April 28th, 2020

ATTN: Kevin Besch

Subject: Analysis of Proposed Solutions to Mitigate Accepted Noise Pollution Created by Possible Outdoor Kennel Facility.

Based on the plan shown to us by a group of neighboring homeowners, it is our professional opinion that sound transmission will emanate from the proposed kennel beyond the generally accepted standards set forth for any property adjacent to residential communities. The general standard adopted nationally for permissible sound pressure levels at the property line of a residential unit is 55 dBA during the daytime and 45dBA at nighttime. These standards have been an established norm for quite some time and still exist today.

During the last meeting, we presented our calculations of what the sound pressure level would be at the property line, both, with a barrier and without. Since we did not have the luxury of making "Extraordinary Assumptions", we needed to acquire a peak sound pressure level for the action of a barking dog from a meter away. In our last presentation, we used the measurements made from our professional sound level meter (equipped with a level 1 microphone) while outdoors with my dog, Loki. In that measurement the peak sound pressure level we observed at one meter was 120 dBA.

The information used for our current calculations are the dog vocalizations observed in a study published in the Journal of the Acoustic Society of America. In the chart below you will see four dogs, the frequency spectrum of their vocalizations in an anechoic chamber, and the maximum peak sound pressure level of those vocalizations. The chart, pulled from a study published by Karl-Heinz Frommolt and Alban Gebler, demonstrates the maximum peak to peak sound pressure level to be expected from varying dog vocalizations with a wide variety of power ranging from smaller dog vocalizations at the upper frequencies to larger dog vocalizations lower in the mid to high frequencies.

When trying to model the outcome of any possible noise level and the impact it might have outdoors, we must assume the maximum levels possible because isolation starts from the maximum possible noise produced and not from the minimum or an average. Using minimum or average vocalizations would not create an accurate picture of the degree to which sound nuisance issues will be present and would be a great error. Therefore, we will be using "Lisa's" maximum vocalization from 1.5 meters away as our base number. In the chart below Lisa's bark was measured at a peak level of 119.1 dB.

TABLE I. Basic characteristics of domestic dog vocalizations. The data were obtained from the measurement in 5-m distance in front of the animal (30° lateral), except the dog Lisa, where the data from the frontal measures at 1.5 m were given. In this analysis, high-frequency whines were excluded.

		Sound-pressure level *re*: 20 μPa (dB)					
		Calculated as root mean square value			Calculated as peak-to-peak value		
Dog	Maximun frequency (Hz) ± s.d.	Mean ± s.d.	Min	Max	Mean ± s.d.	Min	Max
Lisa (N = 104)	1116 ± 284	99.5 ± 8.4	79.2	112.4	107.1 ± 8.3	87.6	119.1
Thorsten (N = 329)	830 ± 187	94.7 ± 4.5	69.0	98.9	101.6 ± 5.0	75.5	106
Amali (N = 77)	603 ± 210	77.4 ± 9.8	57.9	94.3	87.5 ± 9.8	66.3	104.0
Luna (N = 78)	449 ± 143	67.9 ± 6.9	55.6	82.6	78.4 ± 6.4	64.5	92.2

In a report supplied by the petitioner, there was a base assumption made that dog vocalizations are around 90 dB and that is an oversimplification of the issue. The number shown here is 119.1 dB and this will be our starting point. In the same report, the petitioner's appraiser used an online calculator to try and gain an understanding of the sound pressure level at the property line. While this calculator uses the same simple formula we originally used, the difference between their results and ours were quite noticeable. There were two important points that we differ on. The first was the initial assumption of the appraiser that the maximum sound pressure level of a typical barking dog was 90dB. The second was a misunderstanding of the attenuation limitations provided by outdoor sound barriers due to many differing variables. In the chart on the next page, we used the petitioner's calculator to show what the actual results would be when we use

numbers supplied by peer-reviewed studies on dog vocalizations. The vocalizations presented are those of the dog named "Lisa" from the chart above.

Attenuation Calculator

1) *This is the noise present without a barrier at a distance of 42m*

Calculation of the sound level L_2, which is found at the distance r_2		
Reference distance r_1 from sound source: 1.5 m or ft	**Sound level L_1** at reference distance r_1: 119 dBSPL	Search for L_2
Another distance r_2 from sound source: 42' m or ft	**Sound level L_2** at another distance r_2: 90.06 dBSPL	**Sound level difference** $\Delta L = L_1 - L_2$: 28.94 dB

2) *This is the noise present without a barrier at the petitioner's distance of 67.67m*

Calculation of the sound level L_2, which is found at the distance r_2		
Reference distance r_1 from sound source: 1.5 m or ft	**Sound level L_1** at reference distance r_1: 119 dBSPL	Search for L_2
Another distance r_2 from sound source: 67.67 m or ft	**Sound level L_2** at another distance r_2: 85.91 dBSPL	**Sound level difference** $\Delta L = L_1 - L_2$: 33.09 dB

3) *This is the noise present with a barrier at 42m*

Calculation of the sound level L_2, which is found at the distance r_2		
Reference distance r_1 from sound source: 1.5 m or ft	**Sound level L_1** at reference distance r_1: 99 dBSPL	Search for L_2
Another distance r_2 from sound source: 42 m or ft	**Sound level L_2** at another distance r_2: 70.06 dBSPL	**Sound level difference** $\Delta L = L_1 - L_2$: 28.94 dB

4) *This is the noise present with a barrier at petitioners distance.*

Calculation of the sound level L_2, which is found at the distance r_2		
Reference distance r_1 from sound source: 1.5 m or ft	**Sound level L_1** at reference distance r_1: 99 dBSPL	Search for L_2
Another distance r_2 from sound source: 67.67 m or ft	**Sound level L_2** at another distance r_2: 65.91 dBSPL	**Sound level difference** $\Delta L = L_1 - L_2$: 33.09 dB

In the table above we see four different sets of criteria and results for the sound level at the property line if a Dog Kennel is approved. We used both the distance provided by the petitioner and the distance provided by the impacted community and we believe the community-supplied

measurements are the most accurate. Either way, this graphic can finally put to rest the idea sound level will be a "whisper" at the property line when, in fact, it will be quite noisy.

