Cecil Township PA
2024 Augustine & Schultz Well Pad Community Noise Monitoring Report
Noise Impact Addendum

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1 INTRODUCTION

Thornton Acoustics & Vibrations (TAV) was retained by Cecil Township to perform community noise monitoring of the Bernard Schultz Well site and the Augustine Well site to assess the noise emissions incident on residents along Nine-Eighty Road and North DePaoli Road respectively. The monitoring was performed from February 25, 2024 until March 7, 2024.

While the noise levels measured during the monitoring period were found to be in nominal compliance with the Oil & Gas limits, the noise levels were sufficiently high, tonal and containing dominant low-frequency content such that they still create a noise **and vibration** (very low-frequency noise induces vibration, shaking and rattle in the residential homes) nuisance impact on the surrounding residential properties. The Cecil Oil & Gas Code has some fundamental limitations and deficiencies that create a loophole that allows for noise emissions that are within the Oil & Gas Code limits but clearly disruptive and detrimental to residents and in violation of the subjective limits in the Cecil Township Noise Ordinance (§151-2 Noise).

1.1 NOISE PRIMER

In order to understand and interpret the discussions contained in this report it is essential to understand a number of the technical nuances related to sound, noise (unwanted sound) and the human perception of noise. This primate is intended to be a very simple summary of some of the most critical issues.

The American National Standards Institute (ANSI) has developed a consensus standard for Acoustical Terminology (ANSI S1.1-2013) (https://webstore.ansi.org/standards/asa/ansiasas12013) which serves as the gold standard in the US (and is harmonized with International Standards such as ISO). All terminology used in this document and discussion is used as defined in this standard. The Township should purchase and adhere to the terminology as defined in the standard and this standard should be cited/referenced in any Noise Ordinance/Code.

Sound is a pressure perturbation propagating through air (in this case) that can be described in terms of the level, the frequency content (tone/pitch) and temporal variation. These variables affect the perception and impact of the sound, which when unwanted is called noise by convention. An effective noise ordinance must incorporate descriptors/metrics and limits that account for the different ways in which these aspects of sound may affect humans thereby potentially creating a nuisance and deleteriously impacting a community. If an Ordinance is not sufficiently comprehensive it may contain unintended loopholes that allow noise that may be highly disruptive while still meeting the letter of the Code.

In measuring and characterizing noise; there exist numerous metrics and descriptors. The metrics/descriptors used must be carefully chosen such that they capture and accurately describe and characterize the sound or noise problem being addressed. For many of these metrics and descriptors, although they fundamentally differ in their computation, the final results are expressed in terms of decibels (dB, dB(A), dB(C) etc.) and this can lead to confusion and misinterpretation. The use of the wrong metric will distort the measured results leading to erroneous conclusions. While average levels may be useful for steady state/continuous noise sources, many community noise sources do not fall into this category.

1.1.1 Level Effects

The decibel scale used to measure noise is a logarithmic scale rather than a simple linear scale and this leads to misunderstanding and misinterpretation of noise data and levels. Relatively small numerical changes or differences in sound level (expressed in decibels (dB)) are actually relatively large differences in acoustical energy. Several highly simplified rules-of-thumb regarding the sound level/decibel scale are useful. Every **3-dB** increase (or decrease) is a doubling (or halving) of the amount of acoustical **energy** and is generally considered the smallest change perceptible to an average human listener. A **5-6 dB** change is generally considered clearly perceptible to most observers. A **10-dB** increase (or decrease) is a doubling (or halving) of the perceived **loudness** of a sound. For example, if the ambient sound level is increased by 10 dB, the average person would perceive this is twice as loud. An increase by 20 dB, would be perceived as roughly 4-times as loud, 30 dB as 8-times as loud and so on.

Although an effective noise ordinance must establish overall sound level limits, regulating noise strictly based upon the overall levels, particularly the A-weighted level is often insufficient to prevent severe noise impacts. A comprehensive noise ordinance must use other complementary metrics and limits to address these limitations.

Noise may create a deleterious impacts based on the absolute level of the noise and/or the level increase above some baseline or ambient condition. A sufficiently loud noise will interfere with human activity, speech, sleep etc. regardless of the ambient noise environment. However, in quiet environments (with low ambient noise levels), even relatively “quiet” sounds may produce a negative impact to the degree that they exceed the ambient levels. Accordingly, particularly in residential zoned areas, it is best practice to conduct a well-designed ambient noise survey to be used to establish noise limits that are consistent with the character and nature of the community and to avoid arbitrary over or under regulation.

1.1.2 Frequency Effects

Noise may contain different levels of energy over a frequency range of roughly 20 to 20,000 Hertz ((Hz), or cycles per second – the human audible frequency range). The frequency content of noise has a very significant impact on the emission and propagation of noise as well as on the human perception, loudness, and impact of the noise. Humans are generally most sensitive to noise in a frequency range from roughly 500 to 5,000 Hz and less sensitive to lower frequencies. This does not however mean that we are not impacted by low frequency noise. In fact, low frequency sound will propagate farther and will readily propagate through structures and buildings with little attenuation. This means that low frequency noise will readily propagate into the homes of residents having a disproportionately severe impact.

In a very crude attempt to create metrics that approximated the frequency response of human hearing; the A, B, C, D and Z (un-weighted) frequency weightings were developed based upon equal loudness curves over 70 years ago (denoted dB(A), dB(B), dB(C) and dB/dB(Z)). In the subsequently 70 years, more accurate and representative metrics and human loudness descriptors have been developed. Note that the equal loudness curves on which the frequency weighting were developed vary in level and that A-weighting is related to low to mid-level sounds and C weighting is better correlated to louder sounds. The A, C and Z weighting frequency curves are shown in Figure 1.

