement data from the short-term sites, HMMH filtered the long-term sound level data to removed the effects of insect noise and a 125-Hz tone from the measurements.

4. Predicted Noise Levels from the Proposed Substation Rebuild Project

This section describes the noise prediction model, summarizes the input to the model, and presents the predicted operational noise levels and the results of the assessment.

4.1 Noise Prediction Model

The SoundPLAN® computer noise model[6] was used for computing operational noise levels from the proposed substation to noise-sensitive receptors at the western property lines and in the surrounding community. An industry standard, SoundPLAN® was developed by Braunstein + Berndt GmbH to provide estimates of sound levels at distances from specific noise sources taking into account the effects of terrain features including relative elevations of noise sources, receivers, and intervening objects (buildings, hills, trees), and ground effects due to areas of hard ground (pavement, water) and soft ground (grass, field, forest). In addition to computing sound levels at specific receiver positions, SoundPLAN® can produce noise contour graphics that show areas of equal and similar sound level.

The sound propagation model within SoundPLAN that was used for this study was ISO 9613-2.[7] This international standard propagation model is used nearly universally in the U.S. for environmental noise studies, due to its conservative propagation equations. ISO 9613-2 uses “worst-case” downwind propagation conditions in all directions, and accounts for variations in terrain and the effects of ground type.

4.2 Noise Model Input

As input, SoundPLAN incorporated a geometric model of the study area and reference noise levels for the two proposed transformers, which are the predominant source of noise associated with the proposed project. HMMH developed a three-dimensional geometric model of the study area from aerial photography and elevation information obtained in Google Earth Pro© for off-site buildings and structures and from the latest conceptual plan[8] of the substation for on-site buildings and structures. All buildings were modeled as objects that both obstruct (attenuate) and reflect the sound emitted from a source. The SoundPLAN model of the substation included reflections of the 3rd order.

The two transformers to be installed with the rebuild project were modeled at a height of 12 feet, each having an acoustic pressure level of 65 dBA for the maximum MVA rating.[9,10] Following the methods in IEEE Standard C57.12.90-2015,[11,12] this acoustic pressure level corresponds to an A-weighted sound power level of 86.1 dBA.

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[6] SoundPLAN® Version 8 was used for the computations. Documentation provided in SoundPLAN® User’s Manual, Braunstein + Berndt GmbH, 2015. U.S. sales and support services are available via Navcon Engineering Network, Fullerton, CA (http://navcon.com/www/sumpage/software/soundplan)

[7] International Organization for Standardization (ISO), International Standard ISO 9613-2, “Acoustics – Attenuation of Sound during Propagation Outdoors”, Part 2: General Method of Calculation, 1996-12-15.

[8] “Site Plan Arrangement,” Sheet 1 of 2, No. SK-25233-003-001 SH1, Rev. 0-0E, Substation Rebuild – Option #4, 7/8/2019.

[9] Email message from Darin Lemire to Chris Bajdek with the subject “RE: CT substation project – Bridgeport,” dated 10/24/2019 at 5:05 PM.

[10] Table ZD4 in "Iberdrola USA Technical Manual, IUSA Power Transformers," Rev. 02, TM 2.72.10 (09-2014).

[11] The Institute of Electrical and Electronic Engineers, Inc., “IEEE Standard Test Code for Liquid-Immersed Distribution, Power, and Regulating Transformers,” IEEE Standard C57.12.90-2015.

[12] Based on the methods in Section 13.4 of C57.12.90-2015, the length of the ONAF contour was estimated to be 92.78 feet (28.28 meters).

As noted in Section 2, the Connecticut DEEP noise regulation includes provisions and penalties for sources of sound that produce prominent discrete tones. Since spectral sound level data were not available for the transformers, HMMH applied a one-third octave band noise spectrum for a typical transformer[13] to the overall sound power level. Figure 11 in Appendix A shows the sound power level spectrum that was used as input to the SoundPLAN model. As shown in Figure 11, the (unweighted) transformer spectrum includes peaks in the 1/3 octave bands centered at 125 and 400 Hz. As noted in the next section, the assessment of substation noise included an evaluation of prominent discrete tones.

4.3 Presentation of Results: Overall Levels

Table 5 summarizes the computed A-weighted noise levels due to the new transformers, which would be installed as part of the Project, at each of the measurement sites identified in Section 3. Table 5 also shows the land use designation for each receptor and the allowable sound level limits based on the state regulations and the City's ordinance.

Figure 12 in Appendix A shows the noise exposure contours produced by the proposed transformers in 4-decibel intervals. This figure also shows the effects of buildings and structures on sound propagation from the transformers. Note that this figure does not account for the sound from existing noise sources (such as the existing transformers, traffic on local roads, etc.). As shown in this figure the 50 dBA contour lies within the property lines of the site of the proposed Project.

Table 5. Predicted Overall Sound Levels from the Proposed Project (Only)

Receptor/ Meas. Site ID	Description	Predicted Facility Noise Level (dBA)	Land Use	Applicable Sound Level Limit (dBA)
LT-1	Property line; backyard of 60/76 Sequoia Rd.	43	Residential	61 day / 51 night
ST-1 AM	60 Sequoia Rd.	37	Residential	61 day / 51 night
ST-1 PM	25/61 Sequoia Rd.	37	Residential	61 day / 51 night
ST-2	Greentree townhomes on Frenchtown Rd.	29	Residential	61 day / 51 night
ST-3	Behind 2 Hillview St. on Kaechele Pl.	44	Residential	61 day / 51 night
ST-4	Corner of Main St./Minturn Rd.	33	Residential	61 day / 51 night

Source: HMMH, 2019.

Table 6 shows the predicted facility noise levels in the context of the daytime ambient sound levels, which are given in terms of the filtered L_{eq}. The "Total" sound level in Table 6 is the combination (decibel summation) of the predicted facility noise level and the ambient L_{eq} for each receptor and/or measurement site. As shown in Table 6, the Total sound level exceed the applicable daytime limit at Site ST-4.

