FIFTY-STATE SURVEY · SCIENCE, LAW, AND ENGINEERING

Noise and Vibration Rules for Data Centers

What the science, the law, and the engineering say, and what a local government can adopt

VERSION 1.0 Michael J. Bommarito II

Local governments writing data center rules often hear that strict noise limits "have never been done" and cannot be met. This report checks that claim against the science, the law, the engineering, and the codes governments have actually adopted, and it ends with tiered model ordinance text.

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ABOUT THIS REPORT

By the Numbers

The figures below summarize what this report found about adopted noise rules, state benchmarks, and the evidence behind them. Each figure comes from the section named beneath it, where its sources and limits are stated. Counts of adopted rules are a floor, not a census.

10

STATES WITH SITING SOUND LIMITS

For wind, solar, or storage. No state sets a numeric limit for data centers.

Section 6.3

30+

LOCAL DATA CENTER NOISE RULES

Adopted outside Michigan with numeric limits, testing schedules, or both, by November 2026.

Section 8

9

MICHIGAN DATA CENTER SOUND LIMITS

By November 2026: eight confirmed from adopted or final-reading text, one more reported.

Section 7.5

45–60 dBA

TYPICAL ADOPTED NIGHT LIMITS

Range outside Michigan. Michigan's adopted continuous limits go as low as 40 decibels.

Section 8.2

55 dBA

MICHIGAN PA 233 LIMIT

Hourly average for large solar, wind, and storage. It does not cover data centers.

Section 7.3

20 dB

C-MINUS-A GAP WARNING SIGN

A gap this large marked all but one problem site in a peer-reviewed study of low-frequency complaints.

Section 2.3

How to read this report

Section 1 states the question and the main findings. Sections 2 to 4 explain the science and engineering, Sections 5 to 8 cover the law and adopted codes, and Section 9 gives three tiers of limits. Appendix B turns those tiers into model ordinance text. The report rests on 890 source records with web addresses and access dates (Appendix D). Exhibits carry a source line, and the text says where evidence is a prediction, a news report, or a secondary copy.

ABSTRACT

Local governments writing data center rules often hear that strict noise limits "have never been done" or cannot be met. This report tests that claim against the science, law, engineering, and adopted codes, for planning commissioners, board members, attorneys, planners, and residents. The claim is not accurate. By November 2026, at least 30 local governments outside Michigan had adopted data center noise rules with numeric limits, testing schedules, or both. In Michigan, nine local governments had data center zoning with numeric sound limits: eight confirmed from adopted or final-reading text, one more reported. Their fixed continuous limits run from 40 to 60 decibels. A 2025 consent judgment also set a court-ordered limit for one project in Saline Township.

Federal law leaves noise control to state and local governments, and no state sets a numeric sound limit for data centers. Ten states set sound limits for wind, solar, or storage. Michigan's Public Act 233 of 2023 (PA 233) sets 55 dBA for large solar, wind, and storage projects, but it does not cover data centers. The health case rests on sleep disturbance and annoyance. In its 2018 guidelines, the World Health Organization (WHO) sets no value for industrial noise, and claims that infrasound harms health are not supported. A-weighted limits (dBA) alone miss the low-frequency hum behind many complaints. In one peer-reviewed study, nearly every problem site had a C-weighted level (dBC) at least 20 dB above its A-weighted level.

Sound studies filed by data center applicants predict about 45 dBA at nearby homes for several designs that use ordinary measures. A 45 dBA limit with a 3 dB modeling margin, however, needs a design that models at about 42 dBA, and only one study with night results reached that. Limits of 40 dBA at night and tight low-frequency limits (at or below 60 dBC) are harder still, and no published measurement after construction in the United States yet confirms any of these predictions. How a rule measures sound matters more than its number: two rules that both say 50 dBA can differ by 10 dB or more. We offer three tiers of limits (night limits of 50, 45, and 40 dBA) with model ordinance text, measurement procedures, and enforcement provisions. The report rests on 890 source records, current through November 24, 2026.

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SECTION 01

Introduction

What this report is for, what it found, and how to find your way through it.

1 Introduction

This report is for the people who write and live with local noise rules: planning commissioners, township and county board members, local attorneys, planners, and residents. It explains the science, law, and engineering of noise and vibration from data centers and similar energy equipment. It shows what local governments have actually adopted, and it ends with tiered model ordinance language that a local government can adapt.

No training in acoustics or law is assumed. Each technical term is defined where it first matters, and Appendix C collects the definitions in one place. A reader who finishes the report should be able to read a proposed sound limit, ask the right questions about it, and judge whether it can be measured, met, and defended.

1.1 The question this report answers

Many local governments are now writing rules for data centers. A **data center** is a building, or a campus of buildings, full of computer servers. Its outdoor cooling equipment, transformers, and backup generators make sound day and night. In 2025 and 2026, proposals for large campuses reached townships, counties, and small cities that had never reviewed one. Many have paused new projects while they write those rules. Our inventory of these pauses, called moratoria, lists about 150 Michigan entries, and 36 of them name noise among the reasons (Bommarito Consulting 2026).

When a planning commission turns to noise, it often hears one of two objections. The first is that strict data center noise rules "have never been done." The second is that such rules cannot be met, or cannot be measured, so adopting them invites failure or a lawsuit. These objections may come from a consultant, an applicant, or a cautious member of the commission. They deserve a serious answer, because a commission that adopts a rule it cannot defend has gained little.

This report checks those objections against four bodies of evidence:

- **The science.** What sound, noise, and vibration are; how they are measured; and what the health and environmental research shows.
- **The law.** Where a local government gets the power to limit noise, what courts require of a noise rule, and what each of the fifty states adds or takes away.
- **The engineering.** What sounds a data center makes, how far they travel, and how much design can remove.
- **The adopted codes.** What local governments have actually written into law, and how well those texts are drafted.

The report also looks at comparable facilities. Battery storage, substations, solar, wind, cryptocurrency mining, and gas compressor stations use some of the same equipment. States have already written sound limits for several of them, and those limits are useful benchmarks.

A few terms recur from the start. A **decibel** (dB) is the unit of sound level. Because the scale is logarithmic, a 10 dB increase sounds about twice as loud. An **A-weighted** level (dBA) filters sound roughly the way human hearing does at moderate levels, so it discounts low-pitched hum. A **C-weighted** level (dBC) counts that hum more fully. The **equivalent sound level** (Leq) is the steady level that carries the same sound energy as a changing sound over a stated period. Section 2 explains each of these in depth.

1.2 What we found

The short answer is that strict, numeric data center noise rules have been done, many times, and the tools behind them are decades old. What has not yet been done is to prove the strictest limits in operation or in court. The main findings follow, each with the section that supports it.

1. **It has been done.** By November 2026, at least 30 local governments outside Michigan had adopted data center noise rules with numeric limits, testing schedules, or both (Section 8). In Michigan, nine local governments had data center zoning with numeric sound limits: eight confirmed from adopted or final-reading text, one more reported. A 2025 consent judgment set a separate court-ordered limit for one project in Saline Township (Section 7.5).
2. **The tools are old.** Octave-band limits, which cap sound in each slice of the frequency range, appear in the industrial zoning standards Chicago commissioned in the 1950s, described in a 1955 planning report. A Michigan court upheld octave-band zoning limits in 1991, and paired dBA and dBC limits date to 2003 in Hilliard, Ohio (Sections 7.4 and 8.1).
3. **Federal law leaves this job to local governments.** The Noise Control Act of 1972 says primary responsibility for noise control rests with state and local governments, and no federal law sets or preempts noise limits for data centers (Section 5).
4. **States supply benchmarks, not data center limits.** No state has set a numeric sound limit for data centers. Ten states have set limits for wind, solar, or storage, and six of them use 39 to 45 dBA at a neighbor's home at night. West Virginia, by contrast, now bars local noise rules for certified data centers (Section 6).
5. **Sleep and annoyance carry the health case.** The most consistent evidence concerns sleep disturbance and annoyance, both worse at night. In its 2018 guidelines, the World Health Organization (WHO) set no value for industrial noise, so applying its night values to a data center is reasoning by analogy. Heart disease effects are small per person, and infrasound health claims are not supported (Section 3).
6. **A-weighted limits alone miss the hum people complain about.** A-weighting discounts low-frequency sound by design. Virginia's legislative auditors found that complaints arose at 40 to 59 dB, typically below local limits. A proposed 2026 class action in Wisconsin targets tonal sound, a whine or hum with a clear pitch. The data center's operator said its facility met the local ordinance (Sections 2.3, 4.7 and 5.8).
7. **About 45 dBA at homes appears in models; lower targets are hard.** Sound studies filed by applicants predict about 45 dBA at nearby homes for several large data centers that use ordinary measures.

Our Recommended tier sets 45 dBA at night with a 3 dB modeling margin, so a design must model at about 42 dBA, and only one study with night results reaches that. No study we reviewed shows 40 dBA at every home at night, and low-frequency limits near 60 dBC are also hard. All of these results are predictions, not measurements after construction (Sections 4.11 and 9.2.2).

8. **The method matters more than the number.** The same hour of sound can produce numbers 20 dB apart depending on the metric. Courts have struck vague noise rules and upheld measured ones with stated methods. Even so, two adopted Michigan ordinances and the Saline Township consent judgment still say only "decibels" (Sections 2.6, 5.9 and 7.5).
9. **A three-tier menu fits different places.** We offer Baseline (55 dBA day, 50 night), Recommended (50 day, 45 night), and Most protective (45 day, 40 night) tiers. Each comes with low-frequency limits, a tonal penalty, testing, and enforcement procedures (Section 9, Appendix B).

The findings cut both ways, and the report says so throughout. The objection that strict rules "have never been done" is not accurate. The objection that the strictest limits are hard to meet has real force, especially for low-frequency limits and for 40 dBA at night. A commission is better served by an accurate picture of both than by a case that overstates either.

The claim, checked

"This has never been done" is not accurate. Numeric data center noise rules are in force in dozens of local governments, including nine in Michigan (eight confirmed from adopted or final-reading text, one more reported), and their tools have been used in zoning for decades. The fair concession is narrower: these rules are proven in adoption, not yet in court or in long-term operation (Sections 7.5 and 8.6).

1.3 Why noise is the local issue

Data centers raise many public questions, about power, water, taxes, and land. Noise stands out for a local government for three reasons.

First, noise is local by law. Federal funding for the Environmental Protection Agency's noise office ended in 1981 and 1982, after the White House budget office proposed the cut and Congress agreed. In 38 states, we found no general statewide numeric limit for fixed sources such as factories, substations, or data centers (Sections 5.3 and 6.1). In most places, the only numeric limit that will ever apply to a data center is one a local government writes.

Second, noise is the impact that careful neutral observers single out. Michigan's nonpartisan Citizens Research Council judged several common concerns about data centers overstated. It still concluded that "the most concerning negative impact of data centers is noise pollution" (Citizens Research Council of Michigan 2026).

Third, data center sound is unusual. It runs all night, it is often tonal, and much of its energy sits at low frequencies that travel far and pass through walls (Sections 4.3 and 4.8). Many general noise ordinances were written for barking dogs and loud parties, and they handle this kind of sound poorly (Citizens Research Council of Michigan 2026). A neighbor's only other remedy is a nuisance suit, which is slow, costly, and arrives after the facility is built (Section 5.2).

1.4 How the research was done

AI research assistants gathered the sources and wrote first drafts, following a written plan under the author's direction. Every factual statement in this report traces to a source record, and each section was reviewed twice for accuracy and plain language. Each record gives a web address, an access date, and, where possible, a short exact quotation. The project holds 890 such records, one file for each state, 79 coded local provisions outside Michigan, and 39 Michigan ordinances, drafts, and models (Appendix D).

We preferred primary sources: statute and rule text, court opinions, adopted ordinance text, agency manuals, standards catalogs, and peer-reviewed research. Where a source was a secondary copy, a news report, or an applicant's prediction, the text says so. The research cutoff is November 24, 2026. Bills, ordinances, and appeals described here may have changed since then.

1.5 What this report does not cover

The report has limits of purpose and of evidence. A reader should know both before relying on it.

Limits of purpose. This report is not legal advice for any local government or project. It describes the law in general terms, and a local attorney should check any draft text against state and local law before adoption. It is not an acoustic study of any site. It does not model sound from a particular proposal, and it does not replace a qualified acoustical consultant. It does not cover a data center's other impacts, such as power demand, water use, lighting, traffic, or tax effects, except where they bear on noise. It treats sound inside the facility, which workplace safety rules govern, only as context.

Limits of evidence. The local survey is a sample, not a census. We coded rules for about 59 local governments outside Michigan, most from adopted text, and several code-hosting sites blocked automated reading (Section 8.6). The engineering evidence on what designs can achieve comes mostly from applicants' predictive studies (Section 4.11). The 2026 lawsuits are described from complaints and news reports, and none had a ruling on the merits in our sources (Section 5.8). Where we found nothing, we say that we found nothing; we do not claim that nothing exists.

1.6 How to read this report

The report moves from foundations to practice. The early sections explain what the numbers mean and what the evidence shows. The middle sections cover the law and what governments have adopted. The last sections turn all of it into recommendations and model text.

- **Section 2** explains sound, noise, vibration, decibels, frequency weighting, and the metrics that appear in noise rules.
- **Section 3** reviews the medical and environmental evidence, including the evidence that cuts against stricter limits.
- **Section 4** describes data center sound sources, how far their sound travels, and what mitigation can achieve and cost.

- **Section 5** covers police power, nuisance law, federal law, constitutional limits, and the 2026 lawsuits.
- **Section 6** sorts the fifty states by what they add to or take from local noise rules.
- **Section 7** covers Michigan in depth: who adopts what, PA 233, case law, and adopted local rules.
- **Section 8** surveys adopted local codes, classifies their provisions, and lists drafting errors to avoid.
- **Section 9** sets out eight drafting principles, three tiers of limits, and answers to common objections.
- **Section 10** summarizes what we learned, what remains uncertain, and what a local government should do next.
- **Appendix A** gives one row per state with sources and a confidence rating.
- **Appendix B** gives model ordinance text, with each tier's numbers in brackets.
- **Appendix C** defines the technical and legal terms used in the report.
- **Appendix D** explains the methods, the sources, and where the evidence is thin.

Readers need not read the report in order. Each section opens with a short statement of what it covers, and cross-references point to the evidence behind each claim. Exhibits carry a source line.

> **Reader's routes.**
>
> - **Short on time:** the abstract, the "By the Numbers" page, the key-finding boxes, Section 9, and Appendix B.
> - **Michigan readers:** Section 7, then Section 9 (especially Section 9.5) and Appendix B.
> - **Attorneys:** Section 5, Section 6, and Section 7, with Appendix A for state detail.
> - **Engineers and acoustical consultants:** Section 2 and Section 4, then the measurement procedure in Appendix B.
> - **Residents preparing public comment:** Section 3.12, Section 8.4, and Section 9.4.

SECTION 02

Sound, Noise, and Vibration

What the numbers in a noise ordinance mean, and how they are measured.

2 Sound, Noise, and Vibration

This section explains the terms and numbers that appear in noise ordinances and acoustic studies. It is written for readers with no training in acoustics. After reading it, you should be able to read a sound limit such as "45 dBA L_{eq} at the property line" and know what it measures, what it leaves out, and what questions to ask.

The section moves from basic physics to practice. It covers what sound is, how decibels work, how meters weight different pitches, how a changing sound is summed into one number, how measurements are made, and how vibration differs from sound. It closes with lessons for people drafting an ordinance. Section 3 covers what these levels do to people and wildlife, and Section 4 covers the equipment that makes the sound. Appendix C collects every term the report defines.

2.1 What sound is, and what makes it noise

Sound is what we hear when our ears meet small, rapid changes in air pressure. A vibrating solid object, such as a fan blade or a transformer core, usually causes those changes (Federal Transit Administration 2018). The pressure swings are tiny compared with ordinary air pressure, and they swing above and below it.

