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February 12, 2020

Wilton Zoning Board of Adjustment
42 Main Street
P.O. Box 83
Wilton , NH O3086

Dear Zoning Board Members,

I am writing to share some information regarding height as it relates to noise in the Quinn Properties, LLC case. Refraction and shielding affect how sound travels. Since refraction of sound waves can increase with source height, and natural sound shielding typically decreases with source height, the height of the proposed structures is important.

Please take a few moments to watch this video of the Amherst, NH asphalt plant:
https://www.youtube.com/watch?v=O6GMPlZctJo

As you can hear in this video, a great deal of sound emanates from the plant; so much sound that an observer can barely hear a passing car over the din. I've measured the sound from this plant from a distance of about 220 feet. A one minute sound sample averaged 85dB and one of the steam "pops" measured at 90dB.

According to the Quinns, the plant in the video is the same as the 68 foot plant that Quinn Properties, LLC hopes to install on lot B-10 of our Industrial District, along with a 72 foot silo. There are shorter asphalt plant models available. However, we have been told that the applicants would rather have a taller plant and are therefore seeking a variance to exceed our 45 foot height restriction.

Sound waves can be influenced by wind speed gradients. When a sound source is elevated above the ground, the faster wind speed at the level of the source, paired with the slower wind speed closer to the ground, creates a condition that bends the sound waves coming from the source. When the wind is blowing in the direction that the sound waves are moving, the sound waves refract or bend toward the ground instead of traveling straight out (Figure 1). When sound is refracted toward the ground, conditions favor sound propagation, which increases the chance that sounds will be audible at a greater distance. This effect is more pronounced at distances greater than 50 meters from the source. Within limits, the taller the structure and the higher the wind speeds, the stronger the effect.

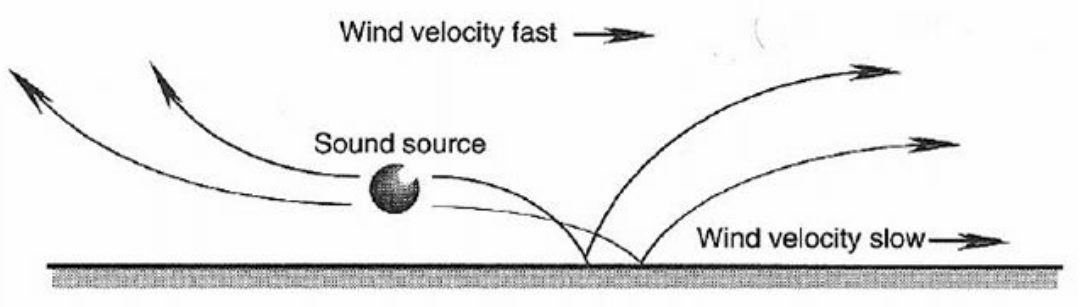

Figure 1 Refraction of sound in upwind (left) and downwind (right) conditions
Source: https://www.softdb.com/effect-of-wind-and-temperature-gradients-on-sound-waves/

Height also matters because, in a taller batch plant, many of the structures that emit loud sounds, such as the elevators, conveyor belts, vibrating screens and steam vents are situated higher than the natural barriers that could otherwise act as sound shields (Figures 2&3).