Both the Connecticut DEEP noise regulation and the City noise ordinance have a provision for areas with high background (ambient) noise. These regulations state:

"In those individual cases where the background noise levels caused by sources not subject to these regulations exceed the standards contained in this chapter, a source shall be considered to cause excessive noise if the noise emitted by such source exceeds the background noise levels by five dBA…"

While the Total sound level exceeds the daytime sound level limit, this does not represent a violation of either the state regulation or the City ordinance because the sound levels due to the proposed Project are *lower* than

[13] Cyril M. Harris (ed.), Handbook of Acoustical Measurements and Noise Control, Third Edition, McGraw-Hill Inc., Figure 35-1, p. 35.2, 1991.

the background (ambient) sound level. In the case of Site ST-4, traffic noise from Main Street dominates the ambient sound levels. Traffic noise is not subject to the limits in Table 1.

Table 6. Predicted Overall Sound Levels from the Proposed Project with Daytime Ambient Sound Levels

Receptor / Measurement Site ID	Allowable Daytime Limit (dBA)	Predicted Facility Noise Level (dBA)	Daytime Ambient L_{eq} (dBA)*	Daytime Total Sound Level (dBA)**	Increase in Daytime Sound Level (dB)***
LT-1	61	43	49	50	1
ST-1 AM	61	37	49ǂ	49	0
ST-1 PM	61	37	49ǂ	49	0
ST-2	61	29	46	46	0
ST-3	61	44	53	54	1
ST-4	61	33	64	64	0

Source: HMMH, 2019.
* The Daytime Ambient L_{eq} is the Filtered L_{eq} from Table 3.
** The "Total" sound level is the decibel addition of the Predicted Facility Noise Level and the Ambient L_{eq}. See Appendix B for more information on adding decibels.
*** Apparent discrepancies are due to rounding.
ǂ Sites ST-1 AM and ST-1 PM are assumed to have the same daytime ambient sound level.

Table 7 shows the predicted facility noise levels in the context of the nighttime ambient sound levels, which are given in terms of the filtered L_{eq}. Following a similar line of reasoning, predicted noise levels from the two transformers are expected to be in compliance with the applicable nighttime sound level limits at adjacent properties.

Table 7. Predicted Overall Sound Levels from the Proposed Project with Nighttime Ambient Sound Levels

Receptor / Measurement Site ID	Allowable Nighttime Limit (dBA)	Predicted Facility Noise Level (dBA)	Nighttime Ambient L_{eq} (dBA)*	Nighttime Total Sound Level (dBA)**	Increase in Nighttime Sound Level (dBA)***
LT-1	51	43	42	46	4
ST-1 AM	51	37	42ǂ	43	1
ST-1 PM	51	37	42ǂ	43	1
ST-2	51	29	44	44	0
ST-3	51	44	44	47	3
ST-4	51	33	58	58	0

Source: HMMH, 2018.
* The Nighttime Ambient L_{eq} is the Filtered L_{eq} from Table 3.
** The "Total" sound level is the decibel addition of the Predicted Facility Noise Level and the Ambient L_{eq}. See Appendix B for more information on adding decibels.
*** Apparent discrepancies are due to rounding.
ǂ Sites ST-1 AM and ST-1 PM are assumed to have the same nighttime ambient sound level.

While the Total sound level exceeds the nighttime sound level limit at Site ST-4, this does not represent a violation of either the state regulation or the City ordinance because the sound levels due to the proposed Project are *lower* than the background (ambient) sound level. Traffic noise from Main Street dominates the ambient sound levels at Site ST-4. Traffic noise is not subject to the limits in Table 1.

4.4 Presentation of Results: Tones

Transformer noise also was evaluated for the presence of prominent discrete tones at the northern property line and in the community. As shown in Figure 13 in Appendix A, the estimated 1/3 octave band sound levels from the transformers were added to the (filtered) nighttime ambient sound levels[14] in 1/3 octave bands at each measurement site. In the context of existing ambient sound levels, the transformers produced a prominent discrete tone in the band centered at 400 Hz at the north property line of the proposed facility that abuts residences on Sequoia Road (Site LT-1), as well as at residences along Sequoia Road (Sites ST-1) and Kaechele Place (Site ST-3). In each case, the level in this band exceeds the arithmetic average of the levels in the two adjacent 1/3 octave bands by an amount that is greater than 7 dB during nighttime periods.

Section 3.3 of the DEEP noise regulations states:

"*Continuous noise measured beyond the boundary of the Noise Zone of the noise emitter in any other Noise Zone which possesses one or more audible discrete tones shall be considered excessive noise when a level of 5 dBA below the levels specified in Section 3 of these Regulations is exceeded.*"

Therefore, the presence of the tone is not considered excessive noise since the A-weighted levels due to the transformers are more than 5 dB below the noise zone standards established by the regulation at these locations. As shown in Table 5, the predicted noise levels due to the transformers range from a low of 29 dBA L_{eq} at Site ST-3 to a high of 44 dBA L_{eq} at Site ST-3. As discussed in Section 2, where a discrete tone exists, it is considered excessive noise, if its level exceeds 5 dBA below the criteria in Table 1, or a level of 56 dBA during the day and a level of 46 dBA at night.

5. Conclusions

Under the assumptions stated in this report, predicted noise levels from the two transformers are expected to be within the allowable sound level limits for adjacent land uses in the surrounding community and at the property line. In addition, when considered in the context of existing ambient sound levels, under certain conditions, the transformers may produce tones as defined by the DEEP noise regulations at sites to the north of the Project along Sequoia Road and to the west at the Greentree townhomes on Frenchtown Road. However, the presence of the tones is not considered excessive as the A-weighted levels at these locations due to the transformers are more than 5 dB below the noise zone standards established by the regulation.

[14] In terms of the 1/3 octave band sound level exceeded 90-percent of the time (or L_{90}).

