EXTANT ACOUSTICAL CONSULTING LLC

adj. (ĕk-stânt') – to stand out or above.

TECHNICAL MEMORANDUM

August 7, 2019

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Transmitted electronically to: cschneider@cityofpacificgrove.org

Subject: Environmental Noise Assessment – Morris Dill Courts Pickleball Noise
Reference: Extant Project No. 190423.01

1 Introduction

The City of Pacific Grove has received comments from residence surrounding the Morris Dill Courts (courts), expressing concern over the noise generated by the on-going pickleball at the Courts. As a result of the expressed concern over the pickleball noise, the City of Pacific Grove is evaluating treatment options for helping control the noise levels in the surrounding community. Extant Acoustical Consulting LLC (Extant) was retained to conduct site specific noise assessment for the project location, prepare a computerized noise model to evaluate potential noise barrier configurations and provide a recommended treatment option. This memorandum presents the approach and methodology for the analysis, applicable regulatory criteria and the findings of the analysis. Appendix A provides a description of the metrics and terminology used in this report along with a discussion of acoustical fundamentals.

2 Regulatory Setting

The City of Pacific Grove has developed goals, policies, programs and thresholds with the intent of controlling and diminishing environmental noise and protecting inhabitants from exposure to excessive noise levels. These standards and guidelines are contained in the City of Pacific Grove General Plan and Municipal Code.

General Plan noise standards applicable to this project are contained within the Noise section of the Health and Safety Element (Chapter 10.14). Specifically, General Plan Program LL requires new proposed stationary noise sources to not exceed average hourly noise levels of 50 dBA or 45 dBA respectively during Daytime and Nighttime periods; and maximum noise levels of 70 dBA or 65 dBA during Daytime and Nighttime periods respectively. Program PP of the General Plan works to maintain consistency of the City's noise ordinance with the General Plan. And Program QQ provides for continued support of the City's noise ordinance as a means of enforcing inappropriate or unnecessary noise.

The primary noise standards contained within the City of Pacific Grove Municipal Code are enumerated in section 11.96.010. The standards provide a subjective basis for evaluating noise within the City, and are presented below:

(a) The level of the noise;
(b) The intensity of the noise;

(c) Whether the nature of the noise is usual or unusual;
(d) Whether the origin of the noise is natural or unnatural;
(e) The level and intensity of the background noise, if any;
(f) The proximity of the noise to residential sleeping facilities;
(g) The nature and zoning of the area within which the noise emanates;
(h) The density of the inhabitation of the area within which the noise emanates;
(i) The time of the day or night the noise occurs;
(j) The duration of the noise;
(k) Whether the noise is recurrent, intermittent, or constant; and
(l) Whether the noise is produced by a commercial or noncommercial activity.

2.1 Additional Criteria Discussion

As presented above, the City of Pacific Grove General Plan noise standards include 24-hour day-night noise levels (Ldn), hourly equivalent average noise levels (Leq) and maximum noise levels (Lmax). Due to the nature of the pickleball hit/impact, evaluating the sounds based on an averaged sound pressure level does not accurately represent the level of annoyance or human perception. The maximum noise level standard contained within Figure 10-7 of the General Plan would be the most appropriate City of Pacific Grove noise standard currently in place. However, sounds that are impulsive and tonal nature, such as the pickleball impacts are often more readily perceptible in the background noise environment, leading to a greater level of annoyance. To account for this increased perception many jurisdictions apply a 5 dB penalty to sounds that are tonal or impulsive, as called out in the ASTM International E1686. The more current American National Standards Institute (ANSI) S12.9, Part 4 also calls for a 5 dB adjustment to the sound exposure level of regularly impulsive sounds.

The noise standards contained within the City of Pacific Grove Municipal code, for the determination of unlawful noises provide significant context for the evaluation of noise within the City; however, the subjective nature of the standards are not easily transited for use in a quantitative evaluation of noise. As such, the Municipal Code noise standards are not applied within this analysis.

To aid in the evaluation of the pickleball noise mitigation effectiveness, this analysis will rely on the application of the City of Pacific Grove maximum stationary noise criteria and ANSI S12.9 Parts 4 and 5.

3 Noise Monitoring Survey

An existing noise survey was conducted by Extant from May 27th to May 29th, 2019 to document the existing noise environment in the neighborhood surrounding the Morris Dill Courts. Specific consideration was given to document existing noise sources levels of the pickleball activities at the Morris Dill Courts and at nearby noise-sensitive uses. Noise measurements were performed in accordance with ANSI and ASTM International guidelines. Measurements were performed at a total of nine measurement locations in the study area.

Noise measurements were performed using Larson Davis Laboratories (LDL) Model 831, Type 1 precision integrating sound level meters (SLMs). Field calibrations were performed on the SLMs with acoustic calibrators before and after the measurements. Equipment used meets all pertinent specifications of ANSI S1.4-1983 (R2006) for Type 1 SLMs. All instrumentation components, including microphones, preamplifiers and field calibrators have laboratory certified calibrations traceable to the National Institute of Standards and Technology (NIST).

Figure 1 shows the locations of each of the noise measurement sites on an aerial photograph of the study area, with the project location shown for context. On the figure, the long-term noise measurement sites are represented as LT-1; short-term measurement sites are represented as ST-1 through ST-8. Microphones were located 5 ft. above the ground, an average height for a person standing. The following sections separately discuss and report the results for the long-term and short-term monitoring.

3.1 Long-Term Monitoring

As noted above and shown in Figure 1, long-term noise monitoring was positioned and conducted to characterize and provide a representative sample of the pickleball source-noise levels. The noise measurements at long-term site spanned from May 27th through May 29th, 2019. Weather during the measurement period was fair. Winds during the measurement period ranged from calm to periods with wind ranging from 0-8 mph, with a few periods of isolated gusts. The temperature averaged 58°F for the measurement period. No precipitation was experienced during the measurement period.

Noise monitoring data is summarized below in Table 1 – Noise Monitoring Summary; detailed results from the Long-term monitoring are presented in Appendix B, in both tabular and graphical form. Monitoring results are described using noise level descriptors: Leq, which is the average sound level with equivalent sound energy as a continuous sound at that level; Lmax, which is the maximum sound level that occurred during the measurement period; and L90, the sound level exceeded 90% of the time, which also closely represents the background noise environment.

The long-term monitoring location was affected by traffic on the local roadway network, general community noise (pedestrians, dogs, kids playing, etc.), aircraft overflights, and noise levels from use of the Morris Dill Courts. Day-night noise levels were approximately 55 to 56 dBA Ldn with hourly average noise levels ranging from 33 dBA Leq to 61 dBA Leq.