Sound has three main features: how strong it is (loud or soft), its frequency (high or low pitch), and how it changes over time (Federal Transit Administration 2018). Each feature needs its own measure, and most of this section explains those measures. A single number in an ordinance captures only part of the picture.

Because the pressure swings above and below the average, a plain average of them is zero. Acousticians therefore use the **root mean square** (rms) of the pressure: they square each value, average the squares, and take the square root (Federal Transit Administration 2018). The result is always positive and tracks the energy in the sound.

Noise is "generally considered to be unwanted sound." The Federal Transit Administration (FTA) uses "noise" and "sound" interchangeably "because there is no physical difference between them" (Federal Transit Administration 2018). Noise is a judgment about a sound, not a separate thing a meter can detect. For drafting, this means an ordinance limits measurable sound. It may call sound above the limit "noise," but the limit itself must be stated in physical terms.

One more distinction matters early. **Sound power** is a property of the source itself, measured in watts. It does not depend on distance or surroundings. **Sound pressure level** describes conditions at one place, and it changes with distance, terrain, obstacles, reflections, and weather (California Department of Transportation 2013).

Sound power and sound pressure. The California Department of Transportation (Caltrans) compares sound power to a light bulb's wattage. Sound pressure level is like the amount of light reaching a reader, which depends on distance and shadows (California Department of Transportation 2013). Equipment makers usually publish sound power for chillers, fans, and generators. Ordinances usually limit sound pressure at a property line or a home. A noise study's job is to convert one into the other.

2.2 Decibels and the logarithmic scale

The decibel is the unit used in every noise rule. It is also the source of most confusion, because decibels do not add or compare like ordinary numbers. This subsection explains why the scale exists and gives the rules of thumb a reader needs.

2.2.1 WHY A LOGARITHMIC SCALE

People with typical hearing can detect sound pressures from about 20 micropascals to 20 million micropascals or more (Federal Transit Administration 2018). A micropascal is one millionth of a pascal, the metric unit of pressure. A range that spans a factor of a million is hard to work with on an ordinary scale. Acousticians compress it with a logarithm, which counts powers of ten.

The **decibel** (dB) does this compression. Sound pressure level in decibels equals 20 times the base-10 logarithm of the rms pressure divided by a reference pressure of 20 micropascals (Federal Transit Administration 2018). On this scale, 20 micropascals is 0 dB and 20 million micropascals is 120 dB (Federal Transit Administration 2018). The "B" is capitalized because the unit honors Alexander Graham Bell (Federal Transit Administration 2018).

Zero decibels is not silence. It is "the generally accepted threshold of the best human hearing," and levels below 0 dB exist but cannot be heard (California Department of Transportation 2013). Each 10 dB step means ten times the acoustic energy. Going from 60 to 70 dB increases energy tenfold (California Department of Transportation 2013).

2.2.2 ADDING SOURCES

Decibels from two sources do not add like ordinary numbers. To combine them, an engineer converts each level back to energy, adds the energies, and converts the sum back to decibels (Federal Transit Administration 2018). The results surprise most people at first.

- **Two equal sources add 3 dB.** Two buses that each produce 70 dB together produce 73 dB, not 140 dB (Federal Transit Administration 2018).
- **The louder source dominates.** A 64 dB source plus a 60 dB source gives about 65.5 dB (Federal Transit Administration 2018).
- **Ten equal sources add 10 dB.** Ten trucks at 80 dBA each would give 90 dBA if they could all occupy the same spot (California Department of Transportation 2013).
- **A much quieter source barely counts.** A source 10 dB below another adds only about 0.4 dB to the

total (our calculation from the FTA formula; later figures in this section without a citation are also our calculations).

These rules matter for a data center campus. A campus with many identical chillers or fans gets louder as units are added, but slowly: doubling the number of identical units adds about 3 dB (Federal Transit Administration 2018). The same arithmetic explains why a quiet source next to a loud one is hard to measure. If a facility is 10 dB below the background sound at a home, a meter there will barely register it.

2.2.3 HOW CHANGES IN LEVEL SOUND TO PEOPLE

Energy and loudness are different things. A sound with twice the energy does not sound twice as loud. Caltrans gives the average listener's response to changes in level, shown in Exhibit 1 (California Department of Transportation 2013). FTA agrees that "each A-weighted sound level increase of 10 dB corresponds to an approximate doubling of subjective loudness" (Federal Transit Administration 2018).

Exhibit 1. How changes in sound level are perceived

Change in level	Change in energy	What the average listener perceives
+3 dB	2 times	A barely perceptible increase.
+5 dB	About 3.2 times	A readily perceptible increase.
+10 dB	10 times	The sound seems twice as loud.
+20 dB	100 times	The sound seems four times as loud.
−10 dB	One tenth	The sound seems half as loud.

Source: California Department of Transportation (2013), Table 2-10; Federal Transit Administration (2018), Appendix B. Values describe average responses to broadband sound; individual listeners vary.

Two practical points follow. First, a 3 dB change doubles the energy, but most people only barely notice it. Second, a difference can be real in a statistical sense yet hard to hear. Caltrans gives an example of two homes that differ by about 3.5 dB: the difference is probably statistically significant but "may be barely perceptible" (California Department of Transportation 2013). Neither point means small changes never matter. Sections 2.3 and 2.5 show that a change in the *character* of a sound, such as a new hum or tone, can matter more than its overall level.

2.2.4 HOW SOUND FADES WITH DISTANCE

Distance is a source's first defense. A small source, called a **point source**, spreads its energy over a growing sphere. Doubling the distance spreads the same energy over four times the area, so the level drops about 6 dB per doubling of distance (California Department of Transportation 2013; Federal Transit Administration 2018). This is the **inverse square law**.

As a worked example, a point source measuring 75 dB at 50 feet would be about 69 dB at 100 feet, 63 dB at 200 feet, 57 dB at 400 feet, and 51 dB at 800 feet. These figures are our calculation from the 6 dB rule and count spreading alone. Real sites add losses from the ground, air, and barriers, and sometimes gains from weather (Section 2.8).

2.2.5 EVERYDAY REFERENCE LEVELS

Numbers mean more next to familiar sounds. Exhibit 2 places common sounds on the A-weighted decibel scale (dBA, explained in Section 2.3). The values come from a Caltrans chart that places example sounds against a scale. They are typical positions, not measurements of any particular lawnmower or bedroom.

Exhibit 2. Typical sound levels of everyday sources

About (dBA)	Outdoor example	Indoor example
110	—	Rock band.
100	Jet flyover at 1,000 ft.	—
90	Gas lawnmower at 3 ft.	—
80–90	Diesel truck at 50 ft, traveling 50 mph.	Food blender at 3 ft.
80	—	Garbage disposal at 3 ft.
70	Noisy urban daytime; gas lawnmower at 100 ft.	Vacuum cleaner at 10 ft.
60–70	Commercial area.	Normal speech at 3 ft.
60	Heavy traffic at 300 ft.	Large business office.
50	Quiet urban daytime.	Dishwasher in the next room.
40	Quiet urban nighttime.	Theater or large conference room (background).
30–40	Quiet suburban nighttime.	Library.
20–30	Quiet rural nighttime.[a]	Bedroom at night; concert hall (background).
20	—	Broadcast or recording studio.

Source: California Department of Transportation (2013), Table 2-5, values read from the chart's position.
Note: (a) The quiet rural nighttime entry is a chart placement, not a measured value for any site. Actual night background at a rural home depends on distant roads, wind, insects, frogs, and season. An ordinance that relies on background sound should require a measurement at the site (Section 2.7).

At the other extreme, gunshots, explosions, and rocket engines can exceed 140 dBA at close range, near the threshold of pain (California Department of Transportation 2013). The chart's main lesson for a rural township is the gap at night. A quiet rural night (20 to 30 dBA on the chart) sits 30 to 50 dB below a commercial area (60 to 70 dBA). By Exhibit 1, a 40 dB gap means the commercial area seems about 16 times as loud (four doublings of 10 dB each). The chart places sounds on a scale; it does not measure any site (note a). Section 3.11 and Section 4.8 report the few published figures for rural background, which come in other metrics and run higher.

2.3 Frequency and frequency weighting

Level alone does not describe a sound. Two sounds with the same decibel reading can differ in pitch, and the ear treats them differently. This subsection explains frequency, why sound meters apply "weightings," and why the most common weighting can miss the low hum that people near industrial sites often complain about.

2.3.1 FREQUENCY, TONES, AND SPECTRA

Frequency is the number of pressure cycles per second, measured in **hertz** (Hz). We hear it as pitch. Typical human hearing covers about 20 Hz to 20,000 Hz (Federal Transit Administration 2018). A **pure tone** is a single frequency, like a whistle. Most real sounds mix many frequencies, and that mix is called the **spectrum** (Federal Transit Administration 2018).

Frequency also sets the size of a sound wave. Sound travels about 1,126 feet per second in air at 68°F (California Department of Transportation 2013). FTA rounds this to 1,000 for easy arithmetic, so a 1,000 Hz tone has a **wavelength** of about 1 foot and a 50 Hz tone about 20 feet (Federal Transit Administration 2018). With the unrounded speed, a 50 Hz wave is about 22.5 feet long, about the size of a house. Long waves pass around obstacles and through walls more easily. FTA notes that low frequencies "transmit indoors with relatively little reduction in strength" (Federal Transit Administration 2018).

2.3.2 OCTAVE BANDS

To describe a spectrum, acousticians split it into bands. An **octave band** is a band whose upper limit is twice its lower limit. It is named by its center frequency, such as the 500 Hz octave band (California Department of Transportation 2013; Federal Transit Administration 2018). A **one-third-octave band** is finer: three adjacent one-third-octave bands make one octave, and neighboring band centers differ by a factor of about 1.26 (California Department of Transportation 2013).

Environmental work commonly uses octave bands centered at 16, 31.5, 63, 125, 250, 500, 1,000, 2,000, 4,000, and 8,000 Hz. The ANSI low-frequency procedure discussed below uses the 16, 31.5, and 63 Hz bands (Acoustical Society of America 2005). The international outdoor propagation standard, ISO 9613-2:2024, works in bands from 63 Hz to 8,000 Hz (International Organization for Standardization 2024). An ordinance can set a separate limit in each octave band. That approach controls the shape of the sound, not just its total.

2.3.3 WHY WEIGHTINGS EXIST

The ear is less sensitive to low and very high pitches. Sounds below about 250 Hz and above 10,000 Hz are less audible than sounds in between (Federal Transit Administration 2018). The international standard ISO 226:2023 maps **equal-loudness contours**: combinations of level and frequency that listeners judge equally loud (International Organization for Standardization 2023).

A **frequency weighting** is a filter in the sound meter that mimics this uneven sensitivity. FTA explains that the A, B, and C weighting curves were designed to represent hearing at normal, very loud, and extremely loud levels (Federal Transit Administration 2018). A weighted reading is written with the curve's letter, as in dBA or dBC.

- **dBA (A-weighting).** The A curve adjusts the overall level "to approximate typical human hearing sensitivity" at ordinary levels (Federal Transit Administration 2018). It discounts low frequencies heavily (see the key finding below).
- **dBC (C-weighting).** The C curve is much flatter than the A curve at low frequencies (California

Department of Transportation 2013). A dBC reading therefore includes much more of the bass and rumble in a sound.

- **dBZ (Z-weighting).** "Z" stands for zero weighting: a flat, unweighted response that treats all frequencies alike within the meter's range.

FTA gives several reasons dBA became the standard for environmental noise. It is easy to measure, it approximates the ear, it matches annoyance surveys better than other basic measures, it has been used since the early 1930s, and most agencies worldwide endorse it (Federal Transit Administration 2018). A-weighting is used internationally for environmental noise, including transportation noise (California Department of Transportation 2013). Those are good reasons, and most limits in this report are written in dBA.

2.3.4 WHY DBA MISSES LOW-FREQUENCY HUM

The A curve's strength is also its weakness. It discounts low frequencies on purpose, so it understates sounds dominated by them. FTA notes that such sounds "seem louder than broadband sounds ... that have the same A-weighted level" (Federal Transit Administration 2018). For that reason FTA sets stricter dBA limits for indoor rumble from ground vibration than for ordinary sound (Federal Transit Administration 2018).

ANSI S12.9 Part 4, the American standard for predicting community annoyance, makes the same point. Sounds with strong low-frequency content "engender greater annoyance than is predicted from the A-weighted sound level" (Acoustical Society of America 2005). The standard gives two reasons: walls block low frequencies less well, and loudness grows faster with level at low frequencies (Acoustical Society of America 2005). We read the 2005 edition, which a 2021 edition has replaced (Acoustical Society of America 2021). The figures in this section come from the 2005 text, and we did not check them against the 2021 edition. An ordinance that adopts this standard should cite the current edition and confirm the values in it.

The 2005 standard also gives working numbers for the 16, 31.5, and 63 Hz octave bands (Acoustical Society of America 2005):

- Annoyance is generally minimal when each of those bands is below 65 dB. Fluctuating low-frequency sound, such as amplified bass, may annoy at lower levels.
- Levels above 75 to 80 dB in those bands may cause noticeable rattling in buildings, which greatly increases annoyance.
- Low-frequency annoyance is "virtually only an indoor problem." Low frequencies pass through walls easily, and room resonances can cancel what little the walls block.

dBA alone can miss the sound people complain about

A-weighting discounts low frequencies by design. Under it, a 50 Hz hum must be about 30 dB stronger than a 1,000 Hz sound to register as equally loud (Federal Transit Administration 2018). Pumps, large fans, compressors, diesel engines, and electrical equipment are typical sources of low-frequency

sound (Institute of Acoustics 2024), and data centers and substations have all of them. A dBA-only limit can be met while a home still hears, and sometimes feels, a steady hum indoors. A complete rule adds a C-weighted or octave-band control.

2.3.5 THE DBC MINUS DBA SCREEN

Because the C curve keeps low frequencies that the A curve discards, the difference between a sound's dBC and dBA readings shows how much low-frequency energy it carries. A larger gap means more low-frequency content. Three thresholds appear in practice.

- **10 dB, as a trigger in ANSI S12.9 Part 4.** The standard's low-frequency assessment "shall not be applied unless the time-average C-weighted sound level exceeds the A-weighted sound level by at least 10 dB" (Acoustical Society of America 2005).
- **More than 10 dB, as a trigger in the WHO 1999 guidelines.** The World Health Organization (WHO) calls the C-minus-A difference "crude information," but "if the difference is more than 10 dB," it recommends a frequency analysis (Berglund et al. 1999).
- **20 dB, as a rule of thumb from Hessler (2004).** George Hessler studied residential complaints near industrial sources such as gas turbine plants. In a peer-reviewed paper, he called a C-minus-A difference of 20 dB or more "a useful barometer for detecting a spectrum with potentially excessive low-frequency noise." The difference exceeded 20 dB at all of his problem sites but one, which measured 19 dB (Hessler 2004). Germany's DIN 45680 (1997 edition) uses the same 20 dB difference to decide when its indoor low-frequency test applies (Exhibit 8) (Poulsen and Mortensen 2002).

Hessler proposed C-weighted limits to supplement A-weighted ones. For very quiet sites, with A-weighted limits below about 40 dB, he suggested keeping C-weighted levels no more than 20 dB above A-weighted levels (Hessler 2004).

The same paper shows the screen's limits. Hessler describes a reciprocating compressor station with a C-weighted level of 60 dB and a C-minus-A difference of only 13 dB. He wrote that the reading "would not seem problematic." The resident moved away to escape the noise (Hessler 2004). A simple C-minus-A test can miss a real problem, especially a tonal one. Whichever threshold a rule picks, the test works as a trigger to look closer, paired with dBC or octave-band limits, not as a limit in itself.

2.4 Low-frequency sound and infrasound

Low-frequency sound gets its own subsection because it is the hardest part of data center noise to regulate and to measure. The terms are used loosely in public debate, so precise definitions matter.