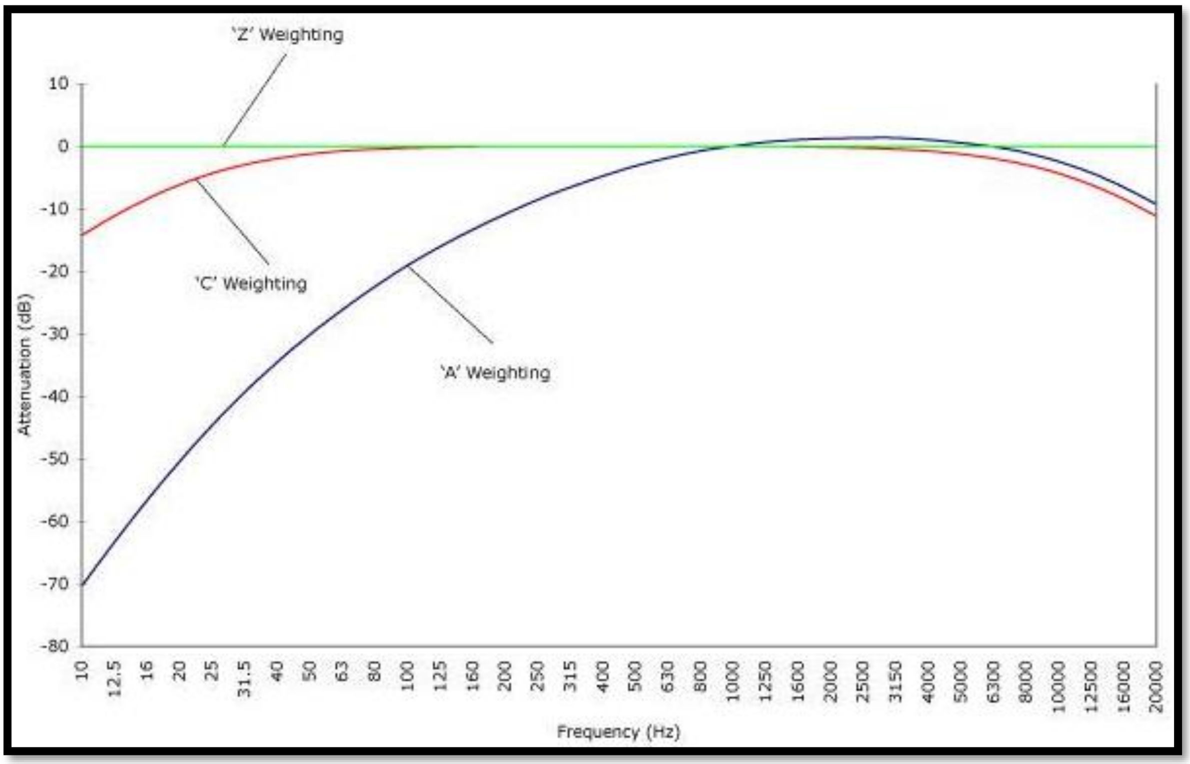

Figure 1 A, C and Z weighting curves.

The A-weighting filter is essentially a low-pass acoustical filter which filters out, deemphasizes, or rejects low frequency acoustical energy below 500 Hz. The A-weighted decibel has been proven over time to be highly correlated with the risk of occupational noise induced hearing loss and this has led to widespread use and familiarity with the A-weighted decibel. This has also led to an overuse and over-emphasis on the A-weighted decibel in noise regulations (many practitioners are unaware of the limitations and alternatives).

Regulating community noise strictly in terms of the A-weighted decibel (dB(A)) will not address common low-frequency community noise sources such as diesel/internal combustion equipment, fans, blowers ,pumps, heat exchangers/radiators etc. (all of which are endemic to Oil & Gas) which emit highly annoying low frequency energy which will be undercounted by A-weighting. In order to address this type of noise, the A-weighted limits must be supplemented with, or replaced by, other metrics such as the C-weighted decibel or with noise frequency-spectrum curve limits.

Low frequency noise, particularly very low frequencies below roughly 50 Hz, will induce vibration in structures whereby the noise frequency content coincides with and excites the natural structural frequencies causing the home, walls and items in the home to shake and rattle. Extremely low frequency noise will also be perceived by people as vibration and felt, particularly in their chest cavity, rather than being heard and perceived as sound. Low frequency noise has a corresponding long-wavelength and as a result low frequency noise readily propagates through and into structures and buildings. It is common for peel to report that the low frequency noise is "louder" inside the home (which is not the case, the home structure more effectively attenuates mid and high frequency noise which masked the low frequency noise outdoors and does not exist or mask the low frequency noise indoors causing people to perceive and increase in the low frequency loudness).

1.1.3 Temporal Effects

Humans do not hear in terms of time averages and we are capable of hearing and perceiving discrete short Impulse noise events. For example, impulsive noises (characterized by rapid rise times, very short durations – much less than a second, and rapid decay times) must be measured with metrics that have sufficiently short time-averaging properties to characterize the levels in a way that can be meaningfully compared to the human perception of loudness. Accordingly, impulsive sounds must be characterized using the Peak sound pressure level (L_{peak}, (dB)). The Peak sound pressure level is the instantaneous (no time averaging) sound level occurring over some arbitrary time interval. For longer duration transient events, the maximum sound level (L_{Smax} or L_{Fmax}) may be sufficient. Attempting to characterize and regulate noise with long time averages will not sufficiently address transient (even repetitive transient events) noise sources.

1.1.4 Ambient Noise

It is common for noise regulations or noise limits to be based in some manner, or referenced to the existing noise environment and to cite Ambient or background noise levels. However, this term is often vague and ambiguous and no clear methodology and metric are established with which to characterize the Ambient noise level**s** (note that I say levels – plural, as the Ambient noise varies with time and attempting to characterize a community with a single level is usually highly distorted).

Although there is not a US standard that defines Ambient noise, there is a clear convention and consensus in the acoustics/engineering community that the Ambient noise should be defined as the level exceeded 90% of the time in a community and that this is well correlated with people's perception. Accordingly, many communities and agencies require that the Ambient sound level be characterized by measuring the level exceeded 90% of the time (L_{90}) over an extended period of time, in discrete segments. A good approach would be to measure the L90 for a period of at least 1-week (to capture weekdays and a weekend) in 1-hour increments (to capture the time varying nature of the ambient noise, specifically the decrease in ambient noise at night).

2 CECIL TOWNSHIP CODE

The Cecil Township Oil & Gas Code has a number of deficiencies including:

1. In the Cecil Oil & Gas Code, Cecil concedes that "…oil and gas development is accompanied by inherent noise…". While drilling is arguably inherently noisy with the current state of the art, hydraulic fracturing, extraction, processing and transmission of oil and gas can be very effectively noise controlled using well developed engineering methods. None of the noise emitting elements inherent in oil and gas are challenging to noise control and have been very effectively noise controlled in some gas projects and throughout other industries where these types of technologies are used and there is sufficient pressure to engineer for quiet.

2. The Ambient noise in the community, on which the Cecil limits are based is not objectively measured according to accepted best practices. The Code allows for an assumed ambient noise level of 55 dB(A) which is significantly higher than the actual levels, particularly at night. For reference, the Federal Energy Regulatory Commission (FERC) sets noise limits (not Ambient) of a day-night sound level L_{DN} of 55 dB(A). Cecil is allowing a level, used as an absolute limit in many communities, to be used as an assumed ambient (baseline – above which Oil & Gas is permitted to create noise). Cecil should require a best-practice (engineering acoustics – not Oil & gas defined best practice) ambient noise study according to clearly, objectively defined methodology and using a required metric.
3. Cecil allows Oil & Gas to emit noise above the ambient levels (assumed 55 dB(A)) by 7/5/10 dB depending on the stage and the time of day. While these exceedances may (arguably) be acceptable above the actual ambient, they result in sound levels, using the assumed ambient, that may be tens of decibels louder than the actual ambient. Recall that for every 10 dB increase the loudness is roughly doubled. The Code allows for Oil & Gas levels that may be 4, 8 or even 16 ties louder than the actual ambient noise levels.

4. Cecil uses only the A-weighted decibel which largely ignores the significant low-frequency noise emitted by Oil & Gas operations (see section 3 of this report for a discussion of the low-frequency noise).
5. Cecil does not regulate the vibration induced by airborne low-frequency noise in residential homes.

3 MEASURED NOISE

The measured noise levels, both A-weighted and C-weighted, at the two monitoring locations are shown in Figures 2 and 3. Due to significant low-frequency noise emitted by both Well sites, the C-weighted level, which account for low-frequency noise, are typically 10-15+ decibels above the A-weighted levels.