3.2 Short-Term Noise Monitoring

Short-term noise monitoring was conducted to provide additional insight into the noise environment within the study area. Additionally, the short-term noise monitoring data provides key information about behavior of sound in the surrounding community and relative exposure at various locations in the project vicinity.

Short-term noise monitoring was performed by Extant on May 28th, 2019 during two (2) scheduled pickleball sessions. The short-term monitoring program documented the existing noise environment and source at eight (8) locations surrounding the Morris Dill Courts. Ambient-noise survey locations are shown in Figure 1. Noise levels and observations for the measurement environment were documented; noise levels recorded at each short-term noise monitoring location are presented in Table 1.

The primary noise source affecting the noise monitoring locations was vehicular traffic on the local roadway network and activity at the Morris Dill Courts (pickleball). Additional noise sources experienced during the noise-monitoring program included general community activities and aircraft overflights. Average noise levels during the short-term monitoring periods ranged from approximately 47 to 61 dBA Leq.

Table 1 – Noise Monitoring Summary

Site	Location	Start Time	Ldn	Average Noise Level, dBA[1]			
				Leq	Lmax	L50	L90
Long-term Monitoring							
LT-1	Western edge of Morris Dill Courts	05/27/2019 – 05/28/2019	54.9	55.4 (43.8)	72.5 (61.7)	45.6 (35.1)	40.7 (33.5)
		05/28/2019 – 05/29/2019	55.9	55.0 (47.0)	75.4 (64.5)	45.2 (34.6)	40.6 (33.1)
Short-term Monitoring – 05/28/2019							
ST-1	609 Fountain Avenue	9:30 AM	-	61.1	75.9	57.4	50.8
ST-2	Fountain Apartments	9:30 AM	-	53.0	69.9	47.6	43.5
ST-3	523 Gibson Avenue	10:10 AM	-	55.4	72.0	51.6	45.3
ST-4	511-515 Gibson Avenue	10:10 AM	-	54.6	69.4	49.4	43.6
ST-5	488 Gibson Avenue	11:00 AM	-	49.3	64.5	45.9	42.7
ST-6	605 14th Street	11:00 AM	-	48.7	67.5	45.1	42.6
ST-7	465-475 Gibson Avenue	11:40 AM	-	49.6	64.5	42.0	40.0
ST-8	502-520 Sinex Avenue	11:40 AM	-	46.8	59.3	42.7	40.8

Notes: dBA = A-weighted decibels; Ldn = average day-night level; Leq = average equivalent noise level; Lmax = maximum noise level; L50 = sound level exceeded 50% of the period; L90 = sound level exceeded 90% of the period.
Locations of noise monitoring sites are shown on Figure 1.
1- Average noise levels expressed for the long-term monitoring location are: daytime (nighttime)
Source: Extant Acoustical Consulting LLC, 2019

3.3 Pickleball Noise Levels

The noise monitoring data was post-processed to extract the pickleball specific noise levels experienced at each of the monitoring locations. Noise levels generated by the pickleball impacts ranged considerably depending on the player, paddle and ball. Documenting the specific paddles or balls in use at the time of the noise monitoring was beyond the scope of this analysis; however, noise levels are estimated to have been documented from several thousand hits/impacts over the course of the monitoring period. As such, the documented pickleball noise levels are considered to be representative of the paddle and ball combinations used at the Morris Dill Courts.

During the short-term monitoring period, noise levels directly attributable to pickleball hits/impacts were notated at each of the monitoring locations. The average and maximum sound pressure levels (SPL) that were directly attributable to the pickleball impact are summarized below in Table 2. Pickleball noise levels at the short-term monitoring location ST-8 were noted to be less than the existing background noise levels and did not result in a noticeable change in the SPL at that location; however, the pickleball hits remained audible on occasion.

As shown in Table 2, pickleball noise levels ranged from below background noise levels to approximately 76 dBA at the residential parcel nearest the Courts (609 Fountain Avenue). With the exception of the 609 Fountain Avenue residence, pickleball noise levels did not exceed the City of Pacific Grove General Plan Maximum Allowable Stationary Noise Level standard of 70 dBA Lmax.

The Pacific Grove 50 dBA Leq (equivalent hourly average) daytime noise level standard for stationary sources was approached or exceeded at short-term sites ST-1 through ST-5 and at ST-7; however, the overall average noise levels documented during the short-term monitoring periods were driven by the ambient background noise levels in the study area and not directly attributable to the pickleball activities. Pickleball noise levels at the long-term reference location documented pickleball source levels ranging from 58.2 to 60.2 dBA Leq during pickleball play. Using standard point source propagation, this would result in pickleball noise levels at the short-term receivers ranging from approximately 40 to 57 dBA Leq. Propagated pickleball noise levels would exceed the City of Pacific Grove 50 dBA Leq standard at receivers ST1 (51.2 dBA), ST2 (52.6 dBA) and ST3 (56.7 dBA). Achieving compliance with the City of Pacific Grove 50 dBA Leq standard would require reductions of noise levels of by approximately 1, 3 and 7 dBA at ST-1 through 3 respectively.

Table 2 – Pickleball Impact Noise Levels

		Sound Pressure Level, dBA				
Site	**Location**	**Average**	**Max**	**Adjusted[1]**	**Design Threshold**	**Required NLR[2]**
LT-1	Western edge of Morris Dill Courts	73.3	83.2	-	-	-
ST-1	609 Fountain Avenue	69.4	76.2	74.4	50	24
ST-2	Fountain Apartments	49.5	53.8	54.5	50	5
ST-3	523 Gibson Avenue	55.5	59.6	60.5	50	10
ST-4	511-515 Gibson Avenue	54.8	61.0	59.8	50	10
ST-5	488 Gibson Avenue	47.9	49.1	52.9	50	3
ST-6	605 14th Street	47.1	53.7	52.1	50	2
ST-7	465-475 Gibson Avenue	43.0	46.5	48.0	50	-
ST-8	502-520 Sinex Avenue	-[3]	-[3]	-	-	-

Notes: dBA = A-weighted decibels.
Locations of noise monitoring sites are shown on Figure 1.
1- Average sound pressure level with ANSI/ASTM impact adjustment.
2- Noise Level Reduction
3- Nosie levels directly attributable to pickleball impacts were at or below the background noise levels or 38 to 40 dBA.
Source: Extant Acoustical Consulting LLC, 2019

As previously discussed, the impulsive nature of the pickleball hits would lend itself to a higher level of human perception within the ambient noise environment and annoyance. Application of the 5 dB adjustment as suggested in ANSI S12.9 would result in average adjusted pickleball noise levels ranging from approximately 48 dBA to 74 dBA at the measurement locations representing nearby noise-sensitive receptors.