APPENDIX A. FIGURES

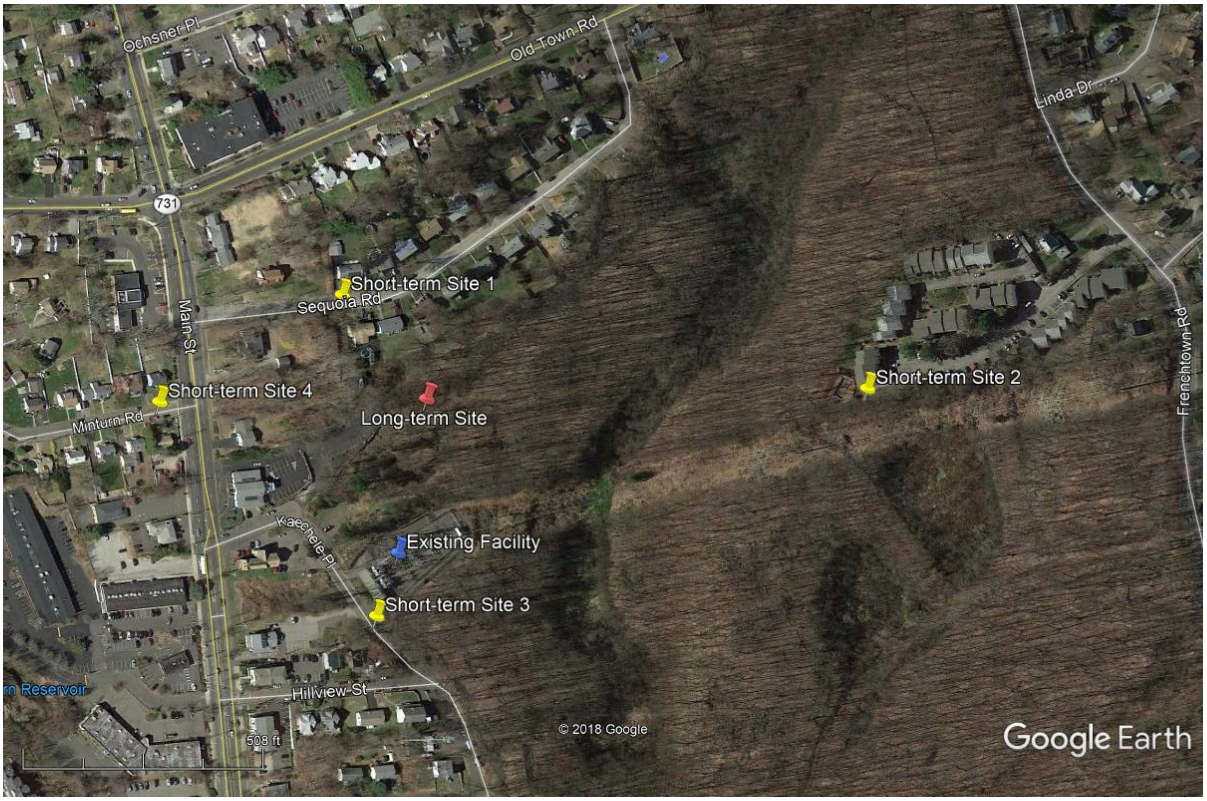


Figure 1. Preconstruction Noise Monitoring SItes from August 12 to 13, 2019

Figure 2. Location of Microphone at Short-term Noise Measurement Site ST-1

Figure 3. Location of Microphone at Short-term Noise Measurement Site ST-2

Figure 4. Location of Microphone at Short-term Noise Measurement Site ST-3

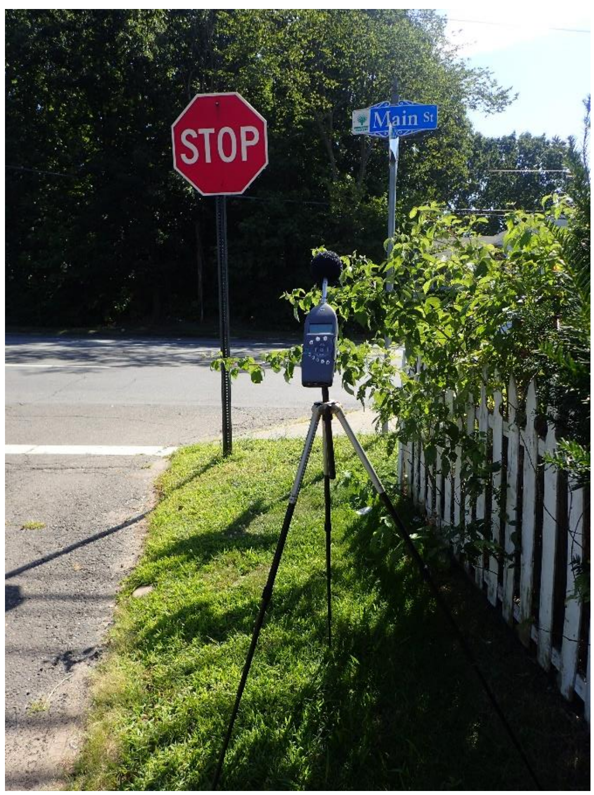


Figure 5. Location of Microphone at Short-term Noise Measurement Site ST-4