Low-frequency sound has no single agreed range. The United Kingdom's Institute of Acoustics takes it to be about 10 Hz to 200 Hz. The Institute notes that it "extends down into the infrasound region" and that its boundaries "are not well defined and best described as 'fuzzy' " (Institute of Acoustics 2024). Other sources use 20 to 200 Hz. This report uses 10 to 200 Hz throughout, and an ordinance should state the range it means. Many sources call unwanted low-frequency sound "low-frequency

noise" (LFN); this report means the same thing by "low-frequency sound."

Infrasound is sound below 20 Hz, the conventional lower limit of human hearing (Federal Transit Administration 2018; Institute of Acoustics 2024). The two ranges overlap: the band from 10 to 20 Hz is both low-frequency sound and infrasound. This report uses "infrasound" only for sound below 20 Hz. "Inaudible" is a convention, not a hard wall: at high enough levels, sound below 20 Hz can be heard or felt. Section 3 reviews what the research shows about its effects.

People describe low-frequency sound as "a throb or low rumbling" or "a 'hum'," often more noticeable at night and indoors (Institute of Acoustics 2024). The Institute of Acoustics lists typical sources as "pumps, large fans, compressors, diesel engines and other rotary machinery, and electrical power transmission systems" (Institute of Acoustics 2024). Sensitivity also varies. About 2.5% of people have low-frequency hearing about 12 dB more sensitive than average, so they hear sounds most others cannot (Institute of Acoustics 2024).

Measuring low-frequency sound is harder than measuring ordinary sound. The Institute of Acoustics says investigation needs "a calibrated Class 1 Sound Level Meter with 1/3 octave measurement ability," and sometimes finer narrow-band analysis (Institute of Acoustics 2024). ANSI/ASA S12.9 Part 7 (2016) addresses outdoor measurement in wind and indoor measurement in occupied rooms (Acoustical Society of America 2016). Its main outdoor problem is wind: wind on the microphone can create "a false indicator of sound pressure at low frequencies" (Acoustical Society of America 2016). With standard small windscreens, accurate outdoor measurement down to the 16 or 31.5 Hz band "can only be made under nearly ideal 'calm and still' conditions" (Acoustical Society of America 2016). Indoors, the wind problem at the microphone goes away, but small rooms have resonances that the measurement must account for (Acoustical Society of America 2016).

2.5 Tones and tonal penalties

A **tonal sound** has a clear pitch that stands out from the surrounding sound, heard as a whine or hum (Federal Transit Administration 2018). Transformers, fans, and pumps can all produce tones. Tones annoy people more than broadband sound at the same level. ANSI S12.9 Part 4 lists "dominant pure tones" among the special features that increase annoyance (Acoustical Society of America 2005). Assessment standards respond by adding a penalty, in decibels, to a tonal sound's measured level.

Three methods exist for deciding whether a tone is "prominent." Each has limits at low frequency, which is where data center tones often occur.

1. **One-third-octave band test.** A one-third-octave band contains a prominent tone if its level exceeds both neighboring bands by a set margin. The margin is largest in the low bands, so fairly strong low tones can pass (Acoustical Society of America 2005).
2. **Tone-to-noise ratio and prominence ratio.** These two narrow-band methods come from the information technology equipment industry, which makes them directly relevant to data centers. The **tone-to-noise ratio** compares the tone with the noise in a narrow "critical band" around it. The **prominence ratio** compares the band holding the tone with its two neighbors. Their thresholds rise as frequency falls, and they do not apply below about 89 Hz (Ecma International 2024).

3. **ISO/TS 20065:2022.** This international technical specification gives "a method for the objective determination of the audibility of tones in environmental noise." It replaced a 2016 version (ISO/PAS 20065) and was confirmed in 2026. It applies only to tones at or above 50 Hz, because "the procedure has not been validated below 50 Hz" (International Organization for Standardization 2022).

A transformer hum at 120 Hz falls within the range of all three methods. Below 50 Hz, only the one-third-octave test applies, and only down to the 25 Hz band, with a 15 dB margin (Acoustical Society of America 2005). A 30 Hz tone like the one reported in Prince William County, Virginia (Section 4.3) would need to stand 15 dB above its neighboring bands to count as prominent. ECMA-418-1 adds a useful safeguard: a tone "shall not be classified as prominent if it is not, in fact, audible" (Ecma International 2024).

> **For specialists: tone-test thresholds.** ANSI S12.9 Part 4 (2005), Annex C, gives "possible choices" for the one-third-octave test: 15 dB in low bands (25–125 Hz), 8 dB in middle bands (160–400 Hz), and 5 dB in high bands (500–10,000 Hz) (Acoustical Society of America 2005). Software documentation from the engineering firm Arup reports the same three values in an informative annex of ISO 1996-2:2017 (Arup 2026). ECMA-418-1 (third edition, December 2024) sets the narrow-band thresholds. A tone between 1,000 and 11,200 Hz is prominent if its tone-to-noise ratio is at least 8 dB, or, under the second method, if its prominence ratio is at least 9 dB. Below 1,000 Hz, the thresholds rise as frequency falls, down to 89.1 Hz (Ecma International 2024). At 100 Hz, by our calculation from the ECMA formulas, the thresholds are about 16.3 dB and 19 dB.

2.5.1 ANSI S12.9 PART 4 ADJUSTMENTS

Once a sound's character is known, ANSI S12.9 Part 4 adds adjustments to its measured A-weighted level. ANSI calls the result the **adjusted sound level**; ISO calls the same idea the "rating level" (Acoustical Society of America 2005). Exhibit 3 lists the 2005 adjustments.

Exhibit 3. Adjustments for special sound characteristics in ANSI S12.9 Part 4 (2005)

Sound characteristic or time period	Adjustment
Regular impulsive sound (brief bursts not listed below).	+5 dB
Highly impulsive sound (for example, gunfire, hammering, pile driving, riveting).	+12 dB
High-energy impulsive sound (for example, quarry blasting, sonic booms).	Separate C-weighted method
Tonal sound (prominent tone under the Annex C test).	+5 dB
Strong low-frequency content.	Separate method (Annex D)
Rapid onset (rising at 150 dB per second or faster).	Up to +11 dB
Nighttime.	+10 dB
Weekend daytime.	+5 dB

Source: Acoustical Society of America (2005), Table 2 and Annexes B–D.
Note: If more than one special-character adjustment applies to one source, only the largest is used. Time-of-day and weekend adjustments are added on top.

Two rules in the standard matter for drafting. Only the largest special-character adjustment applies to a source, but the nighttime and weekend adjustments always add on top (Acoustical Society of America 2005). And very rapid repeated impulses, more than about 20 per second, blend into continuous sound and get no impulse adjustment (Acoustical Society of America 2005).

The standard's low-frequency method works differently from a flat penalty. It sums the 16, 31.5, and 63 Hz octave bands into one low-frequency level. Above 65 dB, predicted annoyance grows twice as fast as the level itself (Acoustical Society of America 2005). A sound 10 dB above that 65 dB point therefore counts like a 20 dB increase.

2.5.2 IMPULSIVE SOUND

An **impulsive sound** is a brief burst that significantly exceeds the surrounding sound, usually lasting less than one second (Acoustical Society of America 2005). The standard divides impulses into the three classes shown in Exhibit 3. When the 2005 edition was published, it noted that "no mathematical descriptor existed to unequivocally define the presence of impulsive sound" (Acoustical Society of America 2005). Most data center sound is steady, but construction, generator starts, and some maintenance work are not.

2.6 Time: turning a changing sound into one number

Sound levels change from moment to moment. A limit needs a single number, so acousticians summarize a period of sound with a **metric** (Federal Transit Administration 2018). Different metrics answer different questions, and the same hour of sound can produce very different numbers depending on which metric a rule names.

2.6.1 METER RESPONSE: FAST AND SLOW

A sound level meter smooths its reading over a short window. On the "slow" setting it averages over about 1 second; on "fast," over 0.125 second (California Department of Transportation 2013). Fast captures short peaks better. FTA typically measures the maximum level of moving vehicles on fast, while "slow" is usually more appropriate for continuous or stationary sources (Federal Transit Administration 2018). The same event reads higher on fast than on slow, so a rule that limits the maximum level should name the setting.

2.6.2 THE COMMON METRICS

- **Equivalent sound level (L_{eq}).** The steady level that would contain the same total energy as the actual varying sound over a stated period, such as one hour (Federal Transit Administration 2018; California Department of Transportation 2013). Written as L_{eq}(1 h) or $L_{Aeq,1h}$ for an A-weighted one-hour value. Because it averages energy, loud moments count heavily.
- **Maximum level (L_{max}).** The highest level during a period or event, read with a stated fast or slow setting. Caltrans discourages calling it "peak," because peak means the unweighted instantaneous pressure, a different quantity (California Department of Transportation 2013).

- **Exceedance levels (L_{10}, L_{50}, L_{90}).** The level exceeded a stated percentage of the time. L_{10} is exceeded 10% of the time and reflects the louder moments (California Department of Transportation 2013). L_{90} is exceeded 90% of the time. It describes the quiet floor between events and is commonly used for background sound (Acoustical Society of America 2014).
- **Sound exposure level (SEL).** The total energy of one event compressed into one second. It lets a short loud event be compared with a long quiet one (Federal Transit Administration 2018; California Department of Transportation 2013).
- **Day-night average sound level (L_{dn} or DNL).** A 24-hour L_{eq} with 10 dB added to sound between 10 p.m. and 7 a.m. (Federal Transit Administration 2018; California Department of Transportation 2013). California's **community noise equivalent level** (CNEL) adds a further 4.77 dB penalty from 7 to 10 p.m. (California Department of Transportation 2013).
- **Day-evening-night level (L_{den}).** The European Union's 24-hour indicator. It divides the day into a 12-hour day, a 4-hour evening, and an 8-hour night, by default 7 a.m.–7 p.m., 7–11 p.m., and 11 p.m.–7 a.m. It adds 5 dB to the evening and 10 dB to the night. The EU also uses a separate night indicator, L_{night}, for sleep disturbance (European Parliament and Council of the European Union 2002).

FTA uses the one-hour L_{eq} for the loudest hour at non-residential uses and L_{dn} for homes (Federal Transit Administration 2018). It does not use L_{max} for transit impact assessment, because L_{max} ignores how many events occur and how long they last (Federal Transit Administration 2018). That is a sound reason for transit, where trains come and go. A data center differs: its cooling equipment runs around the clock, while generator tests are rare but loud.

Averaged 24-hour metrics can also hide night levels. Consider a source that runs at a steady 50 dBA day and night. Its 24-hour L_{eq} is 50 dBA, and its L_{dn} is about 56.4 dBA because of the 10 dB night penalty over 9 of 24 hours. The L_{dn} value (56.4 dBA) is higher than the steady 50 dBA a meter would read at any moment, because of the night penalty. Readers comparing an L_{dn} limit with a plain dBA limit should not compare the numbers directly.

2.6.3 ONE HOUR, FOUR NUMBERS

Exhibit 4 shows how the choice of metric changes the result. It uses three simple, made-up hours of sound at a home. The numbers are our calculations from the standard definitions.

The table shows what each metric is good for. In hour B, three minutes of loud sound drive the hourly L_{eq} up by 22 dB over the quiet level, while L_{10} and L_{90} ignore the event entirely, because it lasts only 5% of the hour. Only L_{max} shows how loud the event was. In hour A, every metric agrees, which is typical of steady equipment. In hour C, L_{10} catches the cycling equipment, but L_{90} still reports only the quiet floor.

Exhibit 4. One hour of sound, summarized four ways (illustrative calculation)

What happens during the hour	L_{eq}	L_{max}	L_{10}	L_{90}
A. Steady equipment hum at 45 dBA for all 60 minutes.	45	45	45	45
B. Quiet 35 dBA for 57 minutes, plus one 3-minute event at 70 dBA (for example, a generator start or truck idling).	57	70	35	35
C. Quiet 35 dBA for 48 minutes, plus 12 minutes at 55 dBA from equipment cycling on.	48	55	55	35

Source: Our calculations from the definitions in Federal Transit Administration (2018) and California Department of Transportation (2013). Levels in dBA, rounded to whole decibels.

Note: Real hours are not this tidy, and a meter reports L_{max} on a fast or slow setting. The table isolates how each metric responds to the same sound.

Each metric answers a different question

L_{eq} measures total energy and is sensitive to loud moments. L_{max} measures the single loudest moment. L_{90} measures the quiet floor and ignores short events. A limit written as "50 dBA" with no metric, period, or meter setting does not say which of these it means. For a data center, a steady-state limit (L_{eq} or L_{90}) addresses round-the-clock cooling equipment, and an L_{max} limit addresses generators and other short, loud events.

2.7 How measurements are made

A limit is only as good as the procedure that tests it. Two consultants measuring the same facility can get different results if the rule is silent on the details. Those details are the equipment, the location, the weather, and how to separate the facility from other sound. This subsection describes the standard choices.

2.7.1 THE INSTRUMENT

The current international specification for sound level meters is IEC 61672-1:2013. It defines two performance categories, Class 1 and Class 2, and Class 2 tolerances are equal to or wider than Class 1 (International Electrotechnical Commission 2013). ANSI/ASA S12.9 Part 7 refers to the U.S. adoption of this specification, ANSI/ASA S1.4-2014 Part 1 (Acoustical Society of America 2016). Older American documents use "Type 1" (precision) and "Type 2" (general purpose) from the 1983 ANSI standard. Caltrans gives their expected total field error as about 1.5 dB for Type 1 and 2.3 dB for Type 2 (California Department of Transportation 2013).

Every meter has its own electrical noise, which sets a floor below which it cannot read. ANSI S12.100 notes that excluding bands above 1,000 Hz can lower that floor by about 10 dB for a typical Type 1 meter (Acoustical Society of America 2014). This matters when measuring quiet rural nights, where the sound being measured may be close to the meter's own floor. For tonal and low-frequency tests, the meter also needs one-third-octave band capability (Institute of Acoustics 2024).

2.7.2 MEASUREMENT STANDARDS

Several consensus standards describe how to measure outdoors. Most are sold rather than published free, so this report describes them from catalog pages, previews, and government manuals that quote them.

- **ANSI/ASA S12.18-1994 (reaffirmed 2023)** describes outdoor measurement while "considering the effects of the ground, the effects of refraction due to wind and temperature gradients, and the effects due to turbulence." It offers a routine method and a precision method, and its results can be used "to assess compliance with regulation" (Acoustical Society of America 2023).
- **ASTM E1014** covers A-weighted measurement "at specified locations or along particular site boundaries." Its uses include documenting levels before a new source arrives and comparing levels with regulatory limits (ASTM International 2012). ASTM's catalog marks the 2012 edition historical; we did not confirm the current designation.
- **ISO 1996-2:2017** covers determining sound levels "as a basis for assessing environmental noise limits," by measurement and by calculation. Under it, the user decides how much measurement effort to spend and therefore how much uncertainty to accept, and the standard sets no maximum allowed uncertainty (International Organization for Standardization 2017). ISO 1996-1:2016 covers the basic quantities and assessment procedures (International Organization for Standardization 2016).
- **ANSI/ASA S12.9 Part 7 (2016)** covers low-frequency sound and infrasound in wind and indoors (Section 2.4) (Acoustical Society of America 2016).
- **ANSI/ASA S12.100-2014** covers background sound in quiet areas, discussed below (Acoustical Society of America 2014).

Because ISO 1996-2 leaves the measurement effort to the user, an ordinance should set its own minimum duration, hours, and conditions.