ANSI 12.9 Part 5 recommends a design threshold of 55 dB; however, the ambient noise level in the vicinity of the Morris Dill Courts is relatively quiet and so the design threshold of 50 dB was used. The required noise level reduction to achieve the design thresholds was calculated to range from 2 to 24 dB. Achieving noise level reductions greater than 15 dB is not typically feasible with the use of barriers, as a result the analysis will focus on mitigation and treatment options to achieve up to 10 dB at the nearby noise-sensitive receptors.

4 Barrier Analysis

Extant Acoustical developed a three-dimensional computerized noise simulation model to evaluate the behavior of the pickleball noise within the surrounding area and the effectiveness of potential treatment options. The pickleball net configurations documented during the field survey and the recorded pickleball noise levels were used as the basis for the noise simulation modeling. Additional inputs to the model were based on a digital terrain model of the surrounding area and aerial photography. Pickleball noise sources were located within the model based on the observed configuration. Noise prediction receivers representing the noise monitoring locations and nearby noise-sensitive receptors were located within the model for reference.

Within the noise simulation model, two barrier layouts were evaluated for effectiveness. Based on our correspondence with the City, they intend to utilize a product that could be attached to the existing fence. The first barrier layout would include placing the barrier material on the fence of the western-most courts that were used for pickleball during the measurement and observation period; separated from the main portion of tennis courts by the existing interior fence. The second barrier layout would include placing the barrier material along the entirety of the Morris Dill Courts perimeter fencing. The barrier layouts are presented on Figure 2 and Figure 3.

The original material which was discussed for use for the fence treatment barrier was a non-absorptive reinforced visco-elastic polymer designed specifically for this purpose. However, as it would be necessary to apply the barrier material to all four sides of the Courts, use of a non-absorptive acoustical treatment option would result in a "parallel barrier effect" that would compromise the effectiveness of the barrier. A parallel barrier effect occurs when, as the name implies, multiple barriers are placed in a manner (typically parallel) in which the acoustic energy of a source in between the barriers is reinforced by the barriers themselves. To limit the compromising impact of the parallel barrier effect on the proposed barrier treatment, the barrier configuration can be modified, or an acoustically absorptive material can be used on the interior facing portions of the barriers. Information on potential barrier materials is provided as an attachment in Appendix C.

The barrier analysis evaluated various configurations, heights and absorption applications to develop the most effective configurations for the potential options. A summary of the barrier effectiveness analysis is provided in Table 3.

Table 3 – Barrier Effectiveness Analysis Summary

Receiver		Noise Level Reduction (dB)					
		Inner Barrier			Outer Barrier		
No.	Description	Existing Fence Height	10-15 ft Non-Absorptive	8-12 ft Absorptive	Existing Fence Height	10-16 ft Non-Absorptive	8-13 ft Absorptive
ST-1	609 Fountain Ave	12	10	13	13	13	14
ST-2	Fountain Apartments	2	3	**5**	**5**	**5**	**5**
ST-3	523 Gibson Ave	6	**10**	**10**	6	**11**	**10**
ST-4	511-515 Gibson Ave	6	**10**	**10**	5	**10**	**10**
ST-5	488 Gibson Ave	**8**	**10**	**12**	**5**	**4**	**6**
ST-6	605 14th Street	**8**	**9**	**11**	**6**	**4**	**6**
ST-7	465-475 Gibson Ave	**6**	**8**	**11**	**3**	**5**	**5**
ST-8	502-520 Sinex Ave	**1**	**2**	**3**	**2**	**3**	**3**

Notes: dB = decibels.
Bold/Highlighted = Meets design criteria
Source: Extant Acoustical Consulting LLC, 2019

As shown above in Table 3, mounting the treatment along the existing fence heights, for both the inner and outer fence perimeter layouts, would not result in noise level reductions sufficient to meet the design goals for the project. Increasing the barrier height to range between 10 and 15 feet at the inner fence layout would meet the design goals of the project at all receivers with the exception of ST-1 and ST-2. Incorporating an absorptive treatment along the interior of the inner fence layout would allow for existing fence heights on the north, east and west fence lines, with the barrier height on the southern fence line being raised to 12 feet in height. The 8 to 12-foot absorptive treatment option would meet the project design goals at all receptors with the exception of ST1; which would not be feasible to achieve regardless of treatment.

For the outer perimeter fence layout, the most effective non-absorptive barrier configuration would require the installation of barrier material at heights ranging from 10 to 16 feet. With the incorporation of acoustically absorptive treatment on the interior of the barrier the required barrier heights to achieve the design goals would range from 8 to 13 feet. The acoustically absorptive barrier would allow for existing fence heights on the north, east and west fence lines, with the barrier height on the southern fence line being raised to 13 feet in height.

5 Conclusion

Extant Acoustical performed an assessment of the noise levels generated by the pickleball activity at the Morris Dill Courts in Pacific Grove. The noise level generated by the pickleball activity was documented at nine (9) locations in the vicinity of the Courts. The average noise level found to be generated by the pickleball paddle/ball impact during play was used as the basis for the noise source within the analysis. It should be noted that due to the variability in impacts from different paddle makes and models, it is expected that noise levels may be above or below the levels used in the analysis.

Pickleball noise levels generated at the Morris Dill Courts during the monitoring period were found to exceed the City of Pacific Grove Maximum Allowable Stationary Noise Level Standards at three of the receivers representing nearby noise-sensitive uses. Achieving compliance with the stationary noise standards is not expected to result in an appreciable reduction in the community reaction to the pickleball activity noise. To aid in the evaluation of community reaction, ANSI S12.9 part 4 and 5 were applied to develop project specific design goals anticipated to result in a more positive community reaction.

A computerized noise simulation model was developed and implemented to evaluate the pickleball noise levels and the effectiveness of various treatment options. The treatment options were evaluated based on their ability to achieve the design goals developed through the application of ANSI S12.9 part 4; with a goal of achieving feasible noise level reductions up to 10 dB in the surrounding community.

The findings of the barrier and treatment option analysis are summarized in Table 3. If the preferred option is to treat only the western-most court, the design goals can be met at 6 of the 8 receptors with a non-absorptive barrier or at 7 of the 8 receptors with an absorptive barrier. If the preferred option is to treat the entire outer perimeter of the Courts, the design goals can be met at 7 of the 8 receptors with wither a non-absorptive barrier or absorptive barrier. It is our recommendation to incorporate an acoustically absorptive noise barrier to help limit the "parallel barrier effect". The recommended barrier configurations for the inner and outer barrier layouts are presented in Figure 2 and Figure 3.

It should be noted that achieving the design goals developed for this project, based on ANSI S12.9 part 4, would result in significant reductions in pickleball noise levels in the surrounding community. However, due to the tonal and repetitive impact nature of the noise, it is reasonable to expect the pickleball impacts to remain audible during quiet ambient noise periods.