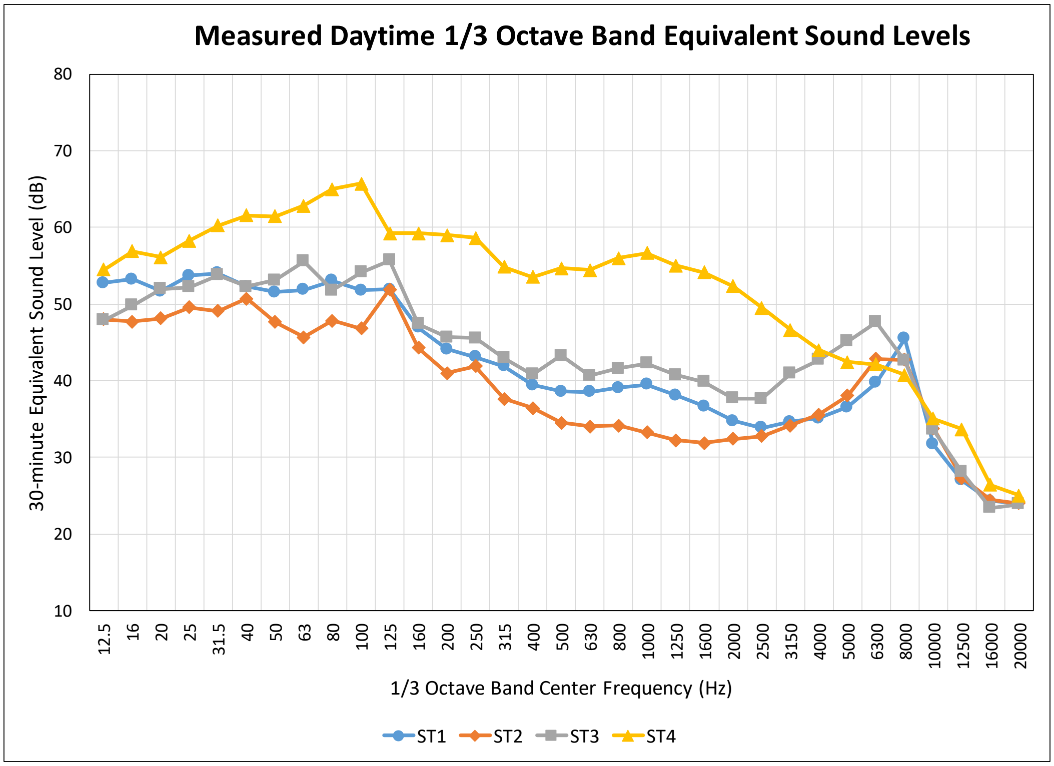


Figure 6. Measured Daytime 1/3 Octave Band Sound Levels at the Short-term Sites (Unfiltered)

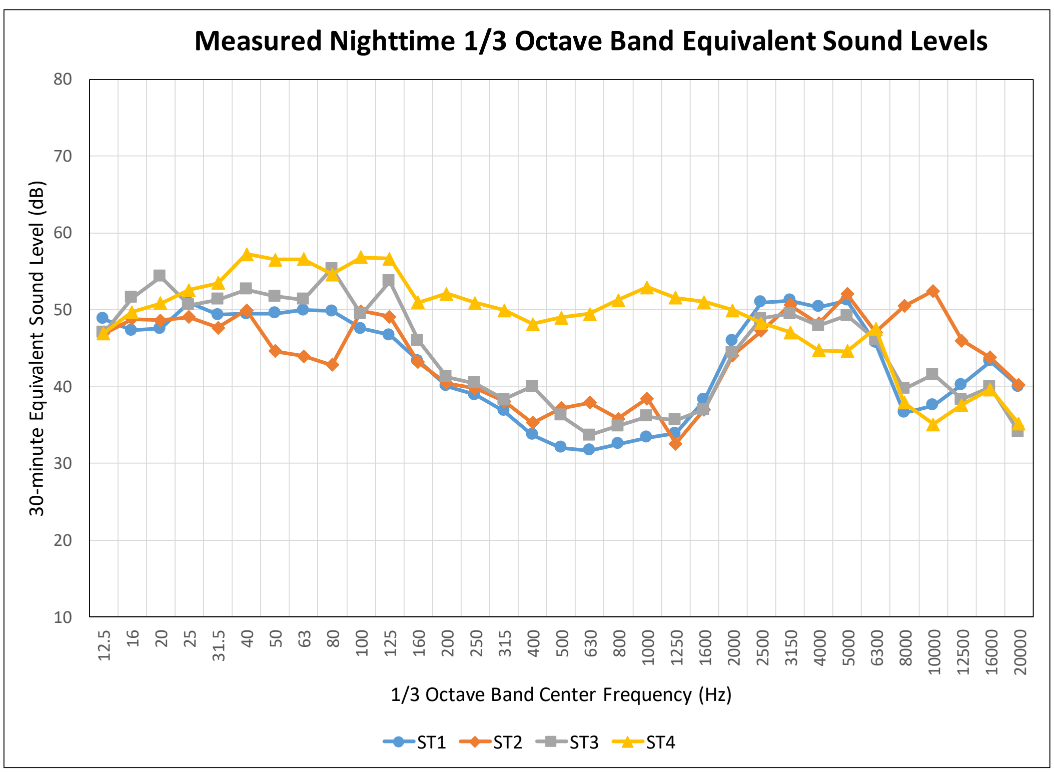


Figure 7. Measured Nighttime 1/3 Octave Band Sound Levels at the Short-term Sites (Unfiltered)

Figure 8. Location of Microphone at Long-term Noise Measurement Site LT-1

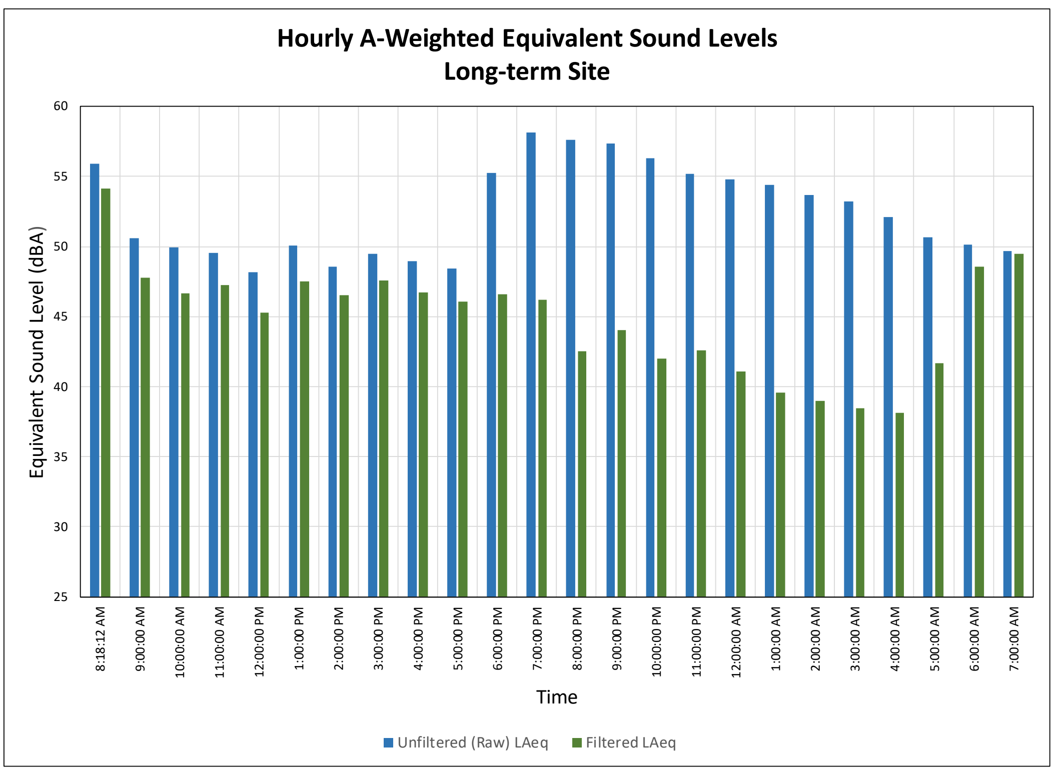


Figure 9. Hourly A-weighted Equivalent Sound Levels at Long-term Site (Unfiltered and Filtered)