2.7.3 WIND AND WEATHER

Wind blowing across a microphone makes its own noise, even with a foam **windscreen** (California Department of Transportation 2013). Caltrans measured about 45 dBA of wind noise at about 11 mph with a half-inch microphone and windscreen, so readings below 55 dBA are contaminated at that wind speed or higher (California Department of Transportation 2013). For highway measurements, the Federal Highway Administration's 1996 guide recommends no measurements above 12 mph wind, and Caltrans recommends an 11 mph maximum (California Department of Transportation 2013). Low-frequency work needs calmer air. Standards usually limit wind to "about 2 m/s or 5 mph," and even that "significantly affects the measurements at very low frequencies" (Acoustical Society of America 2016).

Those highway limits are too loose for a quiet rural limit. If a township sets a night limit of 40 dBA, wind noise at 11 mph, about 45 dBA, would already exceed it (California Department of Transportation 2013). A rural rule needs a lower wind limit, plus a statement that measurements taken outside the limits are invalid and must be repeated. Caltrans also advises avoiding strong temperature inversions during routine measurements (California Department of Transportation 2013), although inversions are

exactly when complaints may peak (Section 2.8). A rule may reasonably require some measurements under those conditions on purpose.

2.7.4 WHERE TO MEASURE

Ordinances measure in one of two places, and many use both. A **property line** measurement is taken at the property line of the site making the sound. A **receptor** measurement is taken at a receptor point, where people hear the sound, such as a home or school. ASTM E1014 describes surveys "around a site boundary" and "at a specified location," so both approaches are standard practice (ASTM International 2012).

Each choice has a trade-off, in our analysis; no standard sets this out. A property-line limit is easy to enforce from public land and protects homes not yet built on vacant land. A receptor limit ties protection to the people actually affected, but enforcement may need access to private property.

Agencies that measure at homes spell out exactly where. FTA, for example, measures existing noise at homes and places the microphone "at the quietest area on the property," shielded from other sources (Federal Transit Administration 2018). The EU measures at the most exposed facade and counts only the sound arriving at the house, not the reflection from its own wall. As a general rule, that "implies a 3 dB correction in case of measurement" (European Parliament and Council of the European Union 2002). Because low-frequency annoyance is mainly an indoor problem (Acoustical Society of America 2005), some low-frequency procedures measure inside homes (Acoustical Society of America 2016).

2.7.5 BACKGROUND, AMBIENT, AND RESIDUAL SOUND

Many rules compare a facility's sound with what was there before. That requires defining the "before." Unfortunately, the words vary. ISO avoids "background" and "ambient" because "they have diametrically opposed meanings in different countries" (Acoustical Society of America 2005). An ordinance should define whichever word it uses.

This report uses one term for the "before" and keeps a second for everything present. **Background sound** is all sound except the source being studied (Acoustical Society of America 2005; California Department of Transportation 2013). In this report it means the L_{90} of sound at a place without the facility. Many ordinances call this "ambient" sound; where a quoted rule says "ambient" in that sense, read it as background. **Ambient sound**, in this report, is all sound present at a place, including the facility. **Residual sound** is ANSI S12.100's name for background: the sound that remains when the source being studied is absent (Acoustical Society of America 2014).

Two limits on background matter for drafting. Caltrans notes that noise abatement "cannot reduce noise levels below background levels" (California Department of Transportation 2013). ANSI S12.9 Part 4 adds that how much one source masks another is hard to determine "unless the differences between the time-average sound levels of the different sources are at least 20 dB" (Acoustical Society of America 2005).

For quiet places, ANSI/ASA S12.100-2014 sets procedures for "residual sound levels in protected

natural areas and quiet residential areas." It specifies instruments, durations, and statistical summaries, including exceedance values "like L_{90}" (Acoustical Society of America 2014). Its stated uses include wind turbines, pipeline compressor stations, highways, and airports (Acoustical Society of America 2014).

The standard solves a specific rural problem. Insects, birds, and rustling leaves add high-frequency sound that raises an A-weighted background reading. That sound does little to mask a low hum. The standard therefore defines **ANS-weighting**: A-weighting with all bands above the 1,000 Hz octave removed (Acoustical Society of America 2014). At 62 National Park Service sites, more than 20% of hourly levels dropped by 3 dB or more when those high-frequency sounds were removed; in urban spectra, the effect was under 1 dB (Acoustical Society of America 2014). Removing the upper bands cut measured leaf-rustle noise by about 3.5 dB (Acoustical Society of America 2014).

The lesson is direct. A summer L_{90} full of crickets can make a rural background look several decibels louder than it is for the purpose that matters. A rule tied to background should name the metric (L_{90} or ANS-weighted L_{90}), the duration, the season, the hours, and the standard.

2.8 How sound travels outdoors

This subsection gives only the basics a reader needs to follow the rest of the report. Section 4 covers propagation and mitigation in more detail.

The loss of sound between a source and a listener is called **attenuation**. Spreading is the largest part of it. A point source, such as one fan or generator, loses about 6 dB per doubling of distance. A **line source**, such as a busy road, loses about 3 dB per doubling for averaged levels (Federal Transit Administration 2018). A long row of rooftop equipment seen from close by can behave more like a line source until the listener is far away compared with the row's length. That is a question for the noise study's model.

Other effects add to spreading or work against it:

- **Ground.** Over soft ground such as grass and fields, traffic noise can fall about 4.5 dBA per doubling of distance rather than 3 dBA (California Department of Transportation 2013).
- **Air.** Air absorbs some sound with distance, more at high frequencies than low (California Department of Transportation 2013).
- **Temperature inversions.** Normally air cools with height, which bends sound upward and away from listeners. In an inversion, air warms with height and bends sound back toward the ground. Inversions let noise travel "with less than the usual attenuation rates," and the effect grows with distance (California Department of Transportation 2013).
- **Wind.** Sound carried downwind bends toward the ground in the same way (California Department of Transportation 2013).

These effects explain a common complaint: a facility that seems quiet in the afternoon is clearly audible at night. On clear, calm nights, inversions are common, the background is lowest, and low frequencies lose little to air or house walls.

The international prediction standard builds this in. ISO 9613-2:2024, the second edition, replaced the 1996 edition in January 2024 and was confirmed in 2025 (International Organization for Standardization 2024). It predicts A-weighted levels under conditions "favourable to propagation": downwind or under a moderate ground-based inversion, "such as commonly occurs in clear, calm nights" (International Organization for Standardization 2024). It covers point sources in octave bands from 63 Hz to 8,000 Hz and treats spreading, air absorption, ground effect, and screening (International Organization for Standardization 2024). Its 63 Hz floor means it does not predict the lowest octave bands discussed in Section 2.4.

2.9 Vibration

Vibration is related to sound but is measured and regulated differently. This subsection explains the terms and the two kinds of criteria: those that protect people from feeling vibration, and those that protect buildings from damage. The gap between them is large. For a data center, operational vibration is rarely a problem off site; construction is the main risk (Section 4.12).

2.9.1 TERMS

Vibration is back-and-forth motion of the ground or a structure. It can be described by **displacement** (how far a surface moves), **velocity** (how fast it moves), or **acceleration** (how fast its speed changes) (Federal Transit Administration 2018). Velocity and acceleration describe how people, buildings, and equipment respond better than displacement does (Federal Transit Administration 2018).

Ground-borne vibration is vibration of the ground and buildings that people can feel. **Ground-borne noise** is the low rumble heard indoors when vibrating walls and floors radiate sound (Federal Transit Administration 2018). FTA notes that ground-borne vibration "is not a common environmental problem." Most indoor vibration people feel comes from inside the building, such as mechanical equipment, footsteps, and slamming doors (Federal Transit Administration 2018).

Two metrics dominate.

- **Peak particle velocity (PPV)** is "the maximum instantaneous positive or negative peak of the vibration signal," usually in inches per second in the United States. It relates to stress in buildings and is used for construction and blasting. It "is not used to evaluate human response" (Federal Transit Administration 2018). One inch per second equals 25.4 millimeters per second.
- **Vibration velocity level (VdB)** expresses the rms velocity, which reflects what the body feels, on a decibel scale. In the United States the reference is one millionth of an inch per second; international work often uses 10^{-8} meters per second, so a report should always state its reference (Federal Transit Administration 2018).

The rms velocity is always lower than PPV. Their ratio, the **crest factor**, is typically 4 to 5 for train vibration and 8 or more for impulsive vibration (Federal Transit Administration 2018).

2.9.2 HUMAN RESPONSE

FTA gives a scale for how people respond to vibration in homes (Federal Transit Administration 2018):

- Typical residential background vibration is 50 VdB or lower.
- People begin to feel vibration at about 65 VdB.
- Complaints "fall rapidly" below 72 VdB. From 75 to 80 VdB, many people are annoyed, and 75 VdB is unacceptable for a frequent, repeated source such as rapid transit.
- 85 VdB in a home "can result in strong annoyance."
- About 100 VdB is the threshold of potential damage to typical buildings.

FTA's criteria, shown in Exhibit 5, apply these findings to transit. They depend on the type of building and on how often events occur. The Federal Railroad Administration publishes a similar manual for high-speed rail and maglev, with three levels of noise and vibration analysis (Federal Railroad Administration 2012). This report uses FTA's criteria.

Exhibit 5. FTA ground-borne vibration and noise criteria for general assessment

	Vibration (VdB)			Ground-borne noise (dBA)		
Land use category	**Freq.**	**Occ.**	**Infreq.**	**Freq.**	**Occ.**	**Infreq.**
1. Buildings where vibration would interfere with interior operations.	65	65	65	n/a	n/a	n/a
2. Residences and buildings where people normally sleep.	72	75	80	35	38	43
3. Institutional land uses with primarily daytime use.	75	78	83	40	43	48

Source: Federal Transit Administration (2018), Tables 6-2 through 6-4. VdB referenced to one micro-inch per second.
Note: Frequent means more than 70 events per day; occasional, 30 to 70; infrequent, fewer than 30. Concert halls and recording studios have separate limits of 65 VdB and 25 dBA. Ground-borne noise is measured indoors.

FTA's criteria are written for train passbys, not for steady equipment. A data center's equipment runs continuously rather than in events. In our view the "frequent" column is the closest match, but that is our interpretation, not FTA guidance.

Human response is also not a matter of magnitude alone. FTA quotes ISO 2631-2 (2003): "human response to vibration in buildings is very complex." Annoyance, the same passage says, "cannot always be explained by the magnitude of the vibration alone." Rattling, visible movement, ground-borne noise, and time of day all play a role (Federal Transit Administration 2018).

Two consensus standards address human response in buildings. ISO 2631-2:2026, the third edition, published in June 2026, replaced the 2003 edition. It covers comfort and annoyance from building vibration from 1 to 80 Hz and defines a frequency weighting, called W_m, for that range (International Organization for Standardization 2026; International Organization for Standardization 2003). The American counterpart, ANSI/ASA S2.71-1983, was reaffirmed in 2025. It assesses "reactions of humans to vibrations of 1 to 80 Hz inside buildings" and applies multiplying factors for different building types (Acoustical Society of America 2025).

2.9.3 BUILDING DAMAGE

Damage criteria use PPV and sit far above the levels people feel. Exhibit 6 compares FTA's construction damage criteria with Caltrans's thresholds for perception.

Exhibit 6. Vibration levels for building damage and for human perception (PPV)

Threshold	PPV (in/s)
FTA construction damage criteria	
I. Reinforced concrete, steel, or timber (no plaster).	0.5
II. Engineered concrete and masonry (no plaster).	0.3
III. Non-engineered timber and masonry buildings.	0.2
IV. Buildings extremely susceptible to vibration damage.	0.12
Caltrans human response, continuous or frequent sources	
Barely perceptible.	0.01
Distinctly perceptible.	0.04
Strongly perceptible.	0.10
Severe.	0.4

Source: Federal Transit Administration (2018), Table 7-5; California Department of Transportation (2020), Table 20.
Note: Caltrans gives higher human-response thresholds for single transient events: 0.04, 0.25, 0.9, and 2.0 in/s. Its building damage guidelines for continuous sources range from 0.08 in/s for extremely fragile historic buildings to 0.5 in/s for new homes and modern commercial buildings.

The gap is the main point. Caltrans's continuous-source damage guidelines run from 0.08 to 0.5 in/s, while people barely perceive continuous vibration at about 0.01 in/s (California Department of Transportation 2020). Caltrans adds that some people "may be annoyed at barely perceptible levels" (California Department of Transportation 2020). A building can be in no danger while the people inside are disturbed. Building damage from vibration is rare for ordinary transportation projects and occurs mainly in extreme cases such as blasting and pile driving (Federal Transit Administration 2018). Germany's DIN 4150-3:2016 also sets damage guidelines (DIN 2016); we did not read its numeric table and do not report it.

For a data center, operational vibration is mainly a comfort question, so human-response criteria (FTA's VdB values, ISO 2631-2, or ANSI S2.71) fit. Construction activities such as pile driving raise the damage question, where PPV criteria fit.

2.10 What this means for an ordinance

The definitions above lead to a set of drafting lessons. They are our conclusions from the sources in this section, not requirements of any standard. Section 9 turns them into model language.

1. **Every limit should name its metric, weighting, period, and meter setting.** "50 dBA" alone could mean an hourly L_{eq}, an L_{90}, or an instantaneous maximum, and Exhibit 4 shows these can differ by 20 dB or more for the same hour.
2. **A dBA limit should be paired with a low-frequency control.** A-weighting discounts the hum that pumps, fans, compressors, and transformers produce. A rule should add a dBC limit or octave-band

limits in the 16 to 125 Hz range, and use the C-minus-A difference only as a screen or supplement.

3. **A tonal penalty should name its test and edition.** The rule should say which method decides that a tone is prominent (one-third-octave test, ECMA-418-1, or ISO/TS 20065:2022) and what penalty applies, because the methods differ at low frequency.
4. **The rule should say where and at what height sound is measured.** Property-line and receptor measurements protect different interests, and many codes use both, with indoor measurement as an option for low-frequency complaints.
5. **Measurement conditions should match the limit.** A Class 1 meter with one-third-octave capability, calibration before and after, and a wind limit low enough for the night limit are basic, and readings outside those conditions should be invalid.
6. **Any background-based limit should define background precisely.** The rule should name the metric (L_{90} or ANS-weighted L_{90}), duration, hours, season, and standard (ANSI/ASA S12.100 for quiet areas), and it should guard against insect-inflated summer readings.
7. **Vibration rules should separate comfort from damage.** Operational vibration should be judged against human-response criteria in VdB or under ISO 2631-2:2026, while construction vibration should be judged against PPV damage criteria.

SECTION 03

Health and Environmental Evidence

What the medical and environmental research shows about noise and vibration, how strong it is, and where it stops.

3 Health and Environmental Evidence

This section explains what research says about how noise and vibration affect people, animals, and quiet places. It matters because a sound limit in an ordinance is only as defensible as the evidence behind it. A township that cites a health study should know what the study measured, how strong its findings are, and whether it applies to a data center at all.

The short version is this. The strongest evidence concerns sleep disturbance and annoyance, and it is strongest at night. Evidence on heart disease is real but the effect per person is small. Almost all of the research studied roads, railways, and aircraft, not industrial plants. No medical study has looked at people living near a data center or cryptocurrency mine.

The section reports the evidence that supports stricter limits and the evidence that cuts against them, and ends with implications for setting limits. The metrics used here (dBA, Leq, Ldn, Lden, Lnight, L90, one-third-octave bands, VdB) are defined in Section 2.

3.1 How to read health evidence

Health research on noise rarely proves that a given sound caused a given illness in a given person. Instead, it asks whether groups of people exposed to more sound have more of some outcome, and by how much. Three ideas help a reader judge such findings.

The first idea is the **exposure–response relationship**: a curve that shows how the share of people with an outcome changes as the sound level rises. For example, the World Health Organization (WHO) estimates that about 2% of people are highly sleep-disturbed by road traffic at 40 dB Lnight, rising to 4.2% at 50 dB and 12.0% at 65 dB (World Health Organization Regional Office for Europe 2018). A curve like this has no sharp line where harm begins. Any limit chosen from it is a judgment about how many affected people are acceptable.