If you should have any questions or would like to discuss any aspect of this memorandum, please contact me via email at mcarr@extantacoustical.com or via phone at (916) 520-4322.

Respectfully,

EXTANT ACOUSTICAL CONSULTING LLC

Michael J. Carr, INCE, CTS
Principal Consultant

Signs and Symbols

- Point source
- Receiver
- Building
- Wall

Noise Level
Leq,1h, dB(A)

	45 - 50
	50 - 55
	55 - 60
	60 - 65
	65 - 70
	>= 70

Figure 1

Noise Monitoirng Locations and Existing Pickleball Conditions

Loudest Hourly Noise Level Contours, dBA Leq,1h

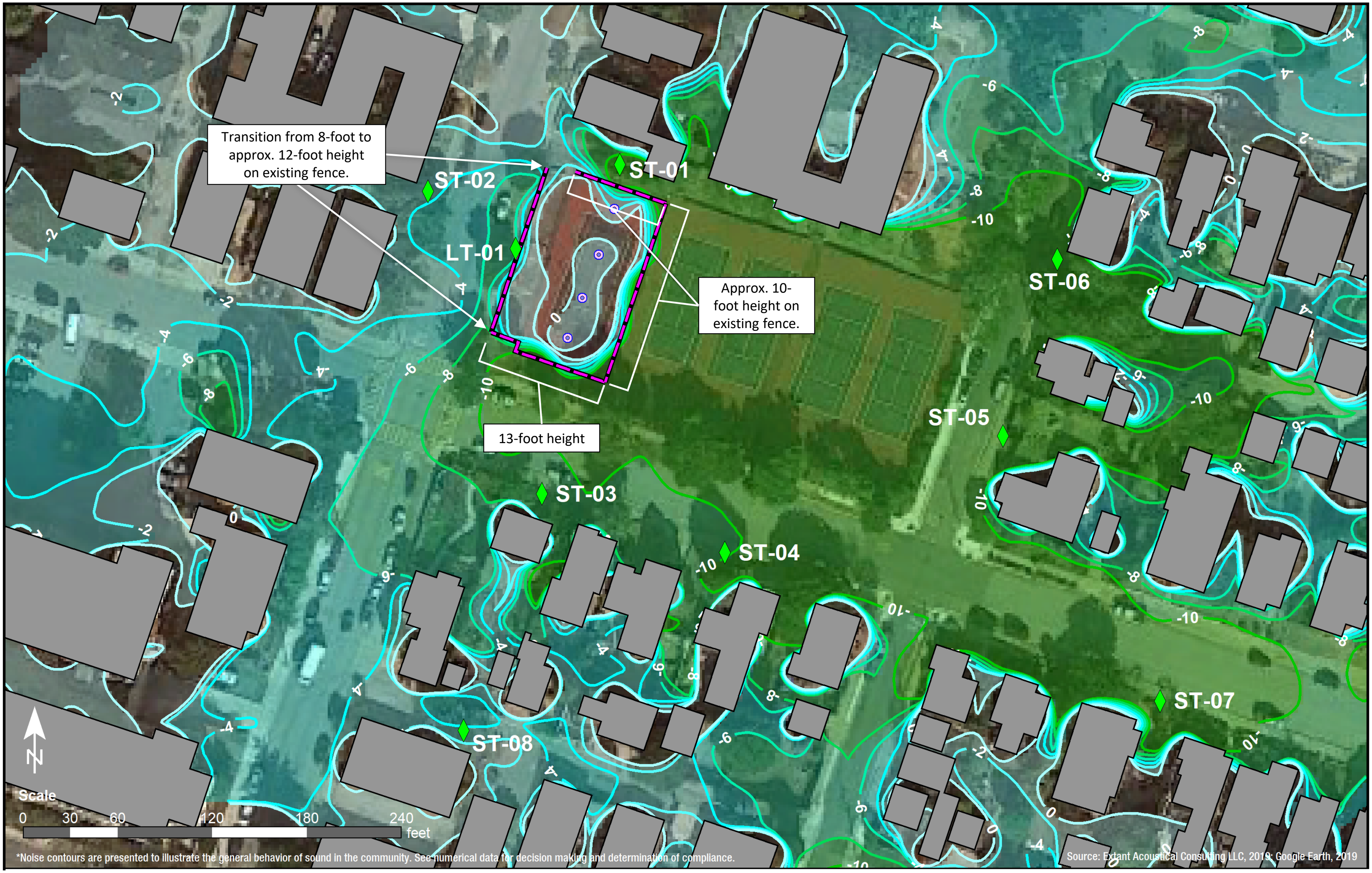
Additional Description

City of Pacific Grove
Morris Dill Pickleball

City of Pacific Grove, CA

EXTANT ACOUSTICAL CONSULTING LLC

Published: 8/1/2019
Engineer: MJC



Signs and Symbols

- Point source
- Receiver
- Building
- Noise Barrier

Difference level
in dB(A)

	<= -10
-10 <	<= -8
-8 <	<= -6
-6 <	<= -4
-4 <	<= -2
-2 <	<= 0
0 <	

Figure 2

Noise Level Reductions - Inner Barrier Layout

8-13 foot tall Absorptive Noise Barrier
Noise Level Difference Contours, dB

City of Pacific Grove
Morris Dill Pickleball

City Pacific Grove, CA

EXTANT ACOUSTICAL CONSULTING LLC

Published: 8/1/2019
Engineer: MJC

Signs and Symbols

- Point source
- Receiver
- Building
- Noise Barrier

Difference level
in dB(A)

	<= -10
-10 <	<= -8
-8 <	<= -6
-6 <	<= -4
-4 <	<= -2
-2 <	<= 0
0 <	

Figure 3

Noise Level Reductions - Outer Barrier Layout

8-12 foot tall Absorptive Noise Barrier
Noise Level Difference Contours, dB

City of Pacific Grove
Morris Dill Pickleball

City Pacific Grove, CA

EXTANT ACOUSTICAL CONSULTING LLC

Published: 8/1/2019
Engineer: MJC

Appendix A

Noise Fundamentals and Description of Noise Metrics

A.1 Noise Fundamentals

A.1.1 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), a logarithmic quantity.

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 frequency spectrum of sound is often represented as the sum of the sound energy in frequency bands that are one octave or 1/3-octave wide. An octave represents a doubling of frequency.

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. 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. The figure below shows common indoor and outdoor A-weighted sound levels and the environments or sources that produce them.

A.1.2 Equivalent Sound Level, Leq

The Equivalent Sound Level, abbreviated Leq, 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 Leq1h, or Leq (24).

Leq 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 Leq 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.

A.1.3 Statistical Sound Level Descriptors, Ln

Statistical descriptors of the time-varying sound level are often used instead of, or in addition to Leq 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 L50 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 L10, 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 L90 is often used to describe the quieter background sound levels that occurred, since it represents the level exceeded 90 percent of the period.