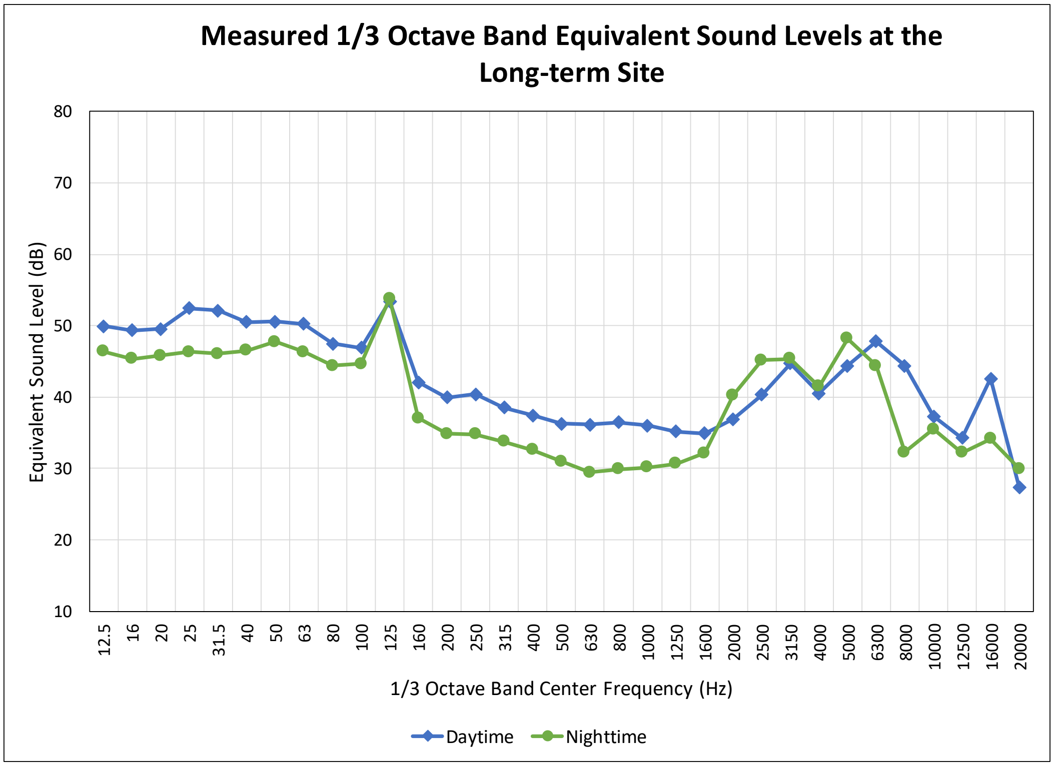


Figure 10. Measured Daytime and Nighttime Sound Level Spectra at the Long-term Site (Unfiltered)