The second idea is the difference between **association** and **causation**. An association means two things rise and fall together. Causation means one produces the other. People who live near busy roads may also breathe dirtier air or have lower incomes, and either could explain poorer health. Researchers adjust for such factors, but observational studies can never fully rule them out. Causation becomes more believable when the association appears in many places, grows with dose, and fits a known biological pathway.

Results are often reported as a **relative risk** (RR). An RR of 1.08 per 10 dB means the outcome is 8% more common for each 10 dB increase in sound level. The **confidence interval** around it shows the range of values the data are consistent with. If that range includes 1.00, the study cannot rule out no effect. An **odds ratio** is a close cousin of relative risk: an odds ratio of 2 means the odds of the outcome double. A **systematic review** gathers all studies on a question by a stated method; a **meta-analysis** pools their numbers into one estimate.

The third idea is **strength of evidence**. WHO graded its 2018 evidence with a method called GRADE

(Grading of Recommendations Assessment, Development and Evaluation). Each body of evidence was rated high, moderate, low, or very low in quality (World Health Organization Regional Office for Europe 2018). WHO then labeled each recommendation *strong* or *conditional*. A strong recommendation "can be adopted as policy in most situations." A conditional one "requires a policy-making process with substantial debate and involvement of various stakeholders" (World Health Organization Regional Office for Europe 2018). A planner should know which kind of number is being cited.

One more point runs through this whole section. WHO chose its guideline values by deciding, for each outcome, the smallest increase in risk it considered relevant. It then read the matching sound level off the curve. For annoyance, the benchmark was 10% of people highly annoyed; for sleep, 3% highly sleep-disturbed; for heart disease, a 5% increase in relative risk (World Health Organization Regional Office for Europe 2018). The resulting values mark where a chosen share of people are affected. They are not thresholds below which no one is affected. WHO says this directly for wind turbines: "there might be an increased risk for annoyance below this noise exposure level" (World Health Organization Regional Office for Europe 2018).

3.2 The main guideline values

Four documents supply most of the health-based numbers cited in noise debates. Exhibit 7 collects them. All are guidance, not law, and each has a different basis.

For a steady source that runs at night, the most relevant number in Exhibit 7 is WHO's bedroom value of 30 dB LAeq.

The WHO 2018 *Environmental Noise Guidelines* are the most current and most rigorous. Eight systematic reviews covered heart and metabolic disease, annoyance, sleep, children's learning, hearing, birth outcomes, mental health, and noise interventions (World Health Organization Regional Office for Europe 2018). The guidelines were written for the European Region, but WHO says the levels "can be considered applicable in other regions" (World Health Organization Regional Office for Europe 2018). Their values are long-term averages measured outdoors at the most exposed wall of a home.

The WHO 2009 *Night Noise Guidelines* set 40 dB Lnight outside as the night guideline, with 55 dB as an interim target for places that cannot yet meet it (World Health Organization Regional Office for Europe 2009). WHO describes the effects by level. Up to 30 dB, it found no substantial biological effects. From 30 to 40 dB, it saw body movements, awakenings, and self-reported sleep disturbance, though "even in the worst cases the effects seem modest." From 40 to 55 dB, "Many people have to adapt their lives to cope with the noise at night." Above 55 dB, the situation becomes "increasingly dangerous for public health" (World Health Organization Regional Office for Europe 2009). WHO says the 2018 guidelines complement these 2009 values rather than replace them (World Health Organization Regional Office for Europe 2018).

The WHO 1999 *Guidelines for Community Noise* are older but still in force for sources WHO did not revisit in 2018 (World Health Organization Regional Office for Europe 2018). Their bedroom values of 30 dB LAeq for continuous sound and 45 dB LAmax for single events are the most direct WHO numbers for a steady source at night (Berglund et al. 1999). The 1999 guidelines also say evening and night levels "should be 5–10 dB lower than during the day" (Berglund et al. 1999).

Exhibit 7. Health-based guideline values for community noise

Document	Source or setting	Value	Status and evidence
WHO 2018	Road traffic	53 dB Lden; 45 dB Lnight	Strong recommendation for both.
WHO 2018	Railways	54 dB Lden; 44 dB Lnight	Strong recommendation for both.
WHO 2018	Aircraft	45 dB Lden; 40 dB Lnight	Strong recommendation for both.
WHO 2018	Wind turbines	45 dB Lden; no night value	Conditional. WHO found the night evidence too low in quality to set a value.
WHO 2018	Leisure, all sources	70 dB LAeq over 24 hours, yearly average	Conditional.
WHO 2018	Industrial sources	None	WHO did not set industrial values and kept its 1999 values for sources it did not cover.
WHO 2009 night guidelines	Outside the home at night	40 dB Lnight; interim target 55 dB	The 40 dB value is the lowest level at which WHO saw adverse effects. The 55 dB target "is not a health-based limit value."
WHO 1999 community guidelines	Bedroom, indoors	30 dB LAeq continuous; 45 dB LAmax for single events	Still valid under WHO 2018.
WHO 1999	Outside the bedroom at night	45 dB LAeq	Set so people can sleep with windows open, assuming a 15 dB window reduction.
WHO 1999	Daytime outdoor living areas	50 dB LAeq (moderate annoyance); 55 dB LAeq (serious annoyance)	WHO called 50 dB the maximum desirable level for new development.
U.S. EPA 1974 Levels Document	Outdoors, homes and farms	55 dB Ldn	Identified to protect against activity interference and annoyance. Not a standard.
EPA 1974	Indoors, homes	45 dB Ldn	Same basis.
EPA 1974	All areas, hearing	70 dB Leq over 24 hours	Protects against more than 5 dB of hearing loss over 40 years.

Source: World Health Organization Regional Office for Europe (2018); World Health Organization Regional Office for Europe (2009); Berglund et al. (1999); U.S. Environmental Protection Agency (1974). WHO 2018 and 2009 values are outdoor values at the most exposed wall of the home.

The U.S. Environmental Protection Agency's *Levels Document* of March 1974 is the main U.S. federal health-based reference. It identified 55 dB Ldn outdoors and 45 dB Ldn indoors for homes, and 70 dB Leq(24) to protect hearing (U.S. Environmental Protection Agency 1974). EPA was explicit that these were not standards: "Neither Congress nor the Environmental Protection Agency has reached the conclusion that these identified levels should be adopted by states and localities." EPA also set them on health and welfare grounds alone, "not on technical feasibility or economic costs" (U.S. Environmental Protection Agency 1974). At 55 dB Ldn, EPA predicted no evident community reaction, "7 dB below level of significant 'complaints and threats of legal action' " (U.S. Environmental Protection Agency 1974).

Workplace limits sit far above all of these. The Occupational Safety and Health Administration (OSHA) allows 90 dBA over an 8-hour shift (Section 5.5), and the National Institute for Occupational Safety and Health recommends 85 dBA (OSHA 2026; National Institute for Occupational Safety and Health 2026). These limits protect workers' hearing over a career. They are 40 to 60 dB above the levels WHO associates with disturbed sleep, and a community ordinance should not borrow them.

There is no WHO number for data centers

WHO's 2018 guidelines "do not explicitly consider industrial noise as an environmental noise source, affecting people living in the vicinities of industrial sites" (World Health Organization Regional Office for Europe 2018). A data center is an industrial source. So it is not accurate to say "WHO recommends 45 dB for data centers."

What a township can say accurately is narrower. WHO's night values for transport sources range from 40 to 45 dB Lnight outdoors. Its 2009 night guideline is 40 dB Lnight. Its 1999 bedroom guideline is 30 dB LAeq indoors, and WHO says that value remains valid for sources it did not cover, "such as industrial noise" (World Health Organization Regional Office for Europe 2018; World Health Organization Regional Office for Europe 2009; Berglund et al. 1999). Applying any of these to a data center is reasoning by analogy. The analogy is reasonable, but it is a policy choice, not a medical finding.

WHO gave a reason for leaving out industrial noise, and the reason is worth noticing. Neighborhood sources, including "ventilation systems," can "cause considerable concern even at low levels." Some of them require indoor measurement because of their low-frequency content (World Health Organization Regional Office for Europe 2018). The sources WHO had in mind resemble a data center's fans and cooling equipment more than a highway does.

3.3 Sleep

Sleep disturbance is the health effect most relevant to a facility that runs all night. The evidence comes from two kinds of studies: surveys that ask people how well they sleep, and laboratory or field studies that record sleep directly.

In surveys, the odds of being highly sleep-disturbed rose with every 10 dB of Lnight. WHO's review by Basner and McGuire (2018) found odds ratios of 1.94 for aircraft, 2.13 for road traffic, and 3.06 for railways when the survey question mentioned noise. An odds ratio of 2.13 means roughly double the odds per 10 dB. WHO rated the evidence for road traffic as moderate quality (World Health Organization

Regional Office for Europe 2018).

Direct measurement tells a similar story. **Polysomnography** records brain waves, eye movements, and muscle activity during sleep. It can detect a **cortical arousal**, a brief shift toward lighter sleep that the sleeper may not remember. In these studies, the odds of waking rose by a factor of about 1.35 for each 10 dBA increase in the indoor maximum level (LAmax). The result held for aircraft, road, and rail noise alike (Basner and McGuire 2018). WHO's 2009 report lists the indoor single-event levels at which effects begin: body movement at 32 dB LAmax, changes in brain-wave sleep patterns at 35 dB, and waking at 42 dB (World Health Organization Regional Office for Europe 2009).

Researchers propose a pathway from disturbed sleep to long-term illness. Night noise fragments sleep and triggers the release of stress hormones. Over time, this may contribute to high blood pressure and heart disease (Münzel et al. 2021; Basner et al. 2014). The pathway is plausible and supported by laboratory work, but it has not been traced step by step in people exposed to a steady industrial source.

Why does steady, around-the-clock sound matter at night? Three reasons follow from the evidence. First, a source that runs 24 hours a day is present during the 8 hours that Lnight measures, when most other sounds have stopped. Second, steady sounds with low-frequency content are often most noticeable indoors at night, because other sounds no longer mask them (Institute of Acoustics 2024). Third, WHO's 1999 guidelines single out low-frequency sound: "low-frequency noise, for example, from ventilation systems, can disturb rest and sleep even at low sound pressure levels" (Berglund et al. 1999).

The sleep evidence has a clear weakness. When surveys did not mention noise in the question, the associations between noise level and sleep disturbance were not statistically significant for road, rail, or aircraft (Basner and McGuire 2018). This suggests that part of the self-reported effect reflects how people perceive the noise, not only what it does to their sleep. WHO rated the evidence for most other sleep outcomes as low or very low (Basner and McGuire 2018). The direct measurements of awakening, which do not depend on wording, rate higher.

3.4 Heart disease and blood pressure

The link between long-term traffic noise and heart disease is the best-known health finding in this field. It is also the one most often overstated.

WHO's 2018 guidelines rated the evidence linking road traffic noise to **ischemic heart disease** (narrowed arteries that reduce blood flow to the heart) as high quality. The pooled estimate was an RR of 1.08 per 10 dB Lden, based on seven studies of 67,224 people (World Health Organization Regional Office for Europe 2018; Kempen et al. 2018). Evidence on high blood pressure was weaker. The one study of new cases found no increase (RR 0.97), and WHO rated it low quality. Studies counting existing cases found RR 1.05, rated very low quality (World Health Organization Regional Office for Europe 2018). The underlying review warned that most blood pressure studies were "cross-sectional and suffering from a high risk of bias" (Kempen et al. 2018).

Later reviews found similar or smaller effects. Vienneau et al. (2015) pooled studies of transportation

noise and reported an RR of 1.06 per 10 dB for ischemic heart disease, with the rise starting at about 50 dB. Fu et al. (2023) found cardiovascular disease risk rose 2% per 10 dB of road traffic noise and 1.6% for aircraft noise. A 2026 review of 11 cohort studies with about 1.35 million people found a small rise in new cases of high blood pressure (Xia 2026).

The largest recent review cuts against the WHO estimate. Pershagen et al. (2025) pooled 20 studies covering more than 8.4 million people. Per 10 dB Lden of road traffic noise, the RR was 1.017 for ischemic heart disease, with a confidence interval of 0.990 to 1.044 that includes no effect. The RRs for heart attack (1.029) and stroke (1.025) were small but statistically significant. The authors noted that risks "appeared higher" in studies with better exposure measurement, and they still concluded that road noise increases ischemic heart disease (Pershagen et al. 2025).

For a township, the practical meaning is this. Per person, the added cardiovascular risk from 10 dB more noise is a few percent at most. That matters for public health when millions of people live near roads. For one facility next to a few dozen homes, the heart disease evidence is a weak basis for a specific limit. The case for protective limits rests more securely on sleep and annoyance.

3.5 Annoyance

Annoyance sounds minor, but researchers treat it as a health effect. WHO counts it among the outcomes that justify its guideline values, and it is the effect most directly tied to complaints, lawsuits, and political conflict over a facility.

Researchers measure annoyance by asking people to rate how much a sound bothers them. A person is counted as **highly annoyed** if they score above 72 on a 0 to 100 scale (Miedema and Oudshoorn 2001). Miedema and Oudshoorn (2001) produced the classic exposure–response curves for road, rail, and aircraft noise. WHO's review found that newer studies show more people highly annoyed at the same levels than the older curves predicted. The reviewers concluded this points "to the necessity of adjusting noise limit recommendations" (Guski et al. 2017). For road traffic, the odds of being highly annoyed roughly tripled per 10 dB (odds ratio 3.03, from 25 studies, moderate quality) (World Health Organization Regional Office for Europe 2018).

Annoyance does not rise at the same rate for every source. At the same Lden, aircraft noise annoys more people than road traffic. That is why WHO's aircraft value (45 dB Lden) is 8 dB below its road value (53 dB Lden) (World Health Organization Regional Office for Europe 2018). Wind turbines reach WHO's 10% highly annoyed benchmark at 45 dB Lden, also well below road traffic, though that finding rests on four low-quality studies (World Health Organization Regional Office for Europe 2018). The source's character matters, not only its average level.

Several features make a sound more annoying than its dBA level suggests. Tonal sound (a hum or whine at a clear pitch) is one. EPA's 1974 community-reaction model added 5 dB to the measured level for "pure-tone or impulsive" character (U.S. Environmental Protection Agency 1974). Low-frequency sound is another, discussed in Section 3.7. Fluctuation is a third. The UK low-frequency procedure says fluctuating sounds are "more disturbing than steady sounds by an equivalent of about 5 dB" (Moorhouse et al. 2005).

Setting also matters. EPA's model added 10 dB for a "quiet suburban or rural community" and 5 dB where the community had no prior experience with the noise (U.S. Environmental Protection Agency 1974). Under that model, widespread complaints were expected once the adjusted intruding noise exceeded the existing level by about 5 dB. "Vigorous community reaction" was expected as the excess approached 20 dB (U.S. Environmental Protection Agency 1974). These corrections are 50 years old and were partly based on the authors' judgment, but they capture a point later research confirms: the same sound annoys more in a quiet place.

Annoyance also depends on factors that have nothing to do with sound. Fidell et al. (2011) showed that communities differ greatly in how annoyed they are at the same Ldn. They summarized those differences in a single number called the **community tolerance level**. In wind turbine studies, annoyance is lower where residents took part in siting decisions (Kamp and Berg 2021). This cuts both ways. It means a strict decibel limit is not the only tool for reducing annoyance. It also means that how a facility is approved can affect how its neighbors experience it.

3.6 Children's learning and mental health

The evidence on children's learning comes almost entirely from aircraft noise near schools. The RANCH study followed 2,844 children aged 9 and 10 near three European airports. Chronic aircraft noise was linked to poorer reading comprehension and recognition memory. Road traffic noise was not, and neither source affected sustained attention or overall mental health (Stansfeld et al. 2005). WHO's review rated the evidence moderate for aircraft noise and reading and long-term memory, with no effect shown for other sources (Clark and Paunovic 2018). A data center near a school is not an airport, and this evidence does not transfer directly.