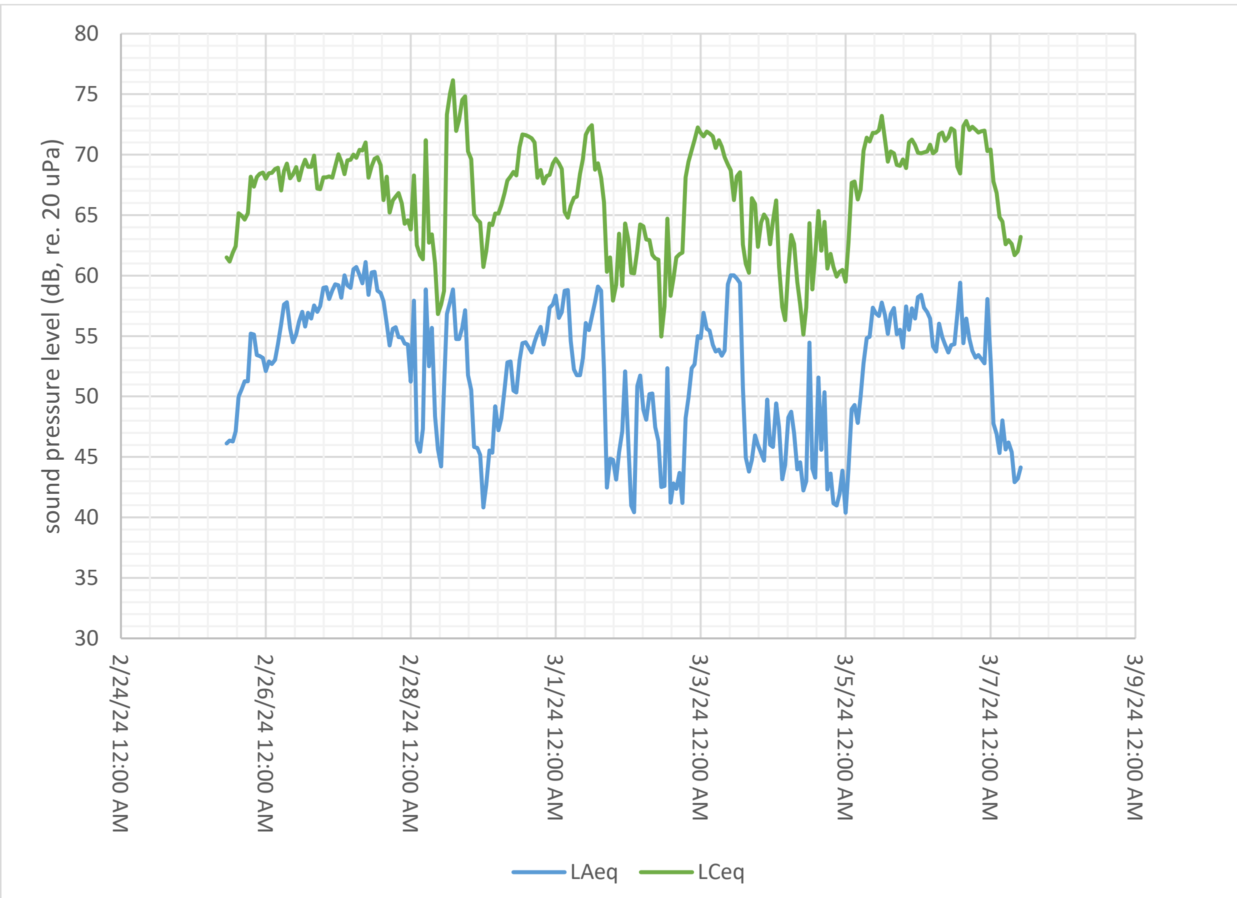

Figure 2 Augustine Well Pad A-weighted versus C-weighted sound levels

Figure 3 Schultz Well Pad A-weighted versus C-weighted sound levels

Loud periods of time were identified at both well sites and the sound levels at those times were analyzed to determine the frequency content. Fourier analysis was used to produce a noise spectrum (a "DNA" print of the sound) at each discrete point in time. The measured spectra, suing Z, A and C – weighting are shown in Figures 4-13. These spectra clearly show the high levels of low frequency noise and the extent to which the A-weighting frequency filter ignores this important component. These spectra also show that the noise emitted by both wells is highly tonal containing a number of pure tones where the energy is concentrated at a single frequency or frequencies, narrow frequency band or bands. Note that the overall sound level, is essentially the area under the spectrum curve, integrated over the spectrum.

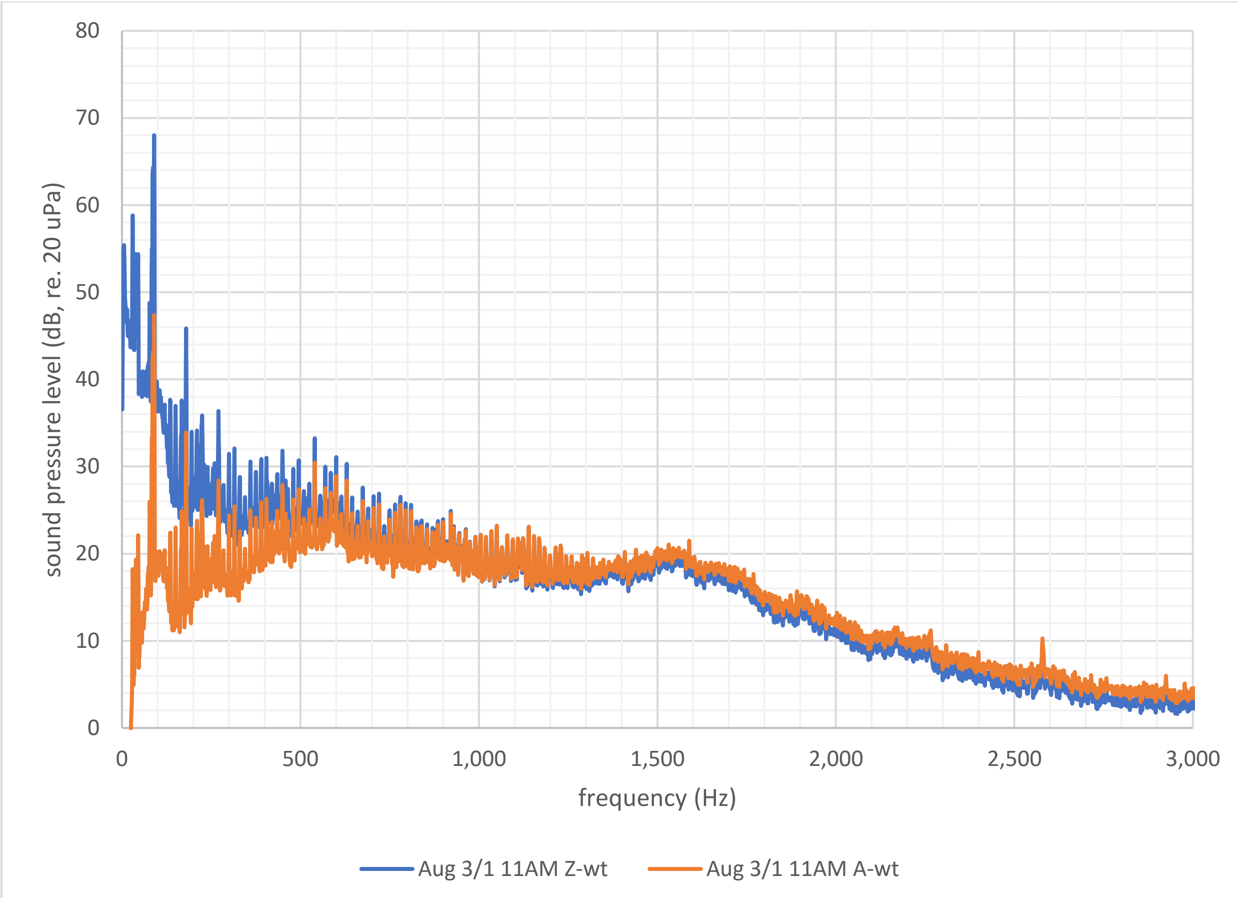

Figure 4 Augustine well site, 3/1/2024 at 11 AM, plotted A and Z-weighted, 0-3,000 Hz.