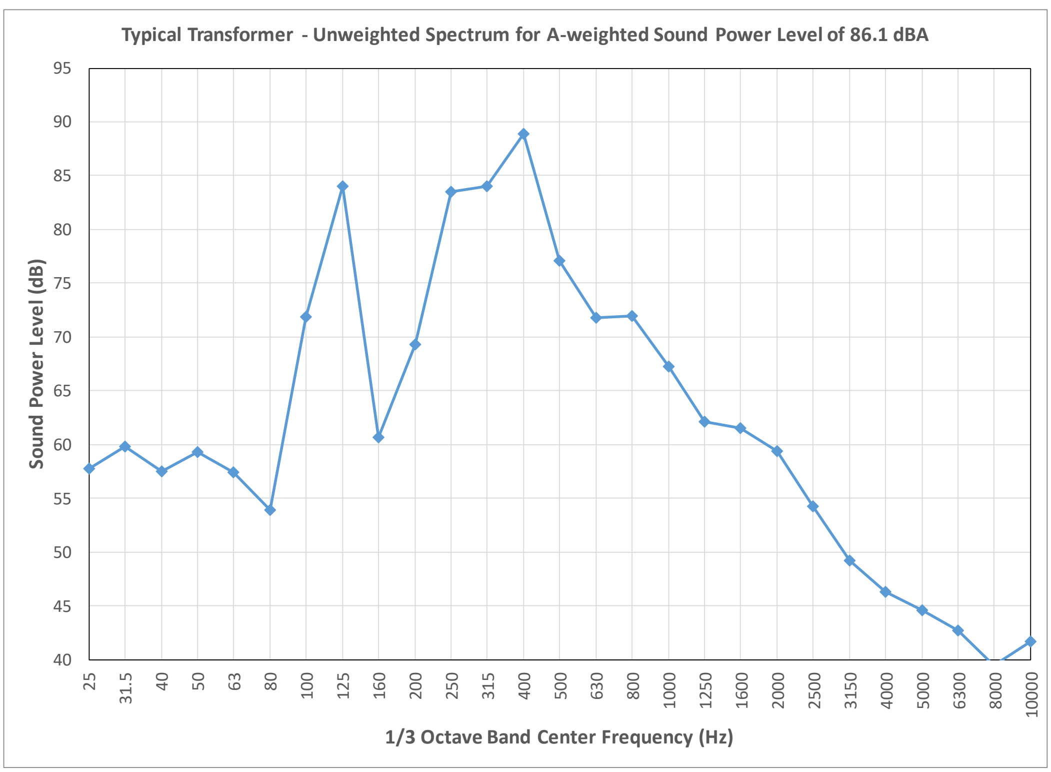
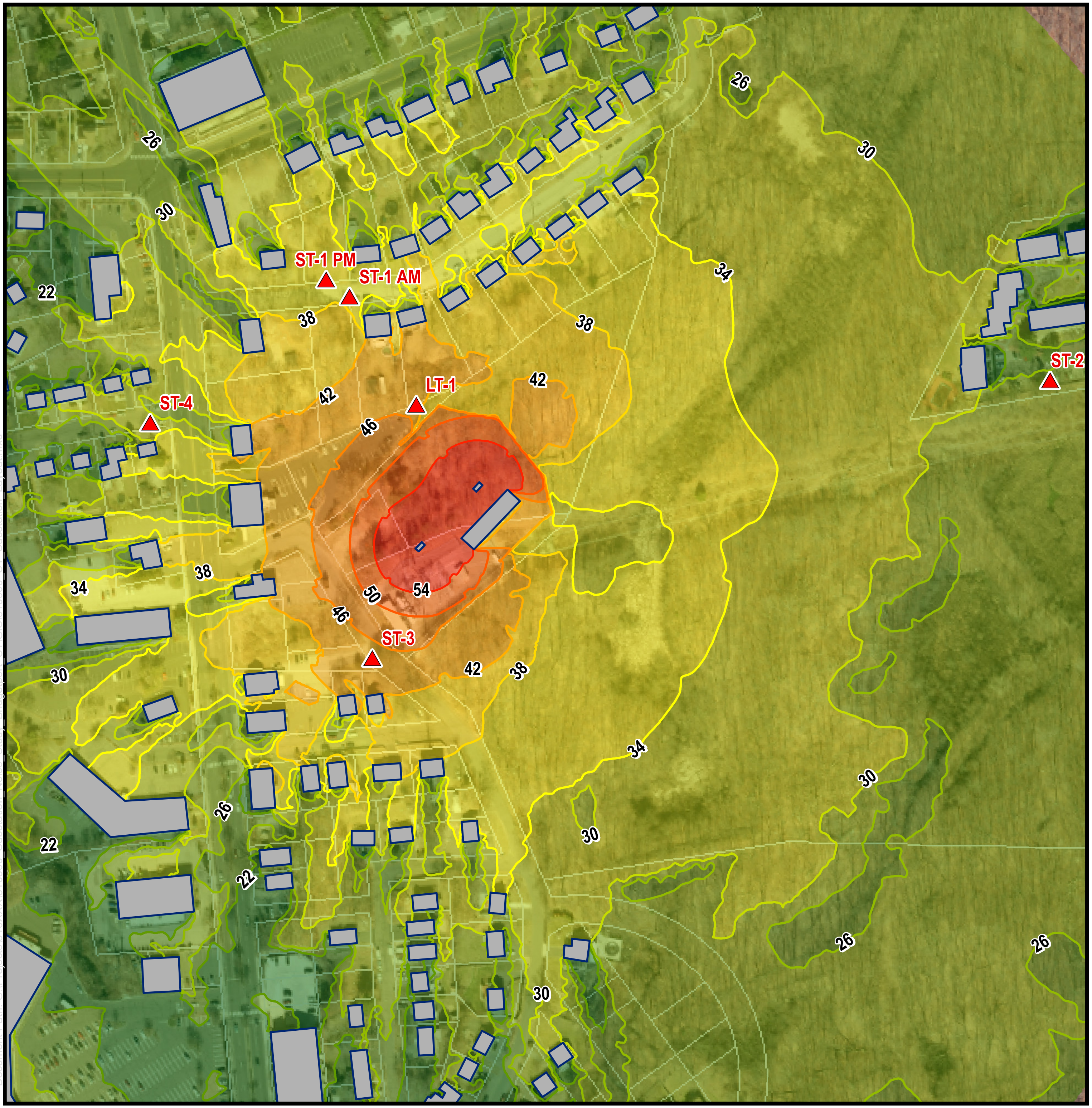


Figure 11. Typical Transformer Spectrum for an A-weighted Sound Power Level of 86.1 dBA



The United Illuminating Company

Figure 12: Noise Exposure Contours (in dBA) for the Operation of the Transformers

Old Town Substation Rebuild Project

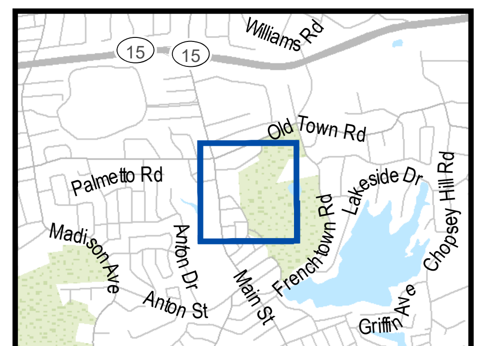
280/312/330 Kaechele Place
Bridgeport, CT

▲ # Measurement Site

A-Weighted Noise Level (dBA)

- Less than 22
- 22 - 26
- 26 - 30
- 30 - 34
- 34 - 38
- 38 - 42
- 42 - 46
- 46 - 50
- 50 - 54
- Greater than 54