Evidence on adult mental health is weaker still. A review commissioned by the UK Department for Environment, Food and Rural Affairs (Defra) found "low-quality evidence for a harmful effect of road traffic noise on medication use and interview measures of depression and anxiety." It named industrial noise as a research priority, which signals how little is known (Clark et al. 2020).

3.7 Low-frequency sound

Low-frequency sound, roughly 10 to 200 Hz and heard as hum or rumble, is defined in Section 2.4. It matters for data centers because its typical sources, pumps, large fans, compressors, diesel engines, and electrical equipment, are the main equipment classes at a data center (Institute of Acoustics 2024). Section 4 describes that equipment.

Low-frequency sound behaves differently from higher-pitched sound in four ways. It travels efficiently, and walls, windows, and hearing protection block it less well (Berglund et al. 1996). A-weighting, which most ordinances use, discounts it heavily. Leventhall (2004) warns that assessments based on A-weighted levels "are inadequate for low frequency noise and lead to incorrect decisions by regulatory authorities." Annoyance rises quickly once the sound becomes audible, and more so when it rattles windows or objects (Berglund et al. 1996; Leventhall 2004). Finally, people differ in how well they hear low frequencies (Section 2.4), so a sound inaudible to most neighbors may be plain to a few.

WHO's 1999 guidelines give a simple screen for low-frequency content. If the C-weighted level exceeds the A-weighted level by more than 10 dB, WHO recommends a frequency analysis. It adds that "still lower values than the guideline values" are needed for such sound (Berglund et al. 1999). This C-minus-A screen is citable and easy to write into an ordinance. As Section 2.3 shows, the screen can miss tonal problems, so it works as a trigger for closer study, not as a limit.

The health research on low-frequency sound is thin. A systematic review by Baliatsas et al. (2016) found only seven observational studies that met its standards. Some linked low-frequency sound to annoyance, sleep problems, poor concentration, and headache. About 10% of exposed people reported high annoyance. But the evidence on chronic disease "was very limited," and the research "is scarce and suffers from methodological shortcomings" (Baliatsas et al. 2016). Sleep complaints are common in case reports, but few studies have measured sleep against the low-frequency content of the noise (Persson Waye 2004).

Despite the thin epidemiology, several European countries have adopted indoor criteria for low-frequency sound. All are measured inside homes, in one-third-octave bands, and most were designed for investigating complaints. They are set close to the threshold of hearing, so they aim at audibility rather than loudness. Denmark's 20 dB night value is the most cited and the simplest to state (Poulsen and Mortensen 2002). The details follow for readers who need them.

For specialists: national indoor criteria for low-frequency sound. Exhibit 8 lists the criteria. Denmark and Germany limit an A-weighted total of the low bands. Sweden, Poland, the Netherlands, and the United Kingdom set a limit for each band.

Exhibit 8. National indoor criteria for low-frequency sound

Country	Method	Key values
Denmark (Information No. 9/1997)	A-weighted sum of one-third-octave bands from 10 to 160 Hz, averaged over 10 minutes, indoors.	20 dB in the evening and night (6 p.m. to 7 a.m.); 25 dB in the day. Values are 5 dB lower for impulsive sound.
Denmark, infrasound	G-weighted level indoors (a weighting for infrasound, defined in Section 3.8).	85 dB(G) in homes. The hearing threshold is usually about 95 dB(G).
Germany (DIN 45680, 1997 edition)	Applies when the C-weighted level exceeds the A-weighted level by 20 dB or more. One-third-octave bands from 10 to 80 Hz.	For sound without tones, 35 dB in the day and 25 dB at night (A-weighted, counting only bands above the hearing threshold). Tonal sound is judged against the hearing threshold.
Sweden (SOSFS 1996:7)	Criterion curve in one-third-octave bands from 31.5 to 200 Hz.	56 dB at 31.5 Hz, falling to 32 dB at 200 Hz.
Poland	Criterion curve from 10 to 250 Hz, each band set to equal 10 dBA.	Sound must exceed both the curve and the background.
Netherlands	Proposed curve from 10 to 200 Hz, with a separate audibility curve from 20 to 100 Hz.	Used to assess complaints.
United Kingdom (Defra NANR45, Salford University, 2005)	One-third-octave Leq over 5 minutes, 10 to 160 Hz.	Night curve from 92 dB at 10 Hz to 34 dB at 160 Hz; day curve 5 dB higher. Relaxed by 5 dB for steady sound. Used to investigate complaints, not as a legal limit.

Source: Poulsen and Mortensen (2002) for Denmark, Germany, Sweden, Poland, and the Netherlands; Moorhouse et al. (2005) and Institute of Acoustics (2024) for the United Kingdom.

Note: DIN 45680 has been revised since 1997; only the 1997 values were checked. Sweden's current guidance was not checked. The Salford procedure was revised in December 2011; the 2005 version was read.

The criteria have limits. Leventhall (2004) notes that the national methods were validated on a limited range of noises and test subjects. Germany's 20 dB C-minus-A trigger sets a higher threshold (harder to trigger) than WHO's 10 dB screen; Section 2.3 compares the thresholds in use.

Using these criteria in an ordinance raises two practical problems. Indoor measurement requires access to a complainant's home, which depends on the resident's cooperation and is harder to schedule than a property-line reading. And because most of the criteria were built for investigating complaints, using them as a permit condition extends them beyond their original purpose.

3.8 Infrasound

Infrasound is sound below 20 Hz, the conventional lower limit of hearing (Section 2.4). People can perceive it, but only at high levels. The Danish environmental agency puts the hearing threshold for

single tones at "usually about 95 dB(G)" and says infrasound below that threshold can be assumed "not annoying" (Poulsen and Mortensen 2002). **G-weighting** is a frequency weighting designed for infrasound, much as A-weighting is designed for ordinary sound. Near the threshold, loudness grows quickly, so a sound "inaudible to some people, may be loud to others" (Møller and Pedersen 2004).

Most research on infrasound and health comes from wind turbines. Governments in Canada, Australia, and Finland commissioned major studies after residents reported symptoms they attributed to turbine infrasound. The findings are consistent.

Health Canada (2014). Researchers studied 1,238 households in Ontario and Prince Edward Island, between 0.25 and 11.22 km from turbines, with a 78.9% response rate. They found no association between turbine noise and self-reported illness, sleep quality (by self-report or wrist-worn monitors), blood pressure, or hair cortisol, a measure of long-term stress. Annoyance did rise with sound level. At 40 dBA or more, 16.5% of Ontario respondents and 6.3% of Prince Edward Island respondents were highly annoyed. Infrasound near homes was "in many cases below background" (Health Canada 2014). The peer-reviewed paper concluded: "Beyond annoyance, results do not support an association between exposure to WTN [wind turbine noise] up to 46 dBA and the evaluated health-related endpoints" (Michaud et al. 2016).

Australia's National Health and Medical Research Council (2015). After a systematic review, the Council stated that "there is currently no consistent evidence that wind farms cause adverse health effects in humans." It also noted that a lack of evidence is not proof of no effect and called for more research (National Health and Medical Research Council 2015). (This summary comes from the Council's web pages, not its full report.)

Finland (2020). A government-funded team combined surveys, measurements, and a double-blind test. In that test, participants who attributed symptoms to infrasound listened to turbine sound with and without infrasound and were not told which was which. They could not detect the infrasound, and "the presence of infrasound made no difference to how annoying the participants perceived the noise." It also did not change participants' autonomic responses, the automatic bodily reactions (such as changes in heart rate or stress markers) that people do not control. The study concluded: "No evidence of health effects of wind turbine infrasound" (VTT Technical Research Centre of Finland 2020). Even so, 15% of residents within 2.5 km reported symptoms they attributed to turbines (VTT Technical Research Centre of Finland 2020).

A 2021 review for the Swiss federal environment agency reached the same overall picture. Annoyance is the main effect and rises with audible sound level; low-frequency content did not add extra annoyance in the studies reviewed; other health effects were not confirmed (Kamp and Berg 2021).

The fair summary is this. The evidence supports the conclusion that audible turbine sound annoys some neighbors, and that annoyance rises with level. It does not support the claim that inaudible infrasound from turbines causes disease or a distinct syndrome. Two questions remain open: effects at night, where WHO found the evidence too thin to set a value, and the role of the rhythmic "whoosh" of turbine blades (World Health Organization Regional Office for Europe 2018).

The wind turbine debate should be kept in proportion for data centers. Data center equipment is dominated by fans, chillers, and transformer hum, whose low-frequency content is mostly in the

audible range above 20 Hz (Section 4). The infrasound findings should not be used to dismiss data center complaints, which concern audible sound. Nor should claims about infrasound be used to inflate them.

3.9 Vibration and people

Ground-borne vibration is motion of the ground or a building that people can feel (Section 2.9). The Federal Transit Administration (FTA) puts the threshold of human perception at about 65 VdB and notes that 85 VdB in a home "can result in strong annoyance" (Federal Transit Administration 2018).

Vibration can disturb sleep on its own. In a laboratory study, freight-train vibration without any sound increased brain-wave arousals and awakenings and raised heart rate; the effects of vibration and noise added together (Smith et al. 2017). A European field and laboratory project also linked nighttime vibration to sleep disturbance (Persson Waye et al. 2019).

Annoyance from vibration depends heavily on what people fear. A study of railway neighbors found annoyance "strongly influenced" by two attitudes: "Concern of property damage and expectations about future levels of vibration" (Peris et al. 2014). Longer, lower-frequency vibration was also more annoying. People tolerated passenger-train vibration about 15 dB better than freight-train vibration at the same level (Sharp et al. 2014).

For a data center, ground-borne vibration at homes is unlikely except near large rotating equipment or generators on poor foundations. The more likely vibration complaint is caused by sound. Low-frequency airborne sound can make windows and objects rattle, which people experience as vibration and which increases annoyance (Berglund et al. 1996). An ordinance can address both with a simple clause. The model is the Federal Energy Regulatory Commission (FERC) rule that a new gas compressor station cause no "perceptible increase in vibration" at homes (FERC 2026b). Section 5.5 describes that rule.

3.10 Data centers and cryptocurrency mines

We found no peer-reviewed study of the health of people living near a data center or a cryptocurrency mine. The best-documented record of community health complaints comes from a bitcoin mine of about 300 MW in Granbury, Hood County, Texas, cooled by fans and by liquid immersion (Peters 2024). What exists there is news reporting and lawsuits, not medical research. Section 4.6 covers the sound measurements, and Section 5.2 covers the lawsuits.

A July 2024 *TIME* investigation reported that more than 40 people described symptoms including high blood pressure, heart palpitations, vertigo, ringing in the ears, migraines, panic attacks, and hearing loss. At least 10 sought urgent or emergency care (Chow 2024). A residents' nuisance suit alleges that "over two dozen individuals" suffered health effects (Earthjustice 2024). The company said it was "not aware of any scientific basis" for the link (Peters 2024). *TIME* itself reported, "There have been no major medical studies on the impacts of living near one" (Chow 2024).

Granbury is the closest real-world comparator to an air-cooled data center, and it shows how a community reacts to a loud, steady, fan-cooled facility. It is not evidence of medical harm. *TIME*

reported a constable's meter that "caps out at 91 decibels" near the mine and a resident's phone app reading 72 dB in a bedroom about 1.5 miles away (Chow 2024). Phone apps are not calibrated instruments, and the reported hearing loss is unlikely to come from the mine.

A single 72 dB reading is not a 24-hour average. EPA's 70 dB Leq(24) level is set to prevent measurable hearing loss over 40 years of exposure all day, every day (U.S. Environmental Protection Agency 1974). Workplace limits for an 8-hour shift are 85 to 90 dBA (OSHA 2026; National Institute for Occupational Safety and Health 2026). Sleep loss and stress, by contrast, are plausible at far lower levels and consistent with the evidence reviewed above.

Data centers themselves have begun to draw noise lawsuits. Several private nuisance suits were filed in 2026 (WilmerHale 2026). One, against Microsoft over a data center in Mount Pleasant, Wisconsin, quotes the company's statement that the facility's noise levels "meet the requirements set by the local ordinance" (*Ostergaard complaint* 2026). Meeting a weak limit does not prevent conflict. Section 5.8 discusses these cases; none reports a medical study.

What is known, then, is limited but useful. Data centers and crypto mines produce steady, around-the-clock sound with low-frequency and tonal content (Section 4), the features the WHO 1999 and 2009 guidelines single out as needing lower values. Whether that sound causes any diagnosed illness is unknown.

Sleep and annoyance carry the case

The most consistent evidence concerns sleep disturbance and annoyance. Both show clear exposure–response relationships across many studies (Basner and McGuire 2018; Guski et al. 2017). Both are worse at night, for tonal and low-frequency sound, and in quiet places, which describes a data center in a rural township.

The heart disease evidence is real but small per person, and the newest large review found a smaller ischemic heart disease estimate than WHO used (Pershagen et al. 2025). Infrasound health claims are not supported (Michaud et al. 2016; VTT Technical Research Centre of Finland 2020). A township that grounds its limits in sleep and annoyance stands on firmer evidence than one that grounds them in heart disease or infrasound.

3.11 Environmental effects

Noise affects more than people. This subsection covers wildlife, quiet places as a resource, how quiet rural areas really are, and how federal and state environmental review handles noise.

3.11.1 WILDLIFE

Animals respond to human noise at levels far below those that harm hearing. A review of research from 1990 to 2013 found that terrestrial wildlife responses "begin at noise levels of approximately 40 dBA, and 20% of papers documented impacts below 50 dBA." Documented effects included changed calls, lower numbers in noisy habitats, and changes in vigilance, feeding, and breeding success (Shannon et al. 2016). Other reviews confirm that chronic noise reduces the distance over which animals can hear each other, prey, and predators (Barber et al. 2010). A 2019 meta-analysis found effects across

amphibians, insects, birds, fish, mammals, mollusks, and reptiles (Kunc and Schmidt 2019).

The most relevant field studies for energy and industrial facilities come from natural gas compressor sites. Compressors resemble data center equipment: mechanical, continuous, rich in low-frequency sound, and running day and night.

- In New Mexico, researchers compared gas wells with and without noisy compressors. "Noise alone reduces nesting species richness and leads to different avian communities." Unexpectedly, nest success rose at noisy sites, because noise disrupted interactions between predators and prey (Francis et al. 2009).
- In the same system, noise disrupted birds' stress hormones in adults and nestlings, and western bluebirds hatched fewer eggs with more noise. The authors concluded that noise "functions as a chronic, inescapable stressor" (Kleist et al. 2018).
- In Alberta's boreal forest, songbird density near silent well pads was "1.5 times higher" than near noisy compressor stations. The authors estimated about $175 million to retrofit existing sites and recommended building noise control in "at the outset of construction" (Bayne et al. 2008).

Experiments confirm that noise itself, not roads or buildings, can cause these effects. Researchers played traffic sounds through speakers in a roadless area during autumn migration. "Thirty-one percent of the bird community avoided the phantom road," and birds that stayed lost body condition (Ware et al. 2015). Bats that hunt by listening for prey avoided foraging areas with traffic noise playback (Schaub et al. 2008).

The wildlife evidence has limits. Most studies concern songbirds, and the literature leans toward urban sources and North America (Shannon et al. 2016; Duquette et al. 2021). Many studies measure behavior rather than survival or population size (Shannon et al. 2016). Responses differ by species, and some species benefit, as the New Mexico nest results show, where predators avoided the noisy sites (Francis et al. 2009). The "about 40 dBA" onset is a pattern across studies with varied metrics, not a dose–response threshold. We found no study of wildlife near data centers, and none that isolates the effect of low-frequency or tonal industrial sound.