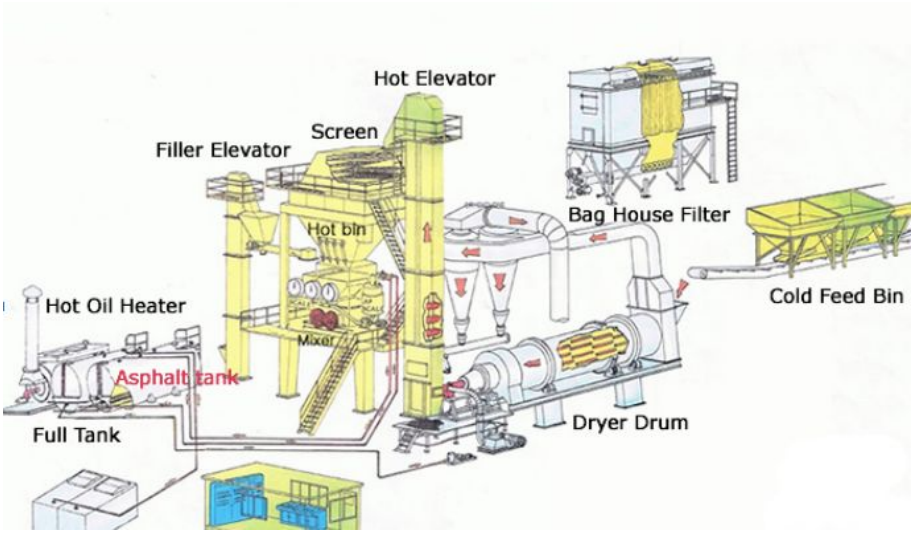

Figure 2 asphalt batch tower

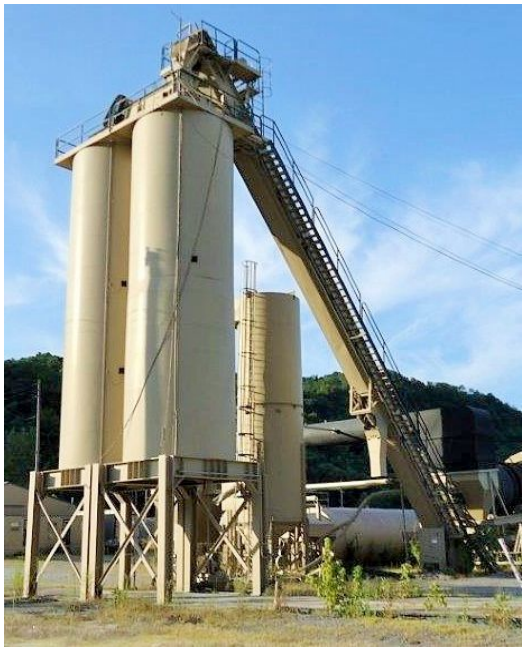

Figure 3-400 ton silo with conveyor

Again, referring to the video of the Amherst plant, if you listen as the car passes between the camera and the plant, you will hear the effect of a sound shield. Since unimpeded sound waves travel in a straight line, a shield is expected to mitigate sound if it lies between the sound source and the receiver. Sound coming from a 68 foot plant and the filling mechanism for a 72 foot silo are more likely to clear the natural shields around the site, while sound waves coming from a shorter plant are more likely to be shielded by the surrounding trees and natural landscape. Furthermore, the above mentioned wind speed gradient effects could also reduce the shielding effects of nearby trees, since the refracted sound would travel more easily over these natural barriers on windy days (Figure 2).

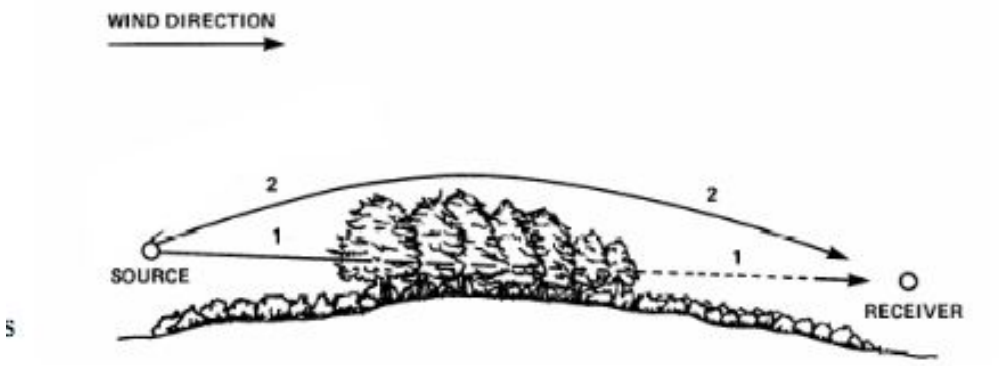

Figure 4 Line2-Refracted sound traveling over a natural sound buffer due to wind gradient effects. Line1-unrefracted sound. source: HANNAH, Lindsay. *Wind and Temperature Effects on Sound Propagation*

