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Data Centers and Noise: What Michigan Communities Should Know Before the Site Plan Arrives

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The noise from data centers is unique, continuous, and different from traditional industrial uses. This article examines the limitations of many existing noise ordinances and offers practical recommendations for updating standards, requiring effective noise studies, and incorporating mitigation into the site planning process.

Data centers are being proposed in Michigan communities at an accelerating pace, and communities are being asked to evaluate them having little prior experience with these facilities. Most of the conversations center on water use, power infrastructure, and traffic - all legitimate concerns. Noise is often treated as an afterthought, typically addressed by applying current noise ordinances or guidelines, which may not reflect how this type of facility actually behaves in the environment.

Noise deserves to be part of that conversation. Unlike traffic or water use, noise impacts are not always obvious during site plan review, and many local ordinances were not written with continuously operating facilities such as data centers in mind. The following observations provide planners and local officials with several issues to consider before the next application reaches the review stage.

Data Center Noise Is Different

Traditional industrial noise sources – manufacturing noise, loading docks, machinery - tend to vary over time. They ramp up during shifts, shut down at night, and often change character throughout the day. In contrast, data centers operate continuously, 24 hours a day, 7 days a week, at close to full capacity. The primary noise sources are cooling systems consisting of large banks of rooftop air handlers, cooling towers, generators, and mechanical chillers that run without interruption regardless of the season or time of day.

In addition, the noise generated by data centers has two unique qualities that are more difficult to manage than standard industrial noise. First, the radiated sound is dominated by continuous **low frequencies** - the deep, steady hum that residents often describe as something they feel as much as they hear. Second, the noise tends to be **tonal** - meaning it contains prominent, narrow frequency components (i.e. at a specific 'pitch', rather than the broad, random 'whoosh' noise more typical of traffic or general machinery).

dBA Doesn't Tell the Whole Story

Both qualities are inadequately characterized by the dBA (A-weighted sound pressure) measurement scale that is referenced by most noise ordinances. A-weighting was designed to approximate how the human ear perceives loudness at moderate sound levels (typically inside rooms or factories), and it significantly reduces the effects of low-frequency sound. C-weighting is more commonly used for 'rock concerts and airports', as it takes into consideration human response at low frequencies. For example, a facility that measures 45 dBA at a property line might concurrently measure 52 dBC - a 7-decibel difference reflecting the low-frequency noise content that the A-scale is diminishing. Residents experiencing low frequency noise or 'hum' may find it more intrusive than the 'dBA' values would suggest. Understanding these characteristics also explains why conventional noise mitigation techniques do not always perform as expected.

KEY TERMS

dBA	A-weighted decibel scale. Approximates how the human ear perceives loudness; significantly reduces the reported contribution of low-frequency sound. The most common unit in municipal noise ordinances.
dBC	C-weighted decibel scale. Relatively flat across audible frequencies, including low frequencies. A gap of 5 dB or more between dBC and dBA readings at the same location indicates significant low-frequency content.
Low-frequency noise	Sound in roughly the 20 to 200 Hz range. Travels farther with less natural attenuation than higher-frequency noise and is less effectively blocked by barriers.
Tonal noise	Noise containing a prominent pure tone or narrow frequency band, often perceived as a steady hum. Perceived as more intrusive than broadband noise at the same overall level.

Noise Walls Aren't Always Enough

When low-frequency noise is the primary concern, typical sound mitigation measures need to be evaluated carefully. Noise walls and solid barriers are effective at blocking mid- and high-frequency sound - the frequencies most associated with traffic and mechanical exhaust. They work by creating an "acoustic shadow" behind the barrier.

Low-frequency sound, however, has long wavelengths that diffract - they "bend" around and over barriers more readily than high-frequency sound energy. A tall noise barrier that provides sufficient attenuation at 1,000 Hz (a mid-frequency range associated with speech intelligibility) will provide minimal attenuation at 100 Hz, where much of the sound energy from large cooling equipment is dominant. This is not a flaw in the barrier design - it is a physical property of sound.