A.1.4 DNL (Day-Night Noise Level)

The 24-hour Leq with a 10 dB "penalty" applied during nighttime noise-sensitive hours, 10:00 p.m. through 7:00 a.m. The DNL attempts to account for the fact that noise during this specific period of time is a potential source of disturbance with respect to normal sleeping hours.

A.1.5 CNEL (Community Noise Equivalent Level)

The CNEL is similar to the DNL described above, but with an additional 5 dB "penalty" for the noise-sensitive hours between 7:00 p.m. to 10:00 p.m., which are typically reserved for relaxation, conversation, reading, and television. If using the same 24-hour noise data, the CNEL is typically 0.5 dB higher than the DNL.

A.1.6 SEL (Sound Exposure Level)

The SEL describes the cumulative exposure to sound energy over a stated period of time. Typically used to compare dissimilar noise events or to determine the effect of exposure to multiple events.

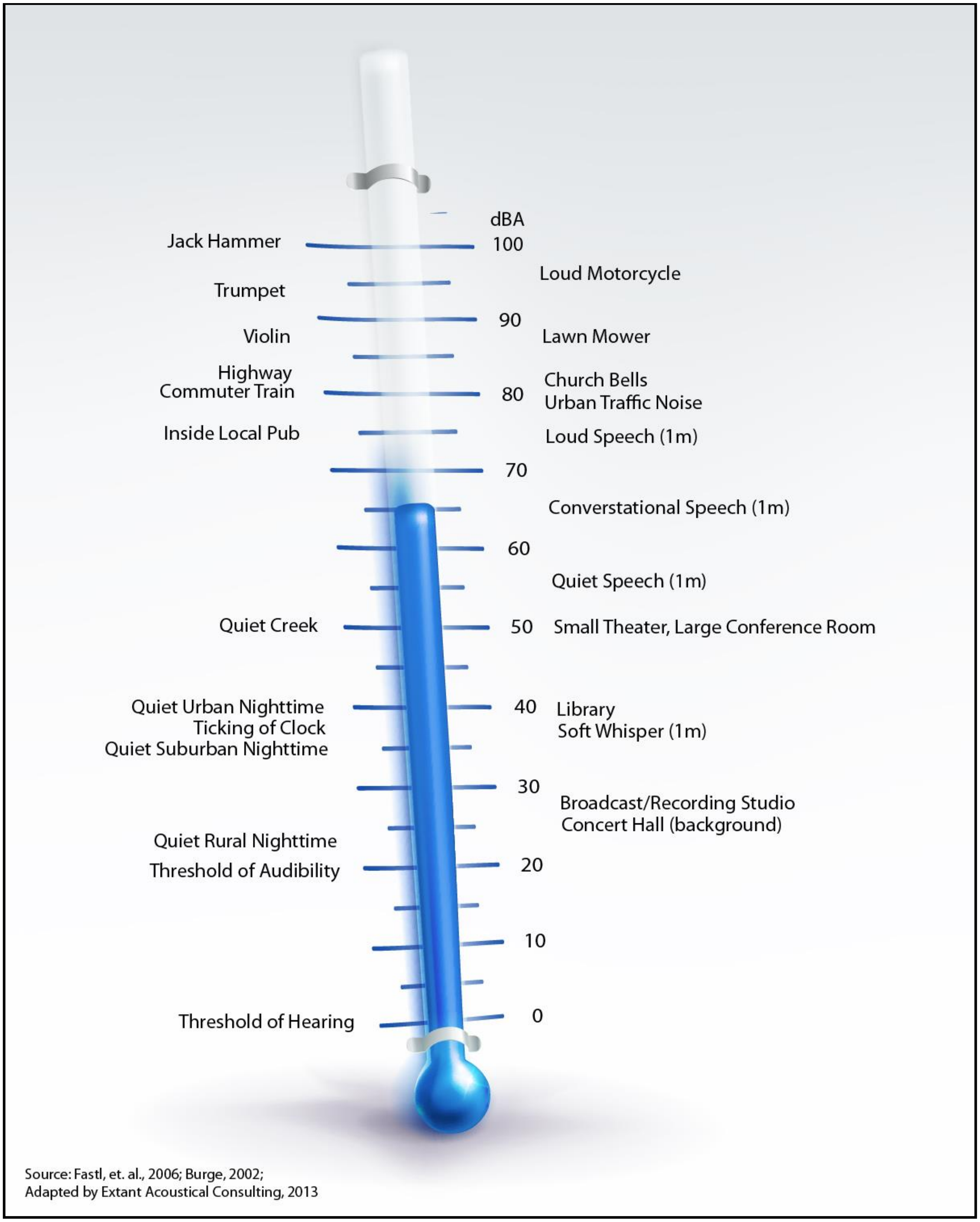


Exhibit 1 – Typical Noise Levels

A.1.7 Sound Propagation

As sound (or noise) propagates from the source to the receptor, the attenuation, or manner of noise reduction in relation to distance, depends on surface characteristics, atmospheric conditions, and the presence of physical barriers. The inverse square law describes the attenuation caused by the pattern of sound traveling from the source to the receptor. Sound travels uniformly outward from a point source in a spherical pattern with an attenuation rate of 6 dBA per doubling of distance. However, from a line source (e.g., a road), sound travels uniformly outward in a cylindrical pattern with an attenuation rate of 3 dBA per doubling of distance. The surface characteristics between the source and the receptor may result in additional sound absorption and/or reflection. Atmospheric conditions such as wind speed, temperature, and humidity may affect noise levels.

Furthermore, the presence of a barrier between the source and the receptor may also attenuate noise levels. The actual amount of attenuation depends on the barrier size and frequency of the noise. A noise barrier may be any natural or human-made feature such as a hill, tree, building, wall, or berm.

A.1.8 Effects of Noise on Humans

Excessive and chronic exposure to elevated noise levels can result in auditory and non-auditory effects in humans. Auditory effects of noise on people are those relating to temporary or permanent noise induced hearing loss. Non-auditory effects of exposure to elevated noise levels are those relating to behavioral and physiological effects. The non-auditory behavioral effects of noise on humans is primarily associated with the subjective effects of annoyance, nuisance, and dissatisfaction; which lead to interference with activities such as communications, sleep, and learning. The non-auditory physiological health effects of noise on humans has been the subject of considerable research efforts attempting to discover correlations between exposure to elevated noise levels and health problems, such as hypertension, and cardiovascular disease. The mass of research infers that noise-related health issues are predominantly the result of behavioral stressors (physiological) and not a direct noise-induced response. The degree to which noise contributes to non-auditory health effects remains a subject of considerable research, with no definitive conclusions.