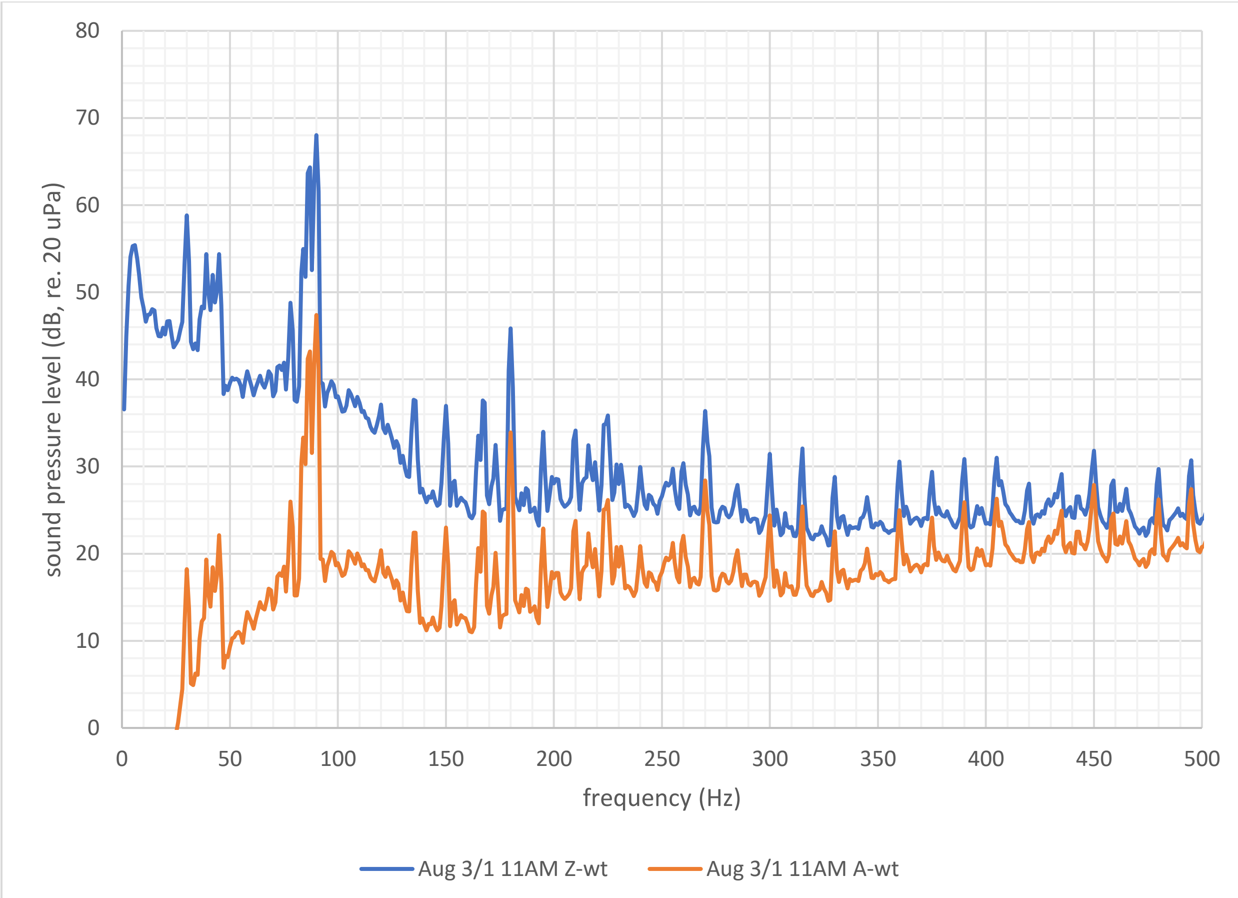

Figure 5 Augustine well site, 3/1/2024 at 11 AM, plotted A and Z-weighted, zoomed 0-500 Hz.

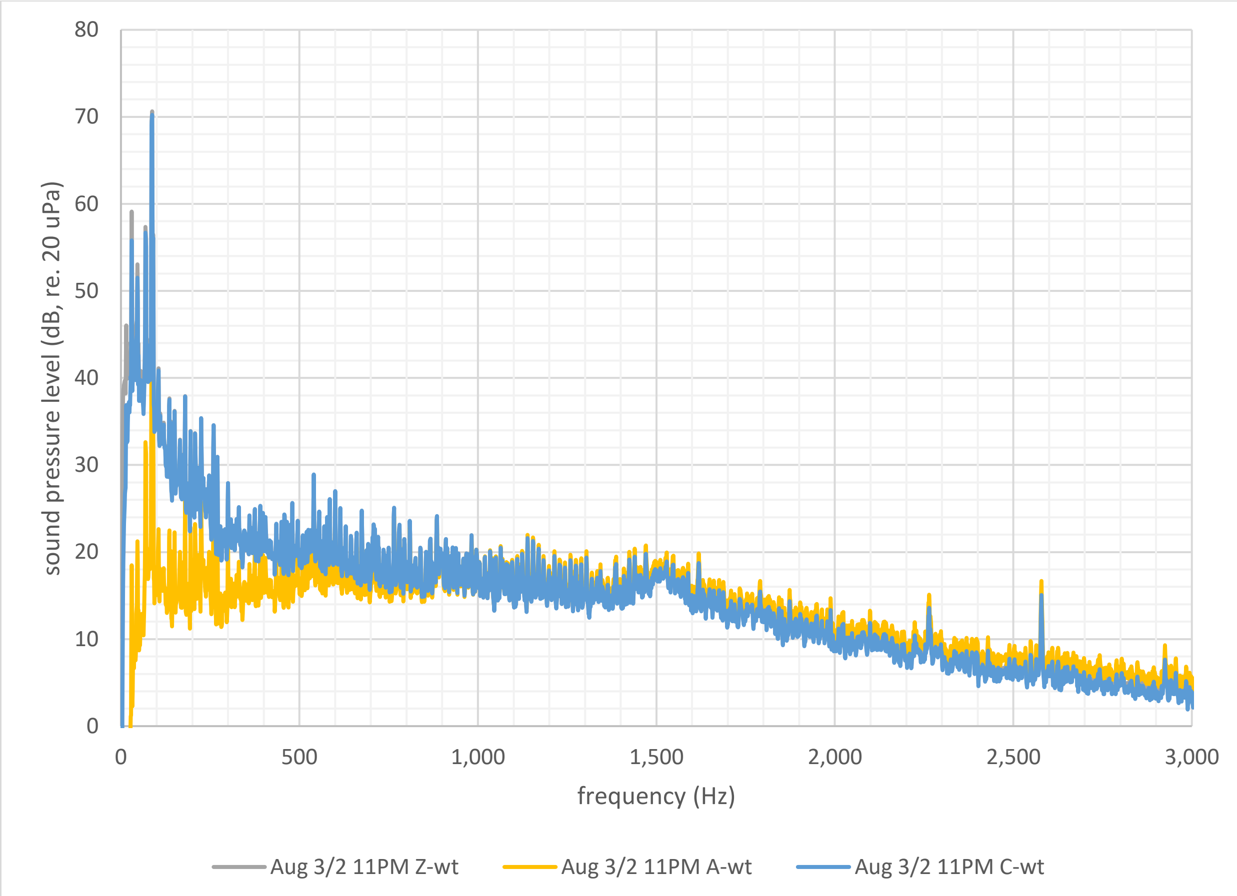

Figure 6 Augustine well site, 3/2/2024 at 11 PM, plotted A, C, and Z-weighted, 0-3,000 Hz.