0 100 200 400 Feet



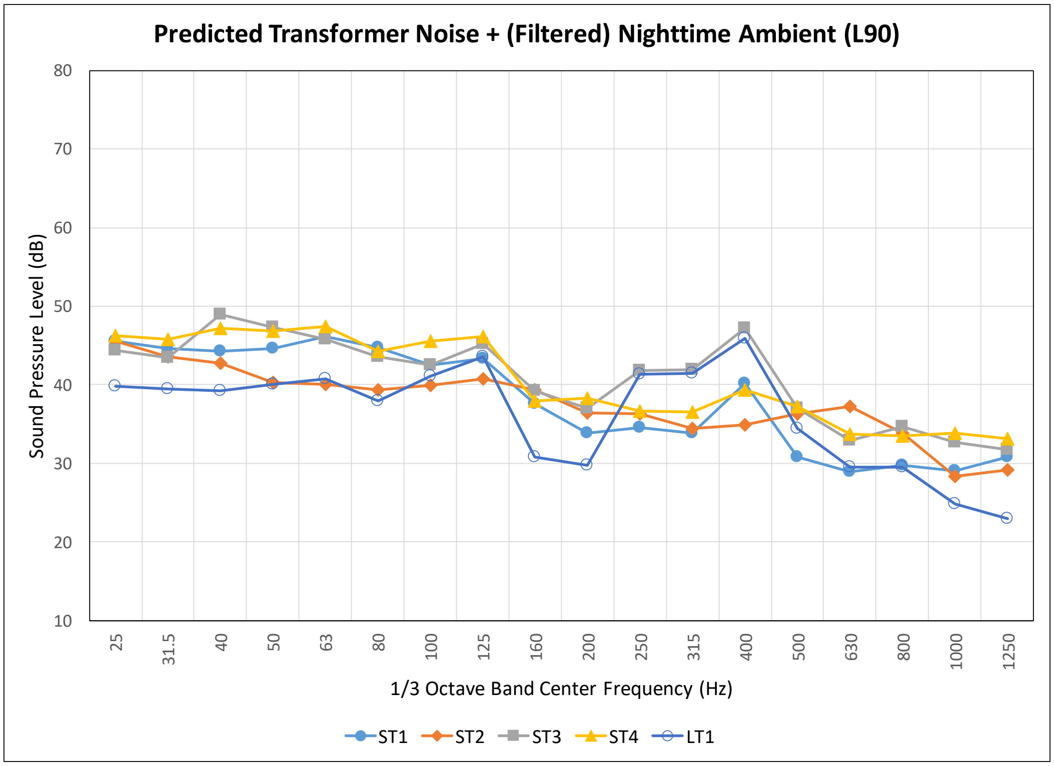


Figure 13. Predicted Transformer Noise Added to (Filtered) Nighttime Ambient L_{90} in 1/3 Octave Bands at Measurement Sites

APPENDIX B. FUNDAMENTALS OF ACOUSTICS

This appendix describes the noise terminology and metrics used in this report.

Decibels (dB), Frequency and the A-weighted Sound Level (dBA)

Loudness is a subjective quantity that enables a listener to order the magnitude of different sounds on a scale from soft to loud. Although the perceived loudness of a sound is based somewhat on its frequency and duration, chiefly it depends upon the sound pressure level. Sound pressure level is a measure of the sound pressure at a point relative to a standard reference value; sound pressure level is always expressed in decibels (dB).

Decibels are logarithmic quantities, so combining decibels is unlike common arithmetic. For example, if two sound sources each produce 100 dB operating individually and they are then operated together, they produce 103 dB. Each doubling of the number of sources produces another three decibels of noise. A tenfold increase in the number of sources makes the sound pressure level go up 10 dB, and a hundredfold increase makes the level go up 20 dB. If two sources differ in sound pressure level by more than 10 decibels, then operating together, the total level will approximately equal the level of the louder source; the quieter source doesn't contribute significantly to the total.

People hear changes in sound level according to the following rules of thumb: 1) a change of 1 decibel or less in a given sound's level is generally not readily perceptible except in a laboratory setting; 2) a 5-dB change in a sound is considered to be generally noticeable in a community setting; and 3) it takes approximately a 10-dB change to be heard as a doubling or halving of a sound's loudness.

Another important characteristic of sound is its frequency, or "pitch." This is the rate of repetition of sound pressure oscillations as they reach our ears. Frequency is expressed in units known as Hertz (abbreviated "Hz" and equivalent to one cycle per second). Sounds heard in the environment usually consist of a range of frequencies. The distribution of sound energy as a function of frequency is termed the "frequency spectrum."

The human ear does not respond equally to identical noise levels at different frequencies. Although the normal frequency range of hearing for most people extends from a low of about 20 Hz to a high of 10,000 Hz to 20,000 Hz, people are most sensitive to sounds in the voice range, between about 500 Hz to 2,000 Hz. Therefore, to correlate the amplitude of a sound with its level as perceived by people, the sound energy spectrum is adjusted, or "weighted."

The weighting system most commonly used to correlate with people's response to noise is "A-weighting" (or the "A-filter") and the resultant noise level is called the "A-weighted noise level" (dBA). A-weighting significantly de-emphasizes those parts of the frequency spectrum from a noise source that occurs both at lower frequencies (those below about 500 Hz) and at very high frequencies (above 10,000 Hz) where we do not hear as well. The filter has very little effect, or is nearly "flat," in the middle range of frequencies between 500 and 10,000 Hz. In addition to representing human hearing sensitivity, A-weighted sound levels have been found to correlate better than other weighting networks with human perception of "noisiness." One of the primary reasons for this is that the A-weighting network emphasizes the frequency range where human speech occurs, and noise in this range interferes with speech communication. Another reason is that the increased hearing sensitivity makes noise more annoying in this frequency range. Figure B-1 shows the relative response of various weighting networks including the A weighting network.

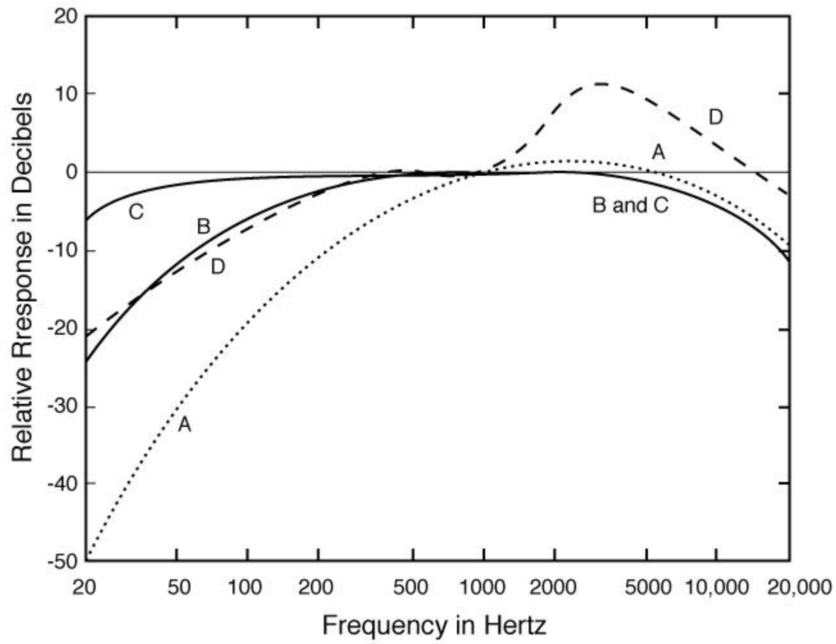


Figure B-1. Relative Response of A-, B-, C-, and D-Weighting Networks

Figure B-2 shows common indoor and outdoor A-weighted sound levels and the environments or sources that produce them