The degree to which noise results in annoyance and interference, is highly subjective and may be influenced by a number of non-acoustic factors. The number and effect of these non-acoustic environmental and physical factors varies depending on individual characteristics of the noise environment including sensitivity, level of activity, location, time of day, length of exposure, etc. One key aspect in the prediction of human response to new noise environments is the individual level of adaptation to an existing noise environment. The greater change in noise levels which are attributed to a new noise source, relative to the environment an individual has become accustom too, the less tolerable new noise source will be viewed.

With regard to human perception of increases in sound levels expressed in dB, a change of 1 dB is generally not perceivable excluding controlled conditions and pure tones. Outside of controlled laboratory conditions the average human ear barely perceives a change of 3 dB. A change of 5 dB generally fosters a noticeable change in human response, and an increase of 10 dB is subjectively heard as a doubling of loudness.

Appendix B

Long-term Noise Monitoring Data

Appendix B-1
Long-Term 24 Hour Continuous Noise Monitoring

Project: Pacific Grove - Morris Dill Pickleball Courts
Date: May 27, 2019 to May 28, 2019
Site:

Hour	Leq	Lmax	L50	L90
12:00	60.9	76.6	44.0	38.7
13:00	52.3	74.3	43.7	38.6
14:00	50.0	71.2	44.4	40.3
15:00	51.1	72.3	44.6	40.3
16:00	55.0	74.7	48.4	40.6
17:00	51.9	72.8	44.7	40.6
18:00	48.2	70.2	41.8	37.5
19:00	49.8	69.5	41.0	36.5
20:00	48.3	69.1	36.4	34.4
21:00	46.1	69.4	35.6	34.2
22:00	45.5	68.3	35.1	33.8
23:00	39.6	63.3	35.0	33.7
0:00	38.3	62.8	34.0	32.9
1:00	36.0	54.3	34.5	33.1
2:00	36.2	49.0	34.3	33.3
3:00	35.3	56.1	33.6	32.8
4:00	37.5	61.6	34.4	32.8
5:00	45.3	68.2	36.0	34.4
6:00	50.6	72.1	38.7	34.8
7:00	51.4	73.4	42.1	35.8
8:00	54.7	71.9	48.6	42.3
9:00	59.6	71.5	57.0	51.5
10:00	59.1	74.5	56.7	51.9
11:00	58.2	76.2	54.8	47.1

Lowermost Level

	Leq	Lmax	L50	L90
Daytime (7 a.m. - 10 p.m.)	46.1	69.1	35.6	34.2
Nighttime (10 p.m. - 7 a.m.)	35.3	49.0	33.6	32.8

Average Level

	Leq	Lmax	L50	L90
Daytime (7 a.m. - 10 p.m.)	55.4	72.5	45.6	40.7
Nighttime (10 p.m. - 7 a.m.)	43.8	61.7	35.1	33.5

Uppermost-Level

	Leq	Lmax	L50	L90
Daytime (7 a.m. - 10 p.m.)	60.9	76.6	57.0	51.9
Nighttime (10 p.m. - 7 a.m.)	50.6	72.1	38.7	34.8

Energy Distribution

Daytime	96%
Nighttime	4%

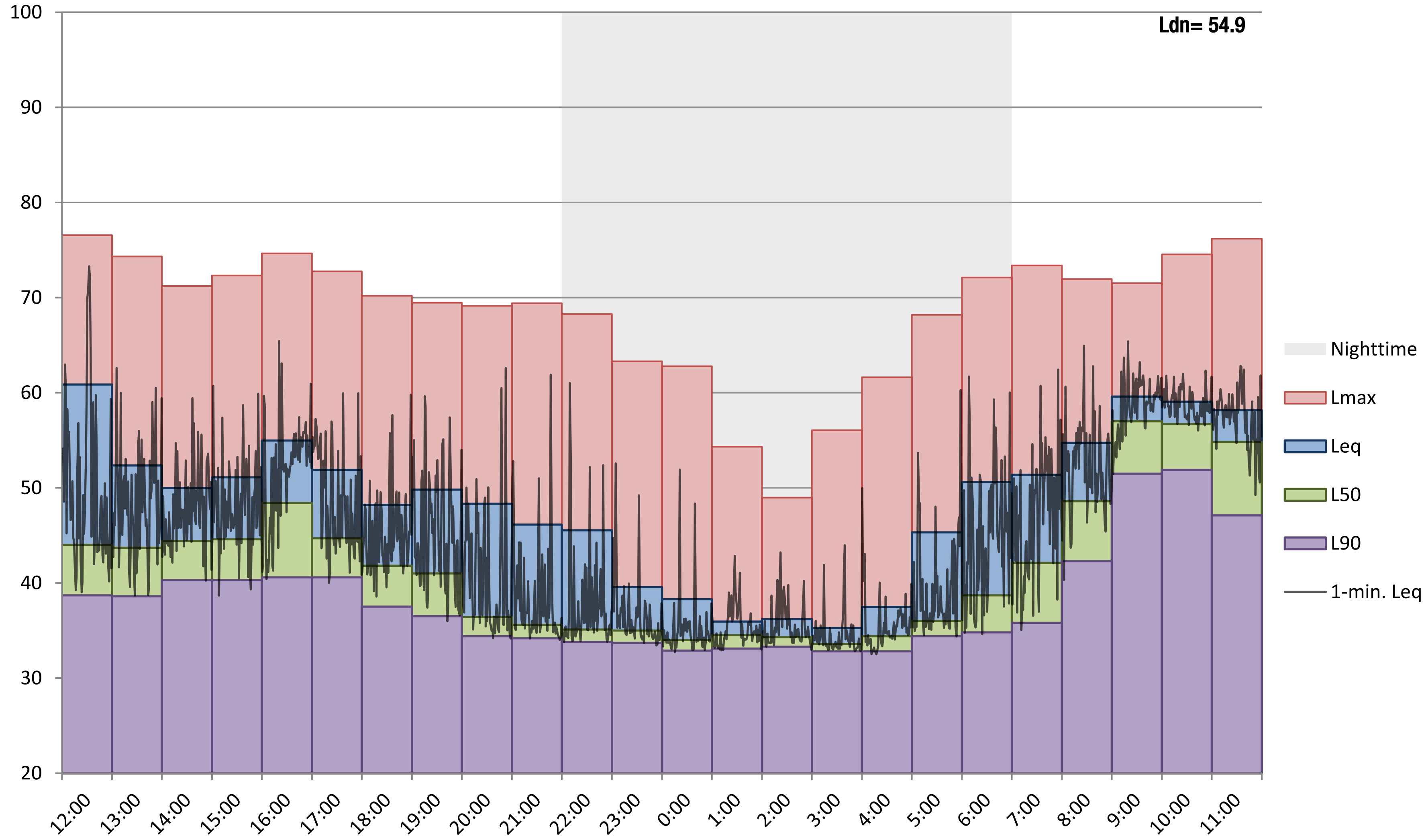
Calculated L_{dn}, dBA

54.9

Appendix B-1

Pacific Grove - Morris Dill Pickleball Courts -

May 27, 2019 to May 28, 2019



Appendix B-2
Long-Term 24 Hour Continuous Noise Monitoring

Project: Pacific Grove - Morris Dill Pickleball Courts
Date: May 28, 2019 to May 29, 2019
Site:

Hour	Leq	Lmax	L50	L90
12:00	53.0	77.2	46.9	41.9
13:00	55.1	79.3	45.9	41.4
14:00	53.7	74.3	46.5	40.9
15:00	59.9	75.2	57.5	52.7
16:00	60.2	77.8	57.6	52.3
17:00	55.4	74.9	46.7	39.5
18:00	54.2	80.3	41.6	37.8
19:00	50.6	76.1	40.0	37.0
20:00	48.5	71.8	37.4	35.7
21:00	49.5	74.7	37.1	34.7
22:00	47.7	74.6	36.0	34.5
23:00	42.0	64.1	34.9	33.3
0:00	39.3	61.9	33.2	32.6
1:00	36.0	60.8	33.4	32.7
2:00	33.4	43.4	33.3	32.8
3:00	38.3	64.1	32.6	31.9
4:00	53.2	74.8	33.6	32.7
5:00	43.0	65.2	34.2	33.1
6:00	51.1	71.9	39.8	34.7
7:00	55.0	79.0	42.5	36.4
8:00	54.5	74.0	47.1	39.1
9:00	52.2	71.3	43.5	38.9
10:00	50.8	69.5	43.4	39.4
11:00	52.5	75.6	44.8	41.1

Lowermost Level

	Leq	Lmax	L50	L90
Daytime (7 a.m. - 10 p.m.)	48.5	69.5	37.1	34.7
Nighttime (10 p.m. - 7 a.m.)	33.4	43.4	32.6	31.9

Average Level

	Leq	Lmax	L50	L90
Daytime (7 a.m. - 10 p.m.)	55.0	75.4	45.2	40.6
Nighttime (10 p.m. - 7 a.m.)	47.0	64.5	34.6	33.1

Uppermost-Level

	Leq	Lmax	L50	L90
Daytime (7 a.m. - 10 p.m.)	60.2	80.3	57.6	52.7
Nighttime (10 p.m. - 7 a.m.)	53.2	74.8	39.8	34.7

Energy Distribution

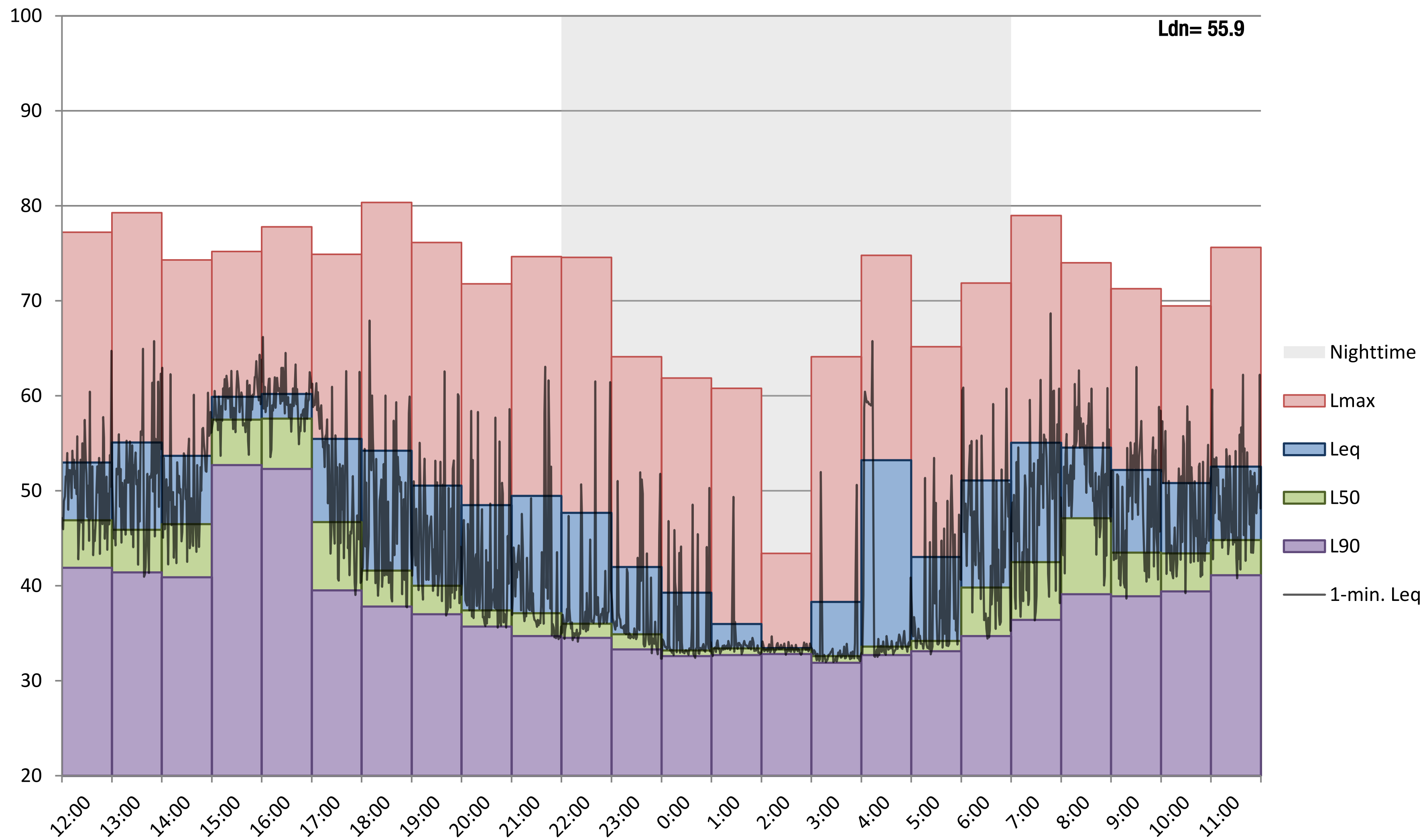
Daytime	91%
Nighttime	9%

Calculated L_{dn}, dBA

55.9

Appendix B-2

Pacific Grove - Morris Dill Pickleball Courts -
May 28, 2019 to May 29, 2019



Appendix C

Product Information

North American Office
Acoustiblok, Inc.
6900 Interbay Boulevard
Tampa, FL 33616 USA
Phone: 813-980-1400
Fax: 813-549-2653
www.acoustiblok.com
sales@acoustiblok.com