This does not mean walls are useless for data center applications. They can effectively reduce overall noise levels, particularly at higher frequencies. But noise reduction performance calculations should be based on the actual frequency content of the source equipment, not just overall dBA levels. A wall

that appears to be adequate on paper may underperform in the field, particularly when the noise content is primarily low-frequency. The technical differences are important because many local ordinances were not written with these characteristics in mind.

Limitations of Traditional Noise Ordinances

Most noise ordinances in Michigan were written and adopted to address the noise concerns like loud machinery during limited operating hours, commercial activity spilling into residential neighborhoods, construction noise, and amplified sound at events. They were written decades before data centers were a land use. As a result, they often do not account for the continuous, low-frequency characteristics of modern cooling equipment.

The regulatory framework of noise ordinances generally falls into one of two types: nuisance ordinances, which prohibit noise that a reasonable person would find disturbing, and performance standard ordinances, which set numeric limits - typically expressed in dBA - at property lines based on zoning district.

Both frameworks share a built-in assumption: that noise primarily occurs during working hours, at varying intensities, with quieter periods that give residents relief. Data centers, AI computing facilities, and similar nocturnal infrastructure do not fit that model.

KEY TERMS

Ambient baseline	Measured sound levels at a location before a new noise source is introduced. Establishes a reference point or "background" noise level for evaluating compliance and responding to future complaints.
Noise impact / propagation study	A pre-construction analysis by a qualified acoustician predicting how a proposed facility will affect sound levels at nearby receptors, including mitigation recommendations where needed.
Tonality penalty	A deduction (typically 5 dB) applied to the permissible noise limit when a source produces tonal noise, reflecting its greater perceived intrusiveness relative to broadband noise at the same level.
Ambient-relative limit	An ordinance provision that restricts how much a new source may increase existing background noise levels, independent of absolute numeric limits. Particularly important for quiet rural or suburban sites.

The gaps in existing ordinances tend to appear in three places. First, limits expressed only in dBA underweight the low-frequency content that these facilities predominantly produce. Second, absolute numeric thresholds set without consideration of the existing ambient sound environment can allow a new source to significantly increase noise levels in a quiet area, while remaining technically "in compliance." When numeric threshold levels are set too low, common noise like traffic or wildlife may already be in violation, making the ordinance difficult to apply to a newly added source. Third, most

ordinances contain no language specifically addressing continuous-operation or tonal noise characteristics that require different evaluation methods.

Addressing these gaps in a revised noise ordinance requires that a 'fresh look' be taken to include the appropriate metrics for the community. Each community can be very different, depending on expectations, current noise sources, and enforcement capability. These changes can include:

- Requiring dBC weighted criteria alongside dBA
- Applying a tonality penalty when tonal characteristics are identified
- Establishing an ambient-relative limit that prevents a new source from raising existing background noise levels beyond a defined threshold
- Defining the minimum scope of a qualifying noise study for uses that present elevated acoustic risk

Communities that establish this language before a data center application arrives will have clear, adopted standards to apply. Communities that wait until an application is in front of them are in a more difficult position - and may find that their existing ordinance does not provide a strong basis to meet community expectations or to enforce potentially problematic noise issues.

Require a Noise Study

A noise study should be required for any activity or business that continuously operates (24/7 operation); has large-scale mechanical or electrical equipment (cooling systems, generators, power transformers); will be sited adjacent to or within a defined distance of residential zones or noise-sensitive uses; is proposed in a greenfield or rural location where ambient noise levels are naturally low; or is a land use with documented histories of low-frequency or tonal noise complaints in other jurisdictions.

A qualified noise impact study should be required as part of the site plan review process, well before construction begins. The study should document existing ambient noise conditions, predict how the proposed facility will affect nearby properties, evaluate compliance with local ordinance standards, and identify any mitigation measures needed before construction.

The ordinance should define the scope of the study so applicants and the community are working from the same expectations. A noise study should include the following:

What are the Existing Noise Conditions. An ambient baseline measurement, establishes existing sound levels at representative receptor locations before the facility operates. Without it, there is no defensible reference point.