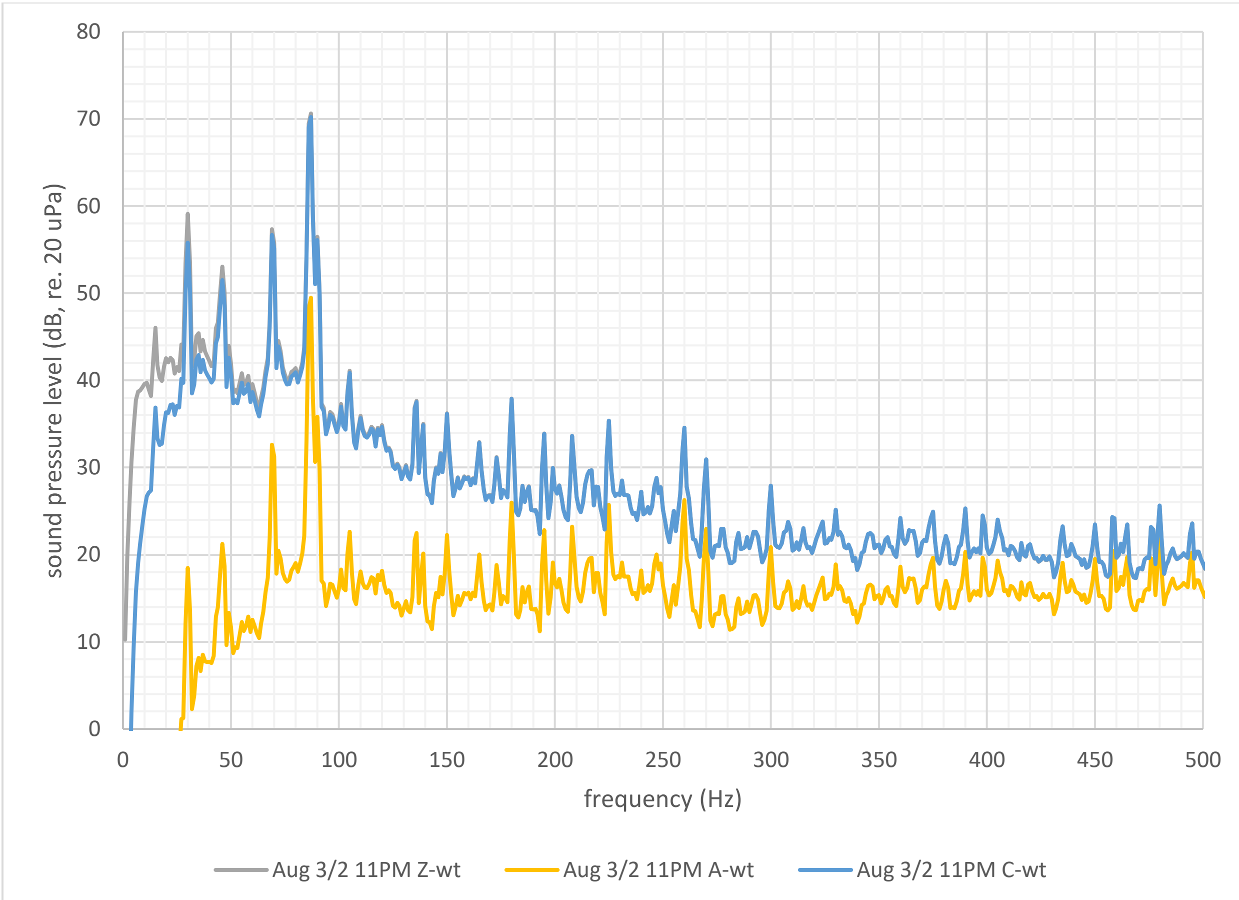

Figure 7 Augustine well site, 3/2/2024 at 11 PM, plotted A, C, and Z-weighted, zoomed 0-500 Hz.