3.11.2 QUIET PLACES AND RURAL BACKGROUND SOUND

A **soundscape** is the full mix of sounds in a place. **Natural quiet** is the soundscape without human-made sound. The National Park Service (NPS) treats natural sound as a park resource to be protected (National Park Service 2026c). Human noise is widespread even there. A 2017 study, using a national sound model, estimated that human noise doubled background sound levels in 63% of U.S. protected area units and caused a tenfold or greater increase in 21% (Buxton et al. 2017).

Quiet places are very quiet. NPS gives examples: the crater of Haleakalā National Park "hovering around 10 dBA," remote Grand Canyon trails at 20 dBA, and a typical suburb that "fluctuates between 50 and 60 dBA" (National Park Service 2026b). NPS publishes national maps of existing and natural sound levels (National Park Service 2026a), built from 270,000 hours of measurements at 190 park sites (Mennitt et al. 2014).

For rural homes, the reference numbers are coarse, and they come in four kinds that are easy to confuse. The first is a chart placement. The chart in Exhibit 2 places a quiet rural night at 20 to 30 dBA and a quiet suburban night at 30 to 40 dBA. Those are positions on a scale, not measurements at any site (California Department of Transportation 2013).

The second is a 24-hour average. EPA estimated in 1974 that most rural U.S. residents lived with outdoor levels of 35 to 50 dB Ldn. The lowest level EPA measured outside a home was 44 dB Ldn, on a farm, and it estimated quiet wilderness at 20 to 30 dB Ldn (U.S. Environmental Protection Agency 1974). Ldn is a 24-hour average with a night penalty, not a night level, so it cannot be compared directly with a night limit.

The third is a planning estimate. New York's Department of Environmental Conservation (DEC) uses about 45 dBA as a reference background level for rural farmland and about 35 dBA for wilderness; DEC calls these "ambient" levels. DEC itself says that if reference values may not fit a site, "field measurements should be undertaken" (New York State Department of Environmental Conservation 2001).

The fourth is a field report, and these are few. The acoustics firm Acentech gave a daytime example near a rural two-lane road. It had an L90 of 43 dBA and a minimum of 34 dBA (Building Design + Construction (Alex Odom, Acentech) 2026). A Prince William County, Virginia advisory group member reported 32 to 35 dB at night (Prince William County, Virginia 2025). Section 4.8 gives both. These are reported figures, not a survey. Taken together, the sources support a qualitative point: a quiet rural night is far quieter than a suburb, and the only reliable way to know a site's background is to measure it (Section 2.7).

This gap matters because annoyance depends on how much a new source stands out. EPA's 1974 model treated an intrusion in a quiet rural community as 10 dB worse than the same sound elsewhere (U.S. Environmental Protection Agency 1974). A steady source that would go unnoticed in a suburb can be the loudest sound on a rural night.

Quiet also has standing as a policy goal. WHO's first guiding principle is to "Reduce exposure to noise, while conserving quiet areas" (World Health Organization Regional Office for Europe 2018). The Federal Highway Administration (FHWA) gives its most protective category to "Lands on which serenity and quiet are of extraordinary significance and serve an important public need" (FHWA 2026b). EPA placed farms alongside homes under its 55 dB Ldn outdoor level (U.S. Environmental Protection Agency 1974).

3.11.3 HOW ENVIRONMENTAL REVIEW HANDLES NOISE

The National Environmental Policy Act sets no noise number. Federal agencies set their own in program rules, and Exhibit 13 in Section 5.5 lists them. U.S. practice generally combines two tests: an *absolute* limit on the level at homes, and a limit on the *increase* over existing sound. The federal highway rule, for example, pairs 67 dBA Leq(h) at homes with a "substantial increase" test of 5 to 15 dBA, with each state choosing its value (FHWA 2026b; FHWA 2026a). FERC's compressor rule even requires the noise study to state sound levels for "cooling equipment" (FERC 2026b).

New York's policy shows how a state frames the increase test. Under Policy DEP-00-1 (2000,

revised 2001), DEC says increases of 0 to 3 dB have no appreciable effect. Increases of more than 6 dB may need closer analysis and "may cause complaints," and an increase of 10 dB deserves consideration of avoidance and mitigation. In non-industrial settings, a new source "should probably not exceed ambient noise by more than 6 dB(A) at the receptor." To avoid raising the existing level at all, a new source must be at least 10 dBA below it. DEC calls these "guidelines subject to adjustment" (New York State Department of Environmental Conservation 2001). Section 6 covers state law more broadly.

The federal absolute limits are permissive compared with health guidance. FERC's 55 dBA Ldn, FHWA's 67 dBA Leq(h), and HUD's 65 dB Ldn all sit well above WHO's night values (FERC 2026b; FHWA 2026b; HUD 2026a). The comparison needs one step, because Ldn and Lnight are different metrics. For a source that runs steadily all day and night, 55 dBA Ldn equals about 48.6 dBA at every hour (Section 4.5), above WHO's 40 to 45 dB Lnight. A developer may cite the federal numbers as the norm. They are, however, program rules shaped by feasibility for highways, pipelines, and housing finance, not health-based guidelines.

3.12 What the evidence does not show

A skeptical planner or developer will test the weakest claim first. The following points cut against stricter limits or mark where the evidence stops. A township should know them before it relies on the research.

1. **The evidence is about transportation, not industry.** Nearly every exposure–response curve behind WHO 2018 comes from road, rail, or aircraft noise. WHO did not set industrial values (World Health Organization Regional Office for Europe 2018). Applying 40 or 45 dB Lnight to a data center is a policy choice made by analogy.
2. **Heart disease effects are small per person.** The largest recent review, of 8.4 million people, found a smaller ischemic heart disease estimate than WHO used, and its confidence interval includes no effect. Its estimates for heart attack and stroke were significant (Pershagen et al. 2025). WHO's high-quality finding rested on seven older studies, and its one study of new high blood pressure cases found no increase (World Health Organization Regional Office for Europe 2018).
3. **Self-reported sleep disturbance depends on how the question is asked.** Associations were not significant when surveys did not mention noise (Basner and McGuire 2018).
4. **WHO's wind turbine value is conditional and low quality**, and WHO set no night value for turbines (World Health Organization Regional Office for Europe 2018).
5. **Infrasound health claims are not supported** by the Canadian, Australian, or Finnish government studies (Michaud et al. 2016; National Health and Medical Research Council 2015; VTT Technical Research Centre of Finland 2020).
6. **Low-frequency sound epidemiology is thin.** A systematic review found seven studies, mostly on annoyance (Baliatsas et al. 2016). The national criteria in Exhibit 8 were validated on limited noises and subjects (Leventhall 2004).
7. **Annoyance is partly non-acoustic.** Attitudes, trust, and involvement in siting change annoyance at the same level (Kamp and Berg 2021; Peris et al. 2014; Fidell et al. 2011). A developer can fairly

argue that a strict decibel limit is not the only way to reduce annoyance.

8. **EPA 1974 is old and not a standard.** EPA said its levels were not meant to be adopted as standards, and they ignore cost. Its rural and tonal corrections were partly judgment (U.S. Environmental Protection Agency 1974).
9. **Health claims near data centers and crypto mines are anecdotal.** No study links their noise to diagnosed disease (Chow 2024).
10. **The cognition evidence is mixed.** RANCH linked aircraft noise to poorer reading but found no such effect for road traffic (Stansfeld et al. 2005).
11. **Wildlife effects vary by species, and some species benefit** (Francis et al. 2009). Wildlife onset levels are a literature pattern, not a regulatory threshold, and no study covers data centers (Shannon et al. 2016).
12. **Rural reference levels are coarse.** New York's 45 dBA for farmland is a planning estimate, and EPA's rural figures are 24-hour averages from 1974 (New York State Department of Environmental Conservation 2001; U.S. Environmental Protection Agency 1974). Neither substitutes for measurement.

These points narrow the case for strict limits; they do not remove it. The sleep and annoyance evidence, the character of data center sound, and quiet rural backgrounds still support protective limits (Section 3.10) (Basner and McGuire 2018; Guski et al. 2017; Berglund et al. 1999; World Health Organization Regional Office for Europe 2009; U.S. Environmental Protection Agency 1974).

3.13 Implications for setting limits

The evidence does not dictate a single number. It does point to several principles that a defensible ordinance can follow. These are our inferences from the sources above, developed further in Section 9.

1. **Night matters most.** The firmest evidence concerns sleep, and a data center runs through the night. WHO's night values (40 to 45 dB Lnight outdoors; 30 dB LAeq in the bedroom) are the most relevant health benchmarks (World Health Organization Regional Office for Europe 2009; Berglund et al. 1999). A night limit should be lower than the day limit, by the 5 to 10 dB WHO suggested in 1999 (Berglund et al. 1999).
2. **A-weighting alone misses low-frequency sound.** Indoor low-frequency criteria exist and are in use in Denmark, Germany, Sweden, Poland, the Netherlands, and the United Kingdom (Exhibit 8). WHO's C-minus-A screen offers a simple trigger for closer analysis (Berglund et al. 1999).
3. **Tonal sound deserves a penalty.** EPA's 1974 model added 5 dB for tones, and the same idea appears throughout later practice (U.S. Environmental Protection Agency 1974). Section 2.5 explains how tones are measured.
4. **A margin above background matters for annoyance.** Annoyance rises when a new source stands out from existing sound, especially in quiet places (U.S. Environmental Protection Agency 1974). Federal and New York review pair an absolute limit with an increase test (FHWA 2026a; New York State Department of Environmental Conservation 2001). Using both protects health and the character of a quiet place, provided background is measured, not assumed.

5. **Vibration can be handled with tested federal language.** FERC's "no perceptible increase in vibration" rule for compressor stations is a ready model (FERC 2026b).
6. **Cite the evidence precisely.** A township that says plainly it is applying transport and night guidance by analogy (Section 3.2) will be harder to challenge than one that overstates the science.

SECTION 04

Where Data Center Sound Comes From and How Much Design Can Remove

The machines, the numbers, how far the sound travels, and what engineering can and cannot fix.

4 Where Data Center Sound Comes From and How Much Design Can Remove

This section explains what makes noise at a data center, how loud each source is, and how far its sound travels. It then sets out what design can remove, what that costs, and how a local government can check the result. The point for an ordinance writer is simple: the sound a neighbor hears is mostly decided before construction, by choices about siting, equipment, and layout. Rules that ask for those choices early, and then require proof after the facility opens, do more than any single decibel number.

The section uses the measurement terms defined in Section 2: A-weighted and C-weighted decibels (dBA and dBC), the equivalent sound level (Leq), the background level (L90), and octave bands. Health effects are in Section 3. Adopted local limits are in Section 8.

Most equipment numbers below come from manufacturer data, which describe a machine under test conditions, or from noise studies that applicants filed to win permits. Neither is a measurement at anyone's home, and we say which kind each number is. Figures marked "our calculation," and later figures in this section that carry no citation of their own, are ones we computed from the cited inputs with the two rules of thumb in the box below.

4.1 What a data center is, physically

A data center is a set of large buildings full of computers, plus the equipment that powers and cools them. Inside are **data halls**: rooms of server racks. Nearly all the electricity the servers use turns into heat, so every data center has an outdoor heat-rejection plant that runs day and night.

Data center sound comes from three groups of equipment (Ostergaard Acoustical Associates for Legend Properties (filed with Smithfield Township) 2026; Ramboll for Kimley-Horn (posted by Fairfax County Sully District) 2023; Building Design + Construction (Alex Odom, Acentech) 2026):

1. **Cooling that runs all the time.** Air-cooled chillers, cooling towers, dry coolers, rooftop exhaust fans, and the intake and outlet louvers of indoor air handlers move the heat outdoors.
2. **Electrical equipment that runs all the time.** Substation and medium-voltage transformers hum at twice the line frequency.
3. **Standby power that runs rarely but loudly.** Diesel (sometimes natural gas) generators sit ready for power outages and are run for testing. Some new campuses for artificial intelligence (AI) add gas turbines or engines that generate power continuously.

The consultant for a 2026 project in Smithfield Township, Pennsylvania put it plainly: "Sound produced by a data center primarily comprises sound from chillers and emergency generators" (Ostergaard Acoustical Associates for Legend Properties (filed with Smithfield Township) 2026).

The scale is what sets data centers apart from an office park. A large data center "may have dozens of air-cooled chillers covering the entire roof" (Building Design + Construction (Alex Odom, Acentech)

2026). Virginia's Joint Legislative Audit and Review Commission (JLARC) found that the average data center site in Virginia has 54 permitted generators, "typically one to three megawatts per unit" (Joint Legislative Audit and Review Commission, Virginia 2024). Permit studies model 48 generators and 60 chillers for one Pennsylvania building (Ostergaard Acoustical Associates for Legend Properties (filed with Smithfield Township) 2026), and 115 exhaust fans for one in Fairfax County, Virginia (Ramboll for Kimley-Horn (posted by Fairfax County Sully District) 2023). A resident of the Great Oak neighborhood in Prince William County, Virginia counted 424 rooftop exhaust fans and 88 backup diesels on the nearby four-building Amazon Web Services (AWS) campus on Tanner Way (Dale Browne, Great Oak Subdivision (resident), posted by Prince William County 2024). That count is the resident's, not the operator's.

> **Two numbers that must be kept apart.** Equipment data come in two forms (Section 2.1). Sound power level is the total sound a machine gives off. It does not depend on distance, and models use it as input. A chiller rated at "104 dBA sound power" does not mean anyone hears 104 dBA. Sound pressure level is what a microphone reads at a particular place, so it always needs a distance, such as "75 dBA at 7 meters." Ordinances limit sound pressure at a property line or a home. A decibel figure for a machine with no distance and no statement of which kind it is cannot be used. Two rules of thumb help with the rest of this section. First, sound from a compact source drops about 6 dB each time the distance doubles, before ground, air, or barriers take their share (Generac Power Systems (Michael Hermes) 2016; Cummins Inc. 2018b). Second, decibels add on an energy basis, so 100 equal chillers are about 20 dB louder at a distance than one (Section 2.2). Quieting a few of many units does little.

4.2 The main sources and how loud they are

Exhibit 9 lists the main sources with the distance and operating conditions behind each figure. Every value is a manufacturer figure or a figure used in an applicant's study, unless the table says it was measured.

Chillers. An air-cooled chiller is a refrigeration machine with compressors and a bank of large fans on top. The chillers in recent permit studies are rated at 96 to 104 dBA sound power each (Ostergaard Acoustical Associates for Legend Properties (filed with Smithfield Township) 2026; Lewis S. Goodfriend & Associates for Sentinel Green Fig LLC (posted by East Whiteland Township) 2026). Quieter versions exist: one maker's chart puts its quiet versions 10 and 17 dBA below a traditional screw chiller, though those units are smaller than data center chillers (Climaveneta (Mitsubishi Electric Hydronics), distributor copy 2026).

A rough calculation shows why chiller counts matter. On flat open ground, one 104 dBA chiller gives about 46 dBA at 300 meters (about 1,000 feet) from spreading alone. Sixty of them give about 64 dBA at the same distance (our calculation). Real results are lower because buildings, barriers, ground, and air absorb some sound. The Smithfield model, with 60 chillers behind a 20-foot barrier set 70 to 100 feet below nearby homes, predicted 38 to 47 dBA there at night (Ostergaard Acoustical Associates for Legend Properties (filed with Smithfield Township) 2026). Those homes are probably closer than 300

Exhibit 9. Typical sound levels of data center equipment, with distance and conditions

Equipment	Level	Kind and distance	Conditions and type of evidence
Air-cooled chiller, about 500 tons	104 dBA (maximum)	Sound power	Low-noise fans at 825 rpm. Manufacturer data used in an applicant model.
Rooftop air-cooled chiller, low-noise mode	96.4–98.6 dBA	Sound power	Fan speed capped at 60%; 55% to 79% load. Applicant model.
Standard screw chiller	96–99 dBA	Sound power	Full load at 35°C. Manufacturer catalog.
Quiet chiller versions (smaller units)	82–94 dBA	Sound power	"Super Low" and "Extra Low" noise versions with electronically controlled fans. Manufacturer catalog.
Dry coolers	23–68 dBA	10 m	The range depends on unit size and fan choice. Manufacturer brochure.
Rooftop exhaust fan	91 dBA day; 87 dBA night	Sound power	Full speed by day, 83% speed at night. Applicant model of 115 fans.
Air handler intake louver	85 dBA per m^2; 71 with silencer	Sound power	The silencer has at least 14 dB insertion loss. Applicant model.
Diesel generator, 2–3 MW, in acoustic enclosure	72–85 dBA	7 m (23 ft)	Enclosure ratings from applicant studies.
Unenclosed diesel generator parts	Exhaust 120–130; fan 100–110; engine 100–105 dBA	1 m	Manufacturer training material.
Load bank used in generator tests	109 dBA	Sound power	One per generator. Applicant model.
Medium-voltage transformer, 4,400 kVA	65 dBA	0.3 m	Applicant filing for a battery site in North Dakota.
Substation transformer	101 dBA; 82 dBA as specified	Sound power	The quieter unit was specified to meet a California county limit. Applicant study.
Battery container fans (measured)	Up to 92 dBA	1 m	Field measurements reported by a practitioner in trade press.