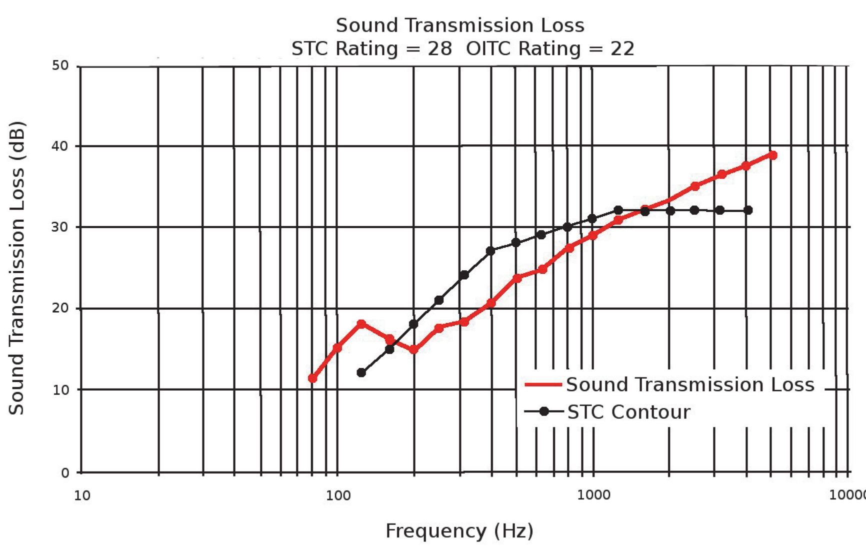
100% Recyclable

Acoustifence® Benefits and Specifications

- The material itself is lab tested STC value of 28, which represents over an 80% reduction in sound to the human ear. (Your results will be less as sound reflects off all surrounding materials or structures, i.e., buildings, trees, etc.)
- Works extraordinarily well at blocking direct line of sight sound.
- Far less sound reflected than solid walls.
- Installed or removed in less than one hour.
- To store, Acoustifence easily rolls up like a carpet into 12 in. roll.
- UV tolerant and does not support mold.
- Virtually indestructible, very resilient material.
- 100% recyclable
- Comprised of 100% recycled materials.
- Will accept most paint finishes.
- Includes qty. 70, 11 in. heavy duty 120 lb. (black) nylon ties; stainless steel ties are available.
- Can blend in with any background using our Acoustifence-Landscapes®.

Material Specifications – Part # "Acoustifence 6x30 Industrial"

Acoustical Rating	STC 28 / OITC 22
Size	6 ft. (1.83m) x 30 ft. (9.14m) x 0.125 in .(3mm) 180 ft² (16.72m²)
Weight	185 lbs. (84Kg)
Fastening	Black brass grommets every 6 in. (152mm) along top edge with four grommets spaced along the bottom edge. Commonly installed horizontally.
Color	Black or Forest Green
(This is an industrial product and minor surface blemishes are a possibility.)	



(Specifications and prices subject to change without notice.)

<u>Acoustifence Installation Pictures</u>

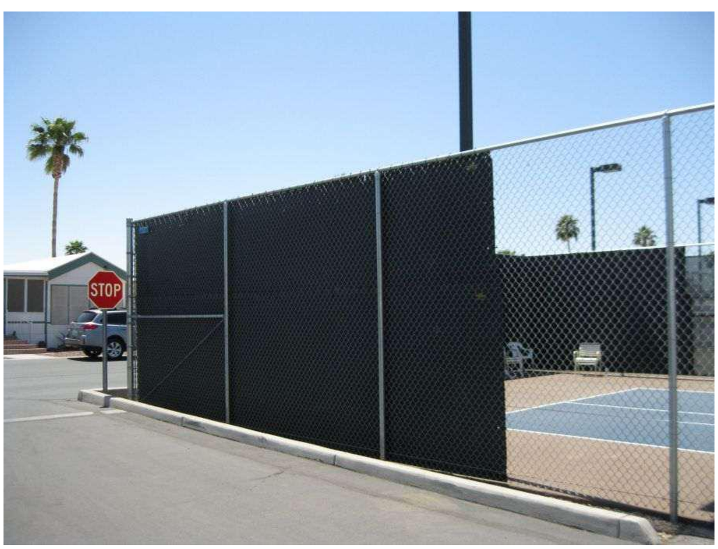
Below are pictures of installed Acoustifence for various types of projects.

King Fence, Inglewood, CA

King Fence, Inglewood, CA

Residential installation on Chain Link

Commercial Installation around electrical Equipment



Pickle Ball Court

Dog Park

Industrial
NOISE CONTROL PRODUCTS

NOISE BARRIER/SOUND ABSORBER COMPOSITE

Spec Data Sheet

BBC-SERIES
NOISE BARRIERS/SOUND ABSORBER COMPOSITES

BBC-13 Noise Barrier/Sound Absorber Composite

Sound Seal's BBC-13 offers the benefits of a noise barrier and a sound absorber. The BBC-13 consists of a reinforced 1-lb psf loaded vinyl noise barrier bonded to a 1" fiberglass that is quilted with a vinyl-coated-fiberglass-cloth facing. Curtain panels are constructed with grommets across the top and Velcro along the vertical edges. Rolls are available 54" wide x 25' long and can be supplied with edges bound or unbound.

- Class A flammability rated per ASTM E84
- Available facing colors: gray, tan, or black
- Available barrier colors: gray, tan, blue or olive

Applications:

Typically used as modular curtain panels in acoustical curtain enclosures where abuse resistance and excellent durability is required. Also used as sliding acoustical doors, durable acoustical jacket on fans or as sound curtain panels on outdoor construction projects. This composite material absorbs sound within an enclosed space and reduces the transmission of noise from that space.

Product Data:

Description	Vinyl coated fiberglass cloth facing quilted on 1" fiberglass/ 1lb-psf reinforced loaded vinyl barrier
Flammability	Flame Spread: 23.0 Smoke density: 30.0
Nominal thickness	1.0 inch
Temperature range	-20° to +180° F
Standard Roll size	54" wide x 25' long
Weight	1.22 lbs. psf

Acoustical Performance:

Sound Transmission Loss

	OCTAVE BAND FREQUENCIES (Hz)						
Product	**125**	**250**	**500**	**1000**	**2000**	**4000**	**STC**
BBC-13	11	16	24	30	35	35	27

ASTM E-90 & E 413

Sound Absorption Data

	OCTAVE BAND FREQUENCIES (Hz)						
Product	**125**	**250**	**500**	**1000**	**2000**	**4000**	**NRC**
BBC-13	.12	.47	.85	.84	.64	.62	.70

ASTM C 423

SOUND SEAL®

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