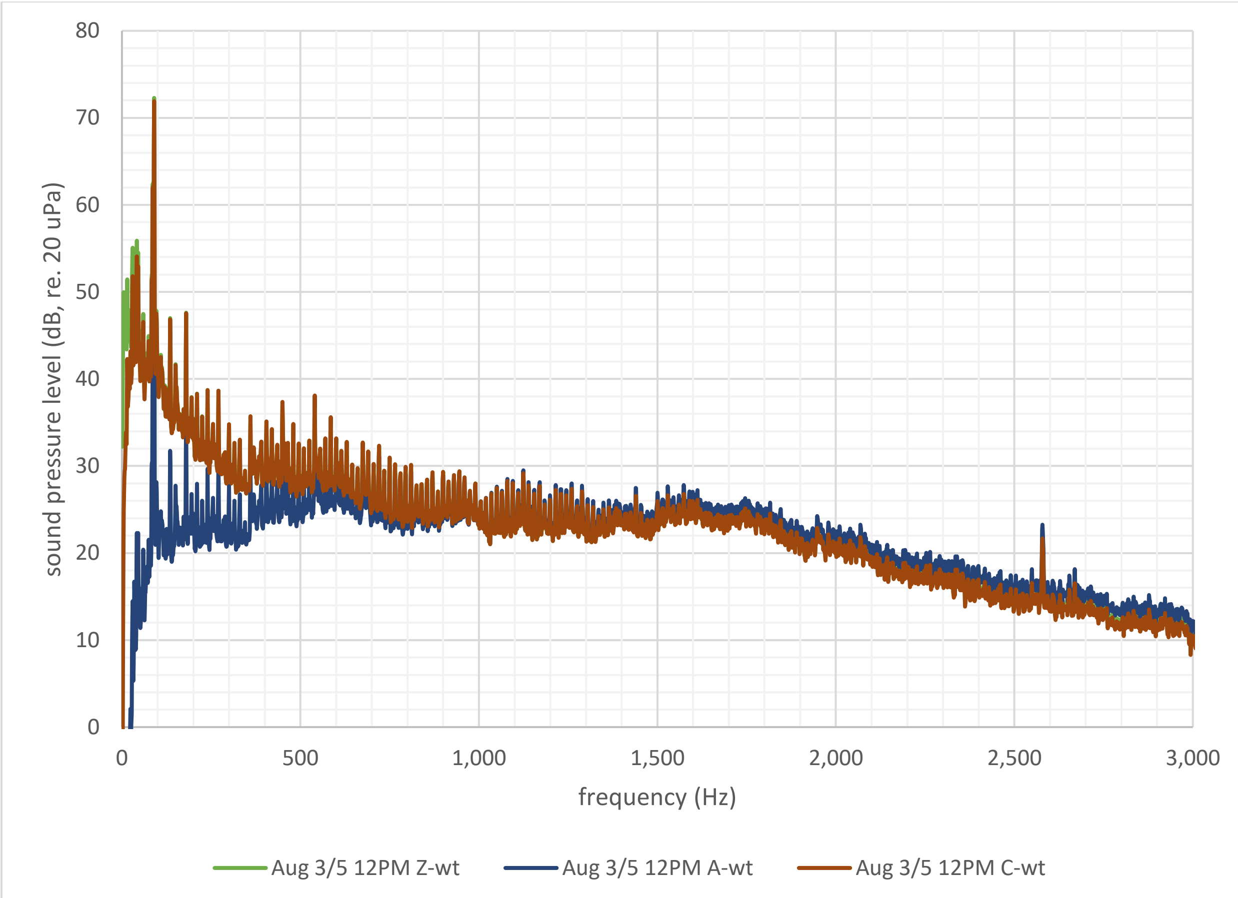

Figure 8 Augustine well site, 3/5/2024 at 12 PM, plotted A, C, and Z-weighted, 0-3,000 Hz.

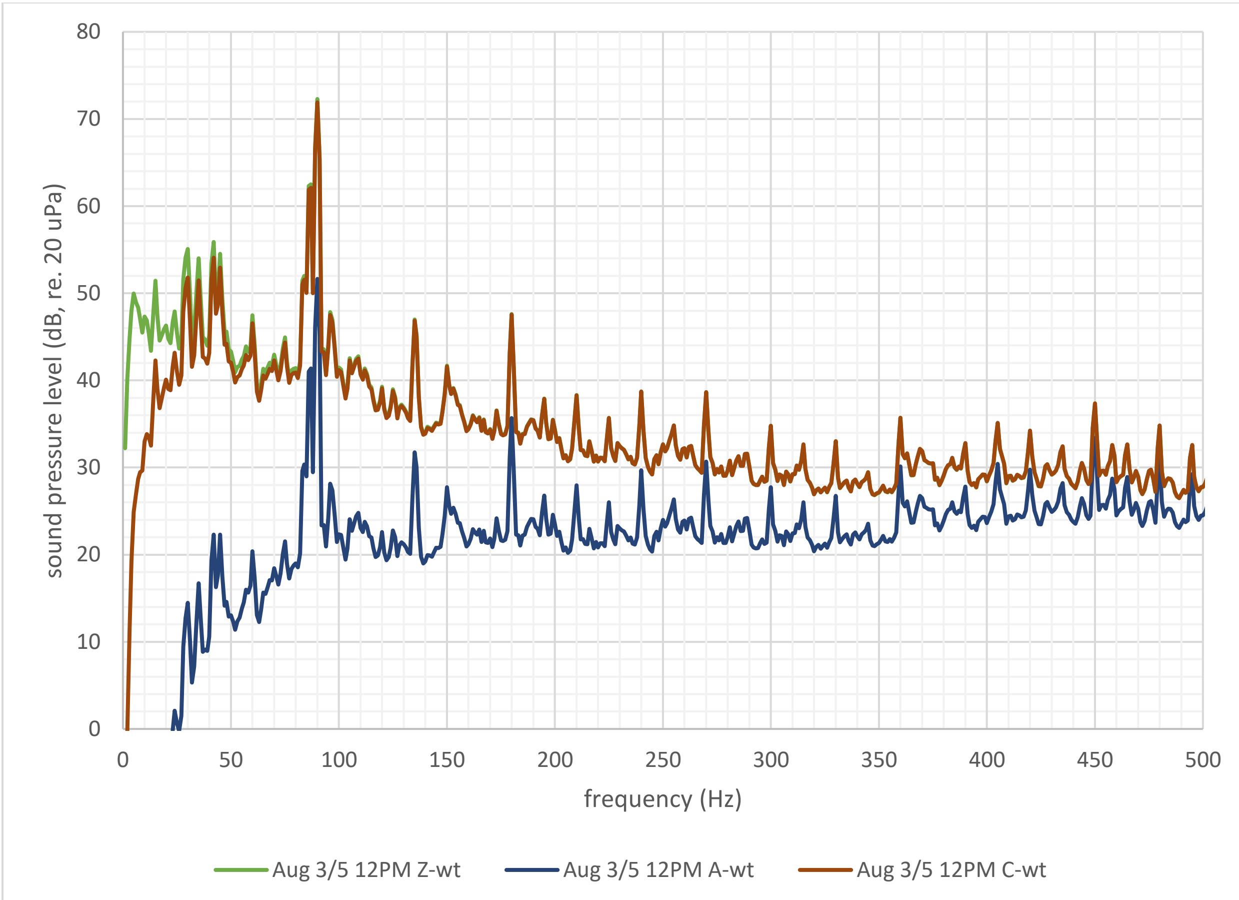

Figure 9 Augustine well site, 3/5/2024 at 12 PM, plotted A, C, and Z-weighted, zoomed 0-500 Hz.