As you weigh the interests of the applicant against the interests of the community and consider the effects of increased height on sound, please keep in mind the following from Basner, M., Babisch, W., Davis, A, Brink, M. et al.(2014):

> Acute exposure to different kinds of noise is associated with arousals of the autonomic nervous system and endocrine system. Investigators have repeatedly noted that noise exposure increases systolic and diastolic blood pressure, changes heart rate, and causes the release of stress hormones (including catecholamines and glucocorticoids). Chronic exposure can cause an imbalance in an organism's homoeostasis (allostatic load), which affects metabolism and the cardiovascular system, with increases in established cardiovascular disease risk factors such as blood pressure, blood lipid concentrations, blood viscosity, and blood glucose concentrations. These changes increase the risk of hypertension, arteriosclerosis, and are related to severe events, such as myocardial infarction and stroke. ... More than 20 studies have shown environmental noise exposure has a negative effect on children's learning outcomes and cognitive performance.

This article cites sleep disturbances as the most prevalent negative health effects of noise. The fact that night paving has become increasingly popular and the fact that there are no ordinances specifically prohibiting 24-hour operations in our industrial district increase the likelihood that the proposed asphalt plant would increase noise pollution leading to sleep disruptions.

It may be because of my training in sound and audition that I am more focused on the auditory impacts of the taller structures, where most people might naturally focus on the visual aspects. However, in this case, it is far more likely that the acoustic effects of taller structures will be more threatening to public health than the visual effects.

Quinn Properties, LLC has the option to install a shorter plant which would allow them to pursue their desired use of the property while reducing the possibility of annoying and potentially harmful noise travelling from the site into the surrounding neighborhoods. If the applicant wishes to assert that increased structure height will not increase noise levels in the region, I suggest the board require them to complete an acoustic study of the site to prove their assertion. Indeed, it would seem that this would be a prudent course of action for them, since it would save them from getting further along in the approval process only to discover that sounds

coming from a taller plant may not meet the town's existing performance standard 4.6.2 which says: " Objectionable noise due to intermittent beat, frequency, shrillness or excessive volume shall be muffled or eliminated so as not to become a nuisance to adjacent property."

Granting the proposed height variance and thus allowing for increased noise in our region would violate the variance criterion that I consider to be paramount: "The variance will not be contrary to the public interest", therefore the variance should not be granted.

Sincerely,

Marilyn Jonas

Sources:

Basner, M., Babisch, W., Davis, A, Brink, M. et al.(2014). Auditory and non-auditory effects of noise on health. *Lancet,* 383(9925), pp.1325-1332, Retrieved from: https://www.thelancet.com/journals/lancet/article/PIIS0140-6736(13)61613-X/fulltext

Rochat, J. L., Reiter, D. (2016). Highway traffic Noise. *Acoustics Today,* Volume 12 (4), pp.34-46. Retrieved from: https://acousticstoday.org/wp-content/uploads/2016/12/Highway-Noise.pdf

Nijs, L. and Wapenarr, C.P.A. *The influence of wind and temperature gradients on sound propagation, calculated with the two-way wave equation*, Journal of Acoustic Society of America. Volume 87, number 5 (May 1990). Retrieved from: http://homepage.tudelft.nl/t4n4v/4_Journals/J.Acoust.Soc.Am/Jasa_90.pdf.

Hannah, L. *Wind and Temperature Effects on Sound Propagation*, New Zealand Acoustics. Volume 20, number 2 (2007). Retrieved from: https://www.acoustics.org.nz/sites/www.acoustics.org.nz/files/journal/pdfs/Hannah,_L_NZA2007_(a).pdf.