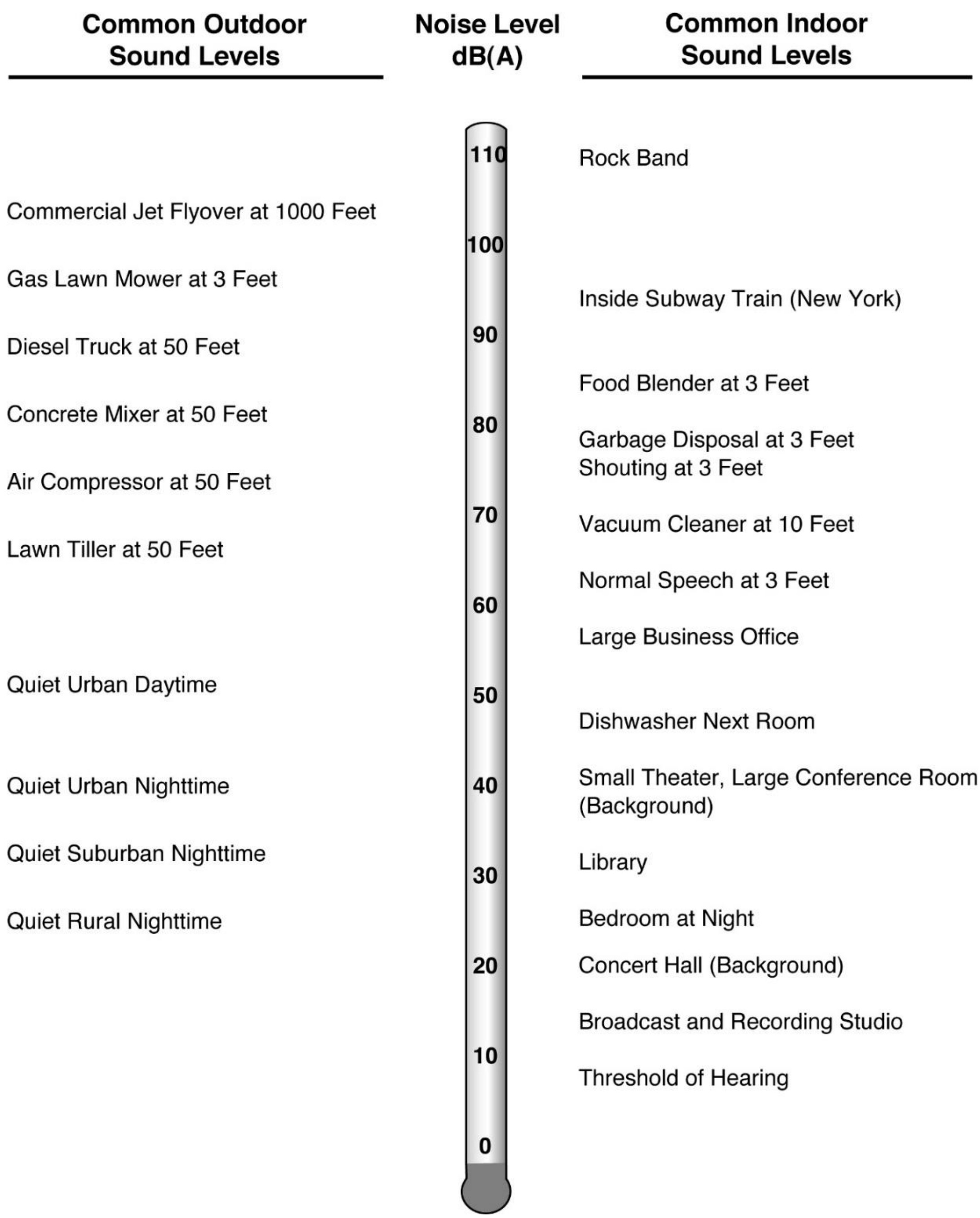


Figure B-2. Common Outdoor and Indoor A-weighted Sound Levels

Maximum Sound Level (L_{max})

The variation in sound level over time often makes it convenient to describe a particular noise "event" by its maximum sound level, abbreviated as L_{max} or L_{Amax}. The maximum level describes only one dimension of an event; it provides no information on the cumulative noise exposure. In fact, two events with identical maxima may produce very different total exposures. One may be of very short duration, while the other may continue for an extended period and be judged much more annoying. The Sound Exposure Level metric corrects for this deficiency.

Equivalent Sound Level (L_{eq})

The Equivalent Sound Level, abbreviated L_{eq}, is a measure of the total exposure resulting from the accumulation of A-weighted sound levels over a particular period of interest -- for example, an hour, an 8-hour school day, nighttime, or a full 24-hour day. However, because the length of the period can be different depending on the time frame of interest, the applicable period should always be identified or clearly understood when discussing the metric. Such durations are often identified through a subscript, for example L_{eq1h}, or $L_{eq(24)}$.

The L_{eq} may be thought of as a constant sound level over the period of interest that contains as much sound energy as (is “equivalent” to) the actual time-varying sound level with its normal peaks and valleys. It is important to recognize, however, that the two signals (the constant one and the time-varying one) would sound very different from each other. Also, the “average” sound level suggested by L_{eq} is not an arithmetic value, but a logarithmic, or “energy-averaged” sound level. Thus, the loudest events may dominate the noise environment described by the metric, depending on the relative loudness of the events.

Statistical Sound Level Descriptors

Statistical descriptors of the time-varying sound level are often used instead of, or in addition to L_{eq} to provide more information about how the sound level varied during the time period of interest. The descriptor includes a subscript that indicates the percentage of time the sound level is exceeded during the period. The L_{50} is an example, which represents the sound level exceeded 50 percent of the time, and equals the median sound level. Another commonly used descriptor is the L_{10}, which represents the sound level exceeded 10 percent of the measurement period and describes the sound level during the louder portions of the period. The L_{90} is often used to describe the quieter background sound levels that occurred, since it represents the level exceeded 90 percent of the period.

Sound Power Level

The sound power level is a fundamental measure of a source of sound and is a measure of the acoustic energy, or power, emitted by a source. Mathematically, the sound power level is ten times the logarithm (to the base 10) of a given sound power to the reference sound power (1 picowatt or 10-12 watt). The unit is the decibel.