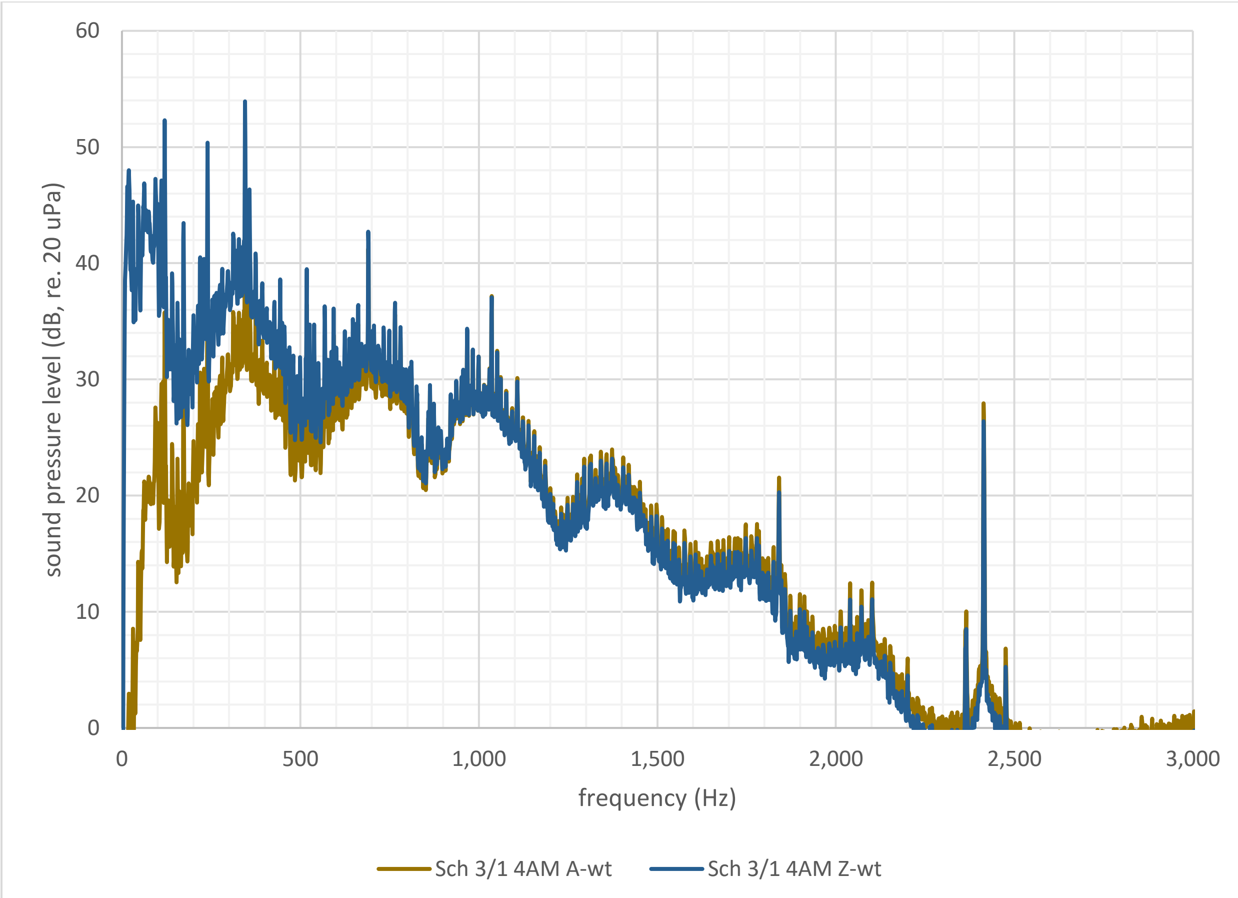

Figure 10 Schultz well site, 3/1/2024 at 4 AM, plotted A and Z-weighted, 0-3,000 Hz.

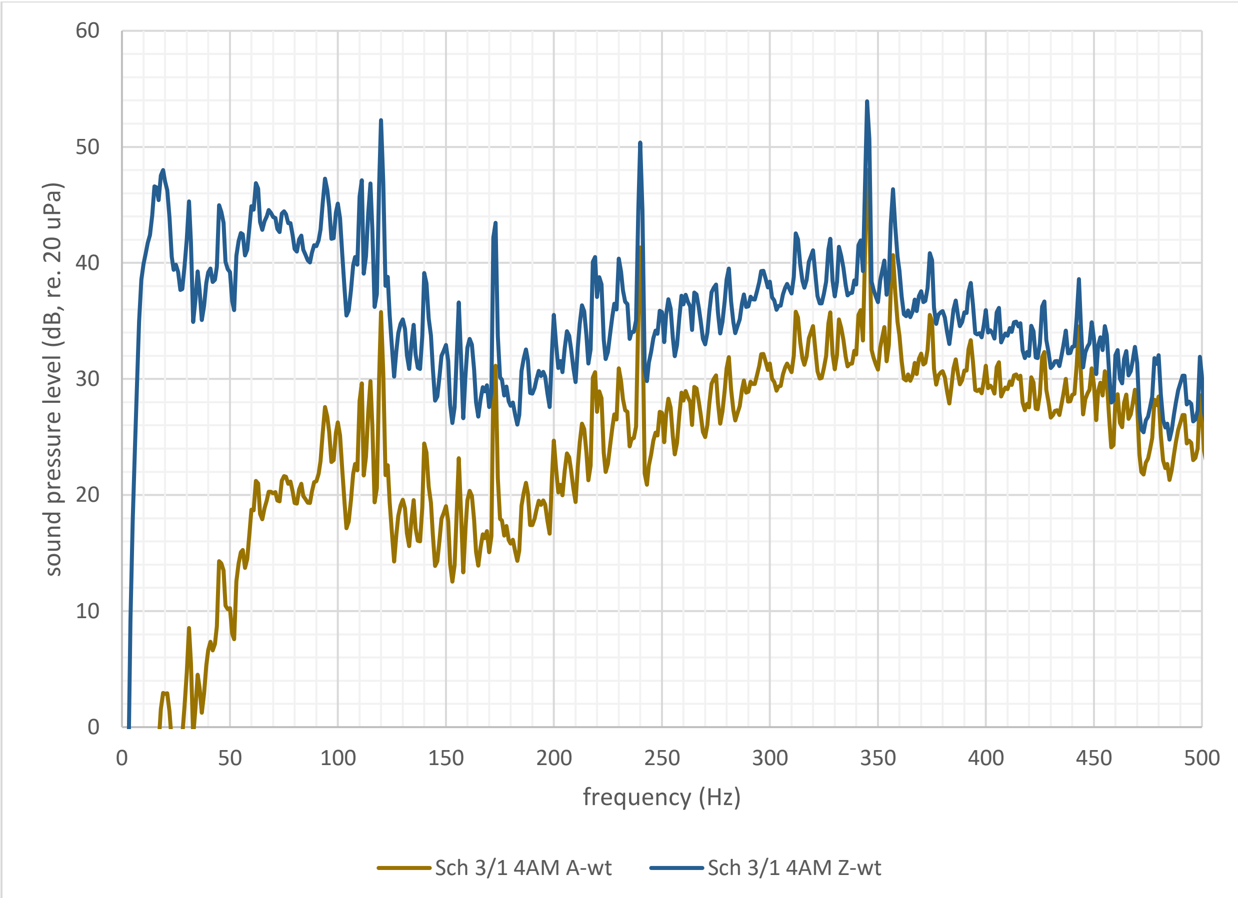

Figure 11 Schultz well site, 3/1/2024 at 4 AM, plotted A and Z-weighted, zoomed 0-500 Hz.