How Loud Will the Facility Be (Appropriate Sound Metrics). dBA alone will underweight low-frequency sounds. dBC may not capture whistle tones or other noises that fall in the frequency range where human hearing is most sensitive. Using appropriate weighting scales is crucial.

Will the Facility Include Low Frequency or Tonal Noise (Assessment of Tonal Noise). If the facility's equipment produces tonal noise i.e. a hum at a specific pitch - standard sound pressure level measurements alone will not quantify the potential risks. Asking whether tonal

characteristics are present in the source equipment is a reasonable starting point; some noise ordinance frameworks apply a sound level penalty adjustment to tonal sources to account for their added intrusiveness. [1]

Post-Construction Verification. A commitment to measure noise levels after the facility is operating validates the actual results and gives the community a path to enforcement if limits are exceeded. A community can determine the effectiveness of noise mitigation requirements.

Design It Right the First Time

When a noise study reveals noise issues, the solutions are real - but they are rarely a simple retrofit. Low-frequency noise is harder to contain after a facility is built. The most effective strategies include:

- **Equipment selection.** The most reliable path to low noise levels is selecting mechanical equipment with reduced acoustic output. When an applicant is required to submit a noise study, it should reflect the noise specifications of the actual equipment to be installed, not conservative placeholders or generic assumptions.
- **Complete enclosures over open-air barriers.** Unlike noise walls or barriers, which leave diffraction paths around and over the structure, complete enclosures surrounding a noise source eliminates indirect paths. Low-frequency sound cannot escape from an enclosure that fully contains it. Many data centers already house mechanical equipment inside the building envelope - the question is whether air intake and exhaust openings are directed away from residential properties, and whether gaps or open paths are acoustically treated.
- **Setback distance.** Sound levels decrease with distance - roughly 6 decibels for every doubling of distance from a source in an open field. Because barriers are less effective for low-frequency content, distance is often the most reliable mitigation tool available. This is a design-phase decision: once a building footprint is permitted close to a property line, noise management becomes extremely difficult.
- **Equipment isolation and orientation.** Mechanically isolating vibrating equipment from the building structure, through vibration isolation mounts and flexible duct connections, reduces low-frequency noise re-radiated through walls and roofs. Directional equipment, such as cooling towers with vertical exhaust, can be oriented to project noise away from sensitive receptors.
- **Transformer placement and specification.** Power transformers produce a characteristic tonal hum at twice the 60 Hz line frequency (120 Hz in the U.S.) that travels efficiently over distance and is usually perceived as intrusive. Low-noise transformer designs are available from manufacturers. Locating transformers inside buildings with heavy masonry or concrete construction significantly reduces this source.

[1]Tonality is not the only noise characteristic that can receive this kind of adjustment - impulse events, cyclically varying levels, and duration-weighted statistics are also addressed in more comprehensive ordinance frameworks - but for continuously operating facilities like data centers, tonality and low-frequency content are typically the most relevant considerations.

The consistent finding across all of these approaches is that they are substantially easier and less expensive to implement during the design phase than after construction is complete. A noise impact study at the site plan stage gives the community the information needed to apply meaningful conditions - equipment setbacks, enclosure requirements, exhaust orientation standards - while the applicant still has design flexibility to respond.

Post-construction acoustic remediation for low-frequency noise is technically achievable, but it is almost always more costly, more disruptive, and less complete than getting the design right from the start. And most importantly, if a viable and meaningful noise ordinance has been established beforehand, all parties will work toward the same target values.

Acoustics are complicated, and the approaches that were used for noise management decades ago - zoning buffers, basic dBA limits at property lines - will not be sufficient for the types of continuously operating, low-frequency industrial facilities that are being built today. The good news is that the technical tools exist to assure a good outcome, and there is a growing body of practice in jurisdictions across the country that have already worked through data center permitting. Acoustic engineers practicing in Michigan are available to assist communities not only with the development and update of noise ordinances, but also with reviewing proposed site plans before permits are issued. Addressing these questions during the planning and permitting phase, rather than in response to complaints after a facility is operating, produces better outcomes for residents, applicants, and the communities responsible for making these decisions.

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