As we said during the last meeting, any outdoor barrier has a limited attenuation of 20dBA given sound will travel over the top of the barrier and any attenuation relies on many varying environmental conditions. For instance, high humidity and wind can also limit the barrier's effectiveness on any given day. Highly humid conditions can create a fairly good reflector and send much of the noise right over the wall to the other side. Any sound barrier must be professionally designed by an Acoustic Consultant or Engineer and installed by someone who has the proper knowledge on how to seal any barrier. Especially, if one wants to achieve the maximum possible level of attenuation. The product being proposed is called Acoustifence made by Acoustiblok. In this graphic, you will see Acoustiblok's disclaimer stating that the 28 dB transmission loss is a number obtained by measuring through the material and is not an in-the-field test of its outdoor barrier characteristics.

> AcoustiFence has an acoustical performance of STC 28, which gives you a transmission loss of 28dB through the material. It is worth noting that the level of attenuation of all outdoor barriers is affected by a variety of factors including end diffraction, angle of diffraction, wind direction, humidity and temperature.

This product was tested at Riverbank Laboratories and the transmission loss test was most likely obtained by measuring a 4-foot by 8-foot panel with the perimeter caulked to the concrete opening. This number demonstrates the quality of the product itself and does not reflect the reality of its in-the-field performance as a noise barrier.

One of the major misconceptions we see with sound nuisance issues is the belief that, if one type of noise pollution is considered acceptable, then any type of additional noise pollution is also deemed acceptable. This is not only an apple to oranges comparison; it is an oversimplification of an extremely complex subject. Last time I spoke, I made a particularly important distinction between impulse noise and broadband noise. Aircraft or lawnmowers would be considered a broadband noise and, while often loud, does not quite rank in the same category as impulse noises. Multiple barking dogs would be considered impulse noise measured peak to peak

with a repetitive atonal component. It is actually because of the constant repetition combined with high sound pressure levels that this specific form of noise pollution is so overwhelming and irritating. Below, is a poll we found from another study published to the ASA on Annoyance Factors for Common Neighborhood Noise. In the survey, canid (dog) vocalizations were found by far to be the most irritating of all the Neighborhood noises and in this particular survey, 12 times as many people listed dog barking more annoying than a helicopter.

TABLE II. Stationary sources most frequently mentioned as annoying.

	Number	Percentage
Dogs	24	38.1
Sirens	8	12.7
Garbage trucks	4	6.3
Buses (stopped)	4	6.3
Children playing	3	4.8
Doors slamming	2	3.2
Noisy neighbors	2	3.2
Helicopters	2	3.2
Walking on metal stairway	2	3.2
Miscellaneous sources (mentioned once each)	12	19.0
Total	63	100.00

Another survey in the same study also found some of the reasons why people were irritated by the different noises and ranked them on a scale of most to least irritating.

TABLE I. Annoyance factors rated by respondents as to degree of contribution to annoyance for neighborhood noise. 5 = contribute greatly; 1 = does not contribute.

Factor	Average rating
a. Loudness	3.59
b. Time of occurrence	3.57
c. How often the noise occurs	3.51
d. Quality of the sound	3.37
k. Interference with sleep	2.94
g. Frustration at inability to control noise	2.52
e. Meaning of sound	2.03
j. Interference with conversation	1.78
h. Not being use to noise	1.63
f. Relationship with person making noise	1.27
i. Fear reaction to the noise	1.21

In this survey the participants found loudness to be the most irritable aspect of neighborhood noise. Therefore, it is important to follow the generally accepted standards of 55 dBA during the day and 45 dBA at night, specifically with regards to neighboring properties. You will also notice the other top factors are all related to the situation that would be present when neighboring a kennel or other business capable of producing loud repetitive bursts of atonal sound during all hours of the day.

With all the proposed treatments and mitigation structures in place (with a noise barrier and a fence) the sound pressure level at the property line will be 65-80 dBA at best. This would not fall within the guidelines set by Title 35 of the Illinois compiled statute's recommendation of acceptable daytime noise levels at the property line. The section makes clear the daytime noise intrusion from neighboring properties should be no more than 55-dBA for this class of property. The sound ordinance for the City of St. Charles states no noise should be "audible" at the property line. This local standard sets the threshold even higher than the Illinois compiled statutes section related to noise pollution.

Conclusion

After looking over all of the information, we believe the sound emanating from the dog kennel will be significantly louder than the generally accepted standards for residential properties and there would be no plausible or reasonable way to alleviate the noise to a necessary level that sound nuisance issues will not be an ongoing problem for the neighboring properties.

Sincerely,
Mike Drapak

Sources

K.-H., Frommolt, and A. Gebler, "Directionality of Dog Vocalizations" J. Acoust. Soc. Am. 116, 561 (2004)

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