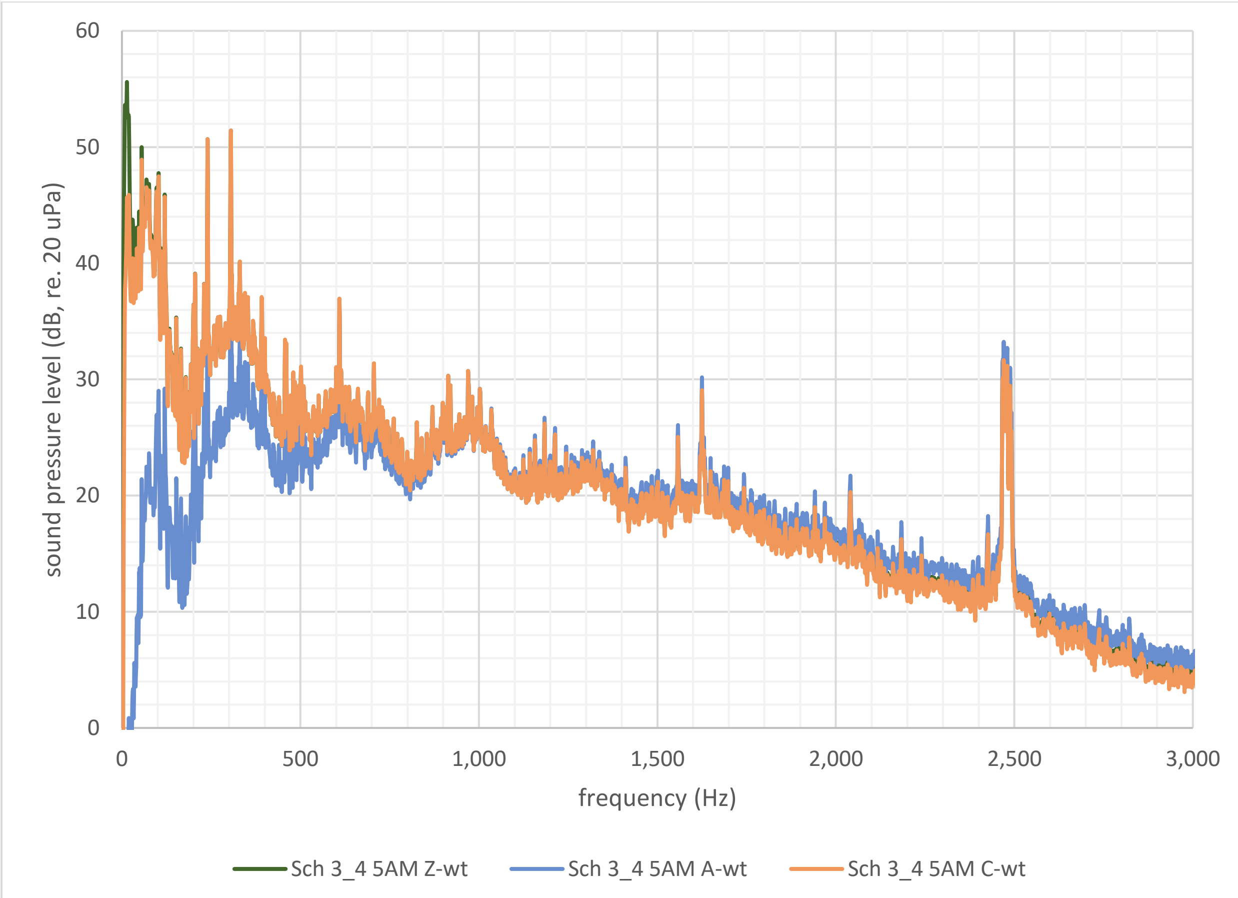

Figure 12 Schultz well site, 3/4/2024 at 5 AM, plotted A, C, and Z-weighted, 0-3,000 Hz.

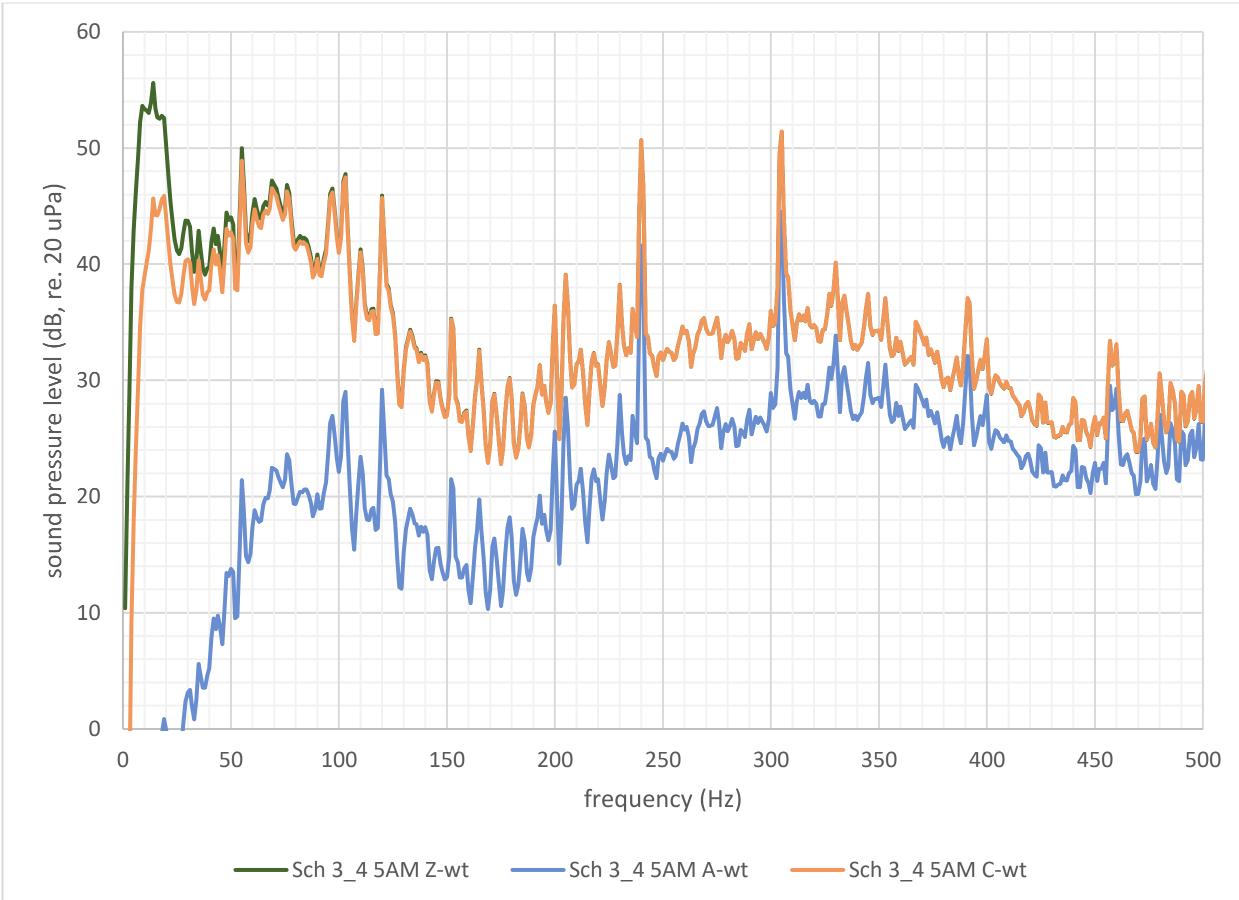

Figure 13 Schultz well site, 3/4/2024 at 5 AM, plotted A, C, and Z-weighted, zoomed 0-500 Hz.

4 CONCLUSIONS

The existing Cecil Oil & Gas Noise Code allows for noise emissions from Oil & Gas operations that have the potential to create several noise and vibration nuisances and impacts on residential properties across large areas of land surrounding these operations. The Cecil Code should be revised to better protect the residents of Cecil Township. While we would strongly advocate an objective, comprehensive Community Noise Ordinance should be developed to better regulate all noise in the community, simply correcting a series of deficiencies in the Oil & Gas Code would be clear step in the right direction. At minimum, we would recommend:

1. Require a clearly defined ambient noise study be performed using accepted best-practices methods and metrics. Eliminate the loophole of allowing an artificial, assumed 55 dB(A) ambient noise level.
2. Establish/reduce the absolute level limits for allowable Oil & Gas noise.
3. Add restrictions to control tonal and low-frequency noise.
4. Add restrictions to control sensible vibration induced in residential homes due to low-frequency noise.

We suggest that a good template for an updated, modern science-based comprehensive noise ordinance would be the Municipality of Murrysville PA Code: https://ecode360.com/11536360. While this code may understandably appear to be complex, it has been developed to address all types of noise and to prevent loopholes.

Please fee l free to contact me with any questions regarding this report.

Best Regards,

William Thornton