Source: Ostergaard Acoustical Associates for Legend Properties (filed with Smithfield Township) (2026), Lewis S. Goodfriend & Associates for Sentinel Green Fig LLC (posted by East Whiteland Township) (2026), Daikin Applied (2016), Climaveneta (Mitsubishi Electric Hydronics), distributor copy (2026), Airedale / Modine (2020), Ramboll for Kimley-Horn (posted by Fairfax County Sully District) (2023), Cummins Inc. (2018b), Geronimo Power, filed with North Dakota Public Service Commission (2026), Tetra Tech (CEQA appendix, San Bernardino County) (2023), and Solar Power World (Kelly Pickerel) (2025). The full list with conditions is in the report's data files (Appendix D).

Note: Sound power has no distance; sound pressure always has one. Sound power is not what a neighbor hears: subtract distance, ground, air, and barrier losses to estimate that (Section 4.8). Terms: a ton of cooling is 12,000 BTU per hour; rpm is revolutions per minute. Insertion loss is the drop in sound a silencer provides. A load bank is an electric heater used to load a generator during tests. kVA (thousand volt-amperes) measures transformer size.

meters, where spreading alone would give more than 64 dBA. The difference is what barriers, grading, and layout removed.

Cooling towers. A cooling tower cools water by evaporation, with a large fan drawing air through falling water. For neighbors the fan matters most, because its sound "has a greater influence on far field receptor locations" than splashing water (SPX Cooling Technologies (Marley) 2026). Low-noise options are ordinary catalog items: one maker lists a low-sound fan worth 4 to 7 dBA and a "super low sound" fan worth 9 to 15 dBA (EVAPCO Inc. 2019). Another lists options from 2 to 19 dB (SPX Cooling Technologies (Marley), copy hosted by Lenntech 2026). These options cost some cooling capacity, about 3% for low-sound fans in one maker's data (Baltimore Aircoil Company (copy hosted by equipment reseller) 2026).

Dry coolers. A dry cooler is a large fan-and-coil unit that rejects heat without using water. The U.S. Department of Energy notes that warmer liquid cooling loops "may allow the use of dry coolers" and save water (U.S. Department of Energy, FEMP 2024). One maker's range runs from 23 to 68 dBA at 10 meters, depending on size and fan choice (Airedale / Modine 2020). Because a dry cooler needs more airflow than an evaporative tower of the same capacity, it needs more or larger fans. That is an engineering principle, not a measured noise difference.

Exhaust fans and air handlers. Designs that cool the data halls with outside air or indoor air handlers send sound out through roof fans and wall louvers. A 2023 study in Fairfax County, Virginia modeled 115 rooftop exhaust fans at 91 dBA sound power each by day and 87 dBA at night, when they slow to 83% speed (Ramboll for Kimley-Horn (posted by Fairfax County Sully District) 2023). That 4 dB drop for a 17% speed cut matches the "fan law," under which fan sound changes with about the fifth power of speed (ASHRAE TC 9.9 2021).

Transformers and substations. Large campuses build their own substations; residents put the AWS Tanner Way substation at 192 megawatts (Dale Browne, Great Oak Subdivision (resident), posted by Prince William County 2024). Transformer hum is covered with tones below, and battery storage with the comparators (Section 4.6).

4.3 Tones and low-frequency sound

Data center sound is often more noticeable than its dBA level suggests, for three reasons: steady tones, beating, and strong low-frequency content. A **tone** is sound concentrated at one pitch, such as a hum or whine. Section 2.5 explains why codes add a penalty for tones.

Where the tones come from. Fans make a tone at the **blade-pass frequency**: the rotation speed in revolutions per minute, times the number of blades, divided by 60. As an illustration, a fan at the Smithfield chillers' 825 rpm with an assumed eight blades would hum at 110 Hz. Transformers hum at 120 Hz in North America, twice the 60 Hz power frequency, plus multiples such as 240 and 360 Hz. The hum comes from the core steel changing length twice in each electrical cycle (Building Design + Construction (Alex Odom, Acentech) 2026). Chiller compressors add higher tones. MD Acoustics, an

Arizona consultant with data center clients, reports that air-cooled chillers "tend to feature annoying tonal sounds at approximately 600–1000 Hz" (MD Acoustics LLC for Town of Marana, AZ 2026).

Beating. Two machines at nearly the same speed make tones that drift in and out of step, producing a slow pulse. Prince William County's acoustics consultant, David Nelson, heard "a slowly pulsating low-frequency tone … around 30 Hz" in the Amberleigh Station neighborhood. He named as the likely source a site about one mile north "with cooling towers," and explained the pulse as two identical machines whose tones "beat" (David A. Nelson, Nelson Acoustics, for Prince William County DCOAG 2025b). It is the clearest public record we found of a data center tone noticed a mile away, though it is an attribution, not a measured source test.

Low-frequency energy. The gap between dBC and dBA is a simple sign of low-frequency content, because C-weighting counts the bass that A-weighting discounts. The Smithfield model predicts dBC levels 8 to 12 dB above dBA at every home it studied. Its consultant says gaps of 5 to 15 dB are common, even for office rooftop units (Ostergaard Acoustical Associates for Legend Properties (filed with Smithfield Township) 2026). Great Oak residents report an average gap of 15.2 dB from October 2024 to April 2025 in their own measurements (Dale Browne, Great Oak Subdivision (resident), posted by Prince William County 2025b).

What the evidence does not show. Claims that data centers emit dangerous infrasound (sound below 20 Hz; Section 2.4) have little engineering support. MD Acoustics reviewed a proposed ordinance for Marana, Arizona. It wrote that it "has not seen sufficient evidence to suspect that data centers produce significant levels of infrasound" (MD Acoustics LLC for Town of Marana, AZ 2026). It added that fan and cooling sound is "primarily in the audible range." At Great Oak, Nelson found that "apparent LFN contributions do not exceed criteria," where LFN means low-frequency noise (David A. Nelson, Nelson Acoustics, for Prince William County DCOAG 2025a). These findings cut against infrasound claims. They do not contradict the finding, discussed in Section 4.7, that a steady low-frequency tone can be audible inside a home.

4.4 Generators and generator testing

Backup generators are the loudest machines on a data center site, but they seldom run. Cummins, a large maker of engines and generators, puts an open unit's unsilenced exhaust at 120 to 130 dBA at 1 meter, with the radiator fan at 100 to 110 dBA and the engine at 100 to 105 dBA (Cummins Inc. 2018b). Generators at data centers sit in acoustic enclosures with exhaust silencers. Enclosed 2 to 3 MW units are rated between 72 and 85 dBA at 7 meters (23 feet) in the permit studies we reviewed (Ostergaard Acoustical Associates for Legend Properties (filed with Smithfield Township) 2026; Ramboll for Kimley-Horn (posted by Fairfax County Sully District) 2023; Lewis S. Goodfriend & Associates for Sentinel Green Fig LLC (posted by East Whiteland Township) 2026).

Two features of generators matter for rules. First, tests often use a **load bank**, a large electric heater that gives the generator something to power. In the Fairfax County study, each load bank was rated at 109 dBA sound power, louder than the enclosed generator it served (Ramboll for Kimley-Horn

(posted by Fairfax County Sully District) 2023). Test rules should cover load banks. Second, generators add up. Thirty to fifty enclosed units running together in an outage are 15 to 17 dB louder than one. The Smithfield model predicted up to 65 dBA at homes with all chillers and all 48 generators running (Ostergaard Acoustical Associates for Legend Properties (filed with Smithfield Township) 2026).

Outages are rare. JLARC reported that "most operators reported experiencing zero to two minor outages per site in the last two years, with nearly all outages being between one and five hours long" (Joint Legislative Audit and Review Commission, Virginia 2024). Testing is routine: about an hour per generator each month in one Pennsylvania study (Lewis S. Goodfriend & Associates for Sentinel Green Fig LLC (posted by East Whiteland Township) 2026), and "one hour, once per week" by Loudoun County, Virginia's account (Loudoun County, Virginia 2026). Federal emission rules cap maintenance and testing of emergency engines at "a maximum of 100 hours per calendar year" (U.S. EPA (via Cornell LII) 2026).

Local governments already limit when tests happen; Henrico County, Virginia, for example, allows testing only "Monday-Friday between 10:00 am and 4:00 pm" (Henrico County, Virginia Planning 2026). Section 8.3.7 surveys these rules. The Pennsylvania and Virginia permit studies we reviewed all treat testing as a daytime activity and emergency operation as exempt (Ostergaard Acoustical Associates for Legend Properties (filed with Smithfield Township) 2026; Ramboll for Kimley-Horn (posted by Fairfax County Sully District) 2023; Lewis S. Goodfriend & Associates for Sentinel Green Fig LLC (posted by East Whiteland Township) 2026).

4.5 On-site gas turbines and engines at AI campuses

Some new AI campuses generate their own power with gas turbines or large gas engines. Acoustically, such a campus is a power plant that runs all night, not a site with generators tested on weekday afternoons.

The equipment data show why. An enclosed 23 MW turbine package (Solar Turbines Titan 250) is rated at "85 dBA at a distance of 1 m (3 ft) from the enclosure wall," not counting its air intake, exhaust, and piping (Solar Turbines (archive.org copy) 2008). A large gas engine (Wärtsilä 50SG) has an engine sound power of 128 dBA and an unsilenced exhaust of 142 dBA, with strong energy down to the 31.5 Hz band. The maker says these are not guaranteed values (Wartsila Finland (filed on Italian MASE EIA portal) 2018). Unmitigated startup can run "as much as 20 dBA over baseload levels" (POWER magazine (P. Saussus) 2012).

The only data center record of this kind is contested. xAI built a gas turbine plant in Southaven, Mississippi, to power its data centers in Memphis, Tennessee, and Southaven. A federal class action filed in Tennessee in September 2026, *Carter v. X.AI Corp.*, alleges that the turbines have produced readings "as high as 70 dBA at residents' property lines" (U.S. District Court, W.D. Tennessee (copy posted by WREG) 2026). News reports describe a $7 million sound wall that "does little to muffle the noise" (Scientific American (Austyn Gaffney) 2026). Both are allegations or press accounts, not independent measurements. A separate suit over xAI's Southaven turbines, *Haley v. X.AI Corp.*, was filed in federal court in Mississippi. Both suits and their status are covered in Section 5.8.

A federal benchmark exists for sources like these. Natural gas compressor stations are often driven

by turbines, and the Federal Energy Regulatory Commission (FERC) limits a new station to 55 dBA Ldn at nearby homes (FERC 2026b). Section 5.5 describes the rule. For a source that runs steadily all day and night, 55 dBA Ldn equals about 48.6 dBA Leq at every hour, matching FERC's practice. FERC certificate orders also require noise surveys after a station enters service (FERC staff (TC Energy copy) 2024). An ordinance that exempts "emergency" generators should put continuous on-site generation in its own category.

4.6 Comparators: energy facilities with similar equipment

Several kinds of energy facilities share data center equipment, and states have written sound limits for some of them. Exhibit 10 compares them. The key difference is whether a facility runs at night.

Exhibit 10. Comparator facilities: night operation, main sound, and example levels

Facility	Runs at night?	Main sound	Example level and type of evidence
Battery storage	Yes	Cooling fan hum, inverter tones, transformer hum	A Tesla Megapack XL is rated at 66.3 dBA at 10 m (manufacturer). Practitioners report up to 92 dBA at 1 m from container fans.
Substation	Yes	120 Hz hum and multiples	A 222 MVA transformer was modeled at 112 dBA sound power from the industry standard (applicant study).
Solar inverters	No	Inverter tones near the unit	Measured levels were 43–46 dBA at 150 ft in full sun, with no sound at night (state-funded field study).
Wind turbine	Yes	Broadband "swish" with a rhythmic beat	A 6.2 MW turbine is rated at 95.0–104.8 dBA sound power, depending on wind (manufacturer).
Crypto mine	Yes	Dense fan walls	A county-funded study in Hood County, Texas reported about 60 dB near the site; operating state was not confirmed.
Gas compressor station	Yes	Turbine or engine, cooler fans	Predicted levels were 50.4 dBA Ldn at 1,800 ft and 39.0 at 6,400 ft (FERC review).

Source: Geronimo Power, filed with North Dakota Public Service Commission (2026), Solar Power World (Kelly Pickerel) (2025), RSG, filed with North Dakota Public Service Commission (2021), Tech Environmental for Massachusetts Clean Energy Center (copy in Champaign County IL record) (2012), Vestas Wind Systems (filed with Shire of Kojonup, Western Australia) (2024), Texas Tribune (2025a), and FERC staff (TC Energy copy) (2024).

Battery storage and substations. Battery sites have the same fans, inverters, and transformers as data center campuses. A monitoring practitioner calls their fan hum "tonal noise [that] can be very intrusive" and reports night limits "often 30–40 dBA at the nearest home" (Solar Power World (Kelly Pickerel) 2025). The transformer standard published by the National Electrical Manufacturers Association, NEMA TR-1, sets maximum factory-test levels by size: for one common class, 68 dB at 10 MVA up to 78 dB at 100 MVA (National Electrical Manufacturers Association 2013). Those are ceilings. Buyers often specify "the NEMA TR1 value minus X dB" (IEEE PES Transformers Committee 2004). A federal case study describes two transformers bought 9 dB below the standard, with no complaints after three years (NIOSH (from 1979 noise control manual) 1979).

Solar. A Massachusetts field study found solar inverter tones in "harmonic pairs" and no sound at night, when inverters stop (Tech Environmental for Massachusetts Clean Energy Center (copy in Champaign County IL record) 2012). Solar inverter limits written for daytime equipment are not a model for a facility

that runs all night.

Wind. One large wind turbine, at about 105 dBA sound power, is about as loud a source as one large chiller (Vestas Wind Systems (filed with Shire of Kojonup, Western Australia) 2024; Ostergaard Acoustical Associates for Legend Properties (filed with Smithfield Township) 2026). But a data center has dozens to hundreds of chiller-sized sources on one site, while turbines stand hundreds of meters apart.

Crypto mines. Bitcoin mines cooled by walls of fans are the closest comparator to an air-cooled AI data center. They draw a lot of power per acre, run all night, and are often rural. The best-known case, a mine in Granbury, Hood County, Texas, produced a county study of about 60 dB near the site that could not confirm the mine was "operating in typical fashion" (Texas Tribune 2025a). The county could not set a limit, because "Texas counties lack authority to enforce noise limits" (Texas Tribune 2025b). The prosecutions and lawsuits that followed are in Section 5.

4.7 Real complaints and what was actually measured

Public debate about data center noise mixes three kinds of evidence. **Measurements** are readings taken with instruments, by consultants, staff, or residents. **Models** are predictions made before construction. **Allegations** are claims in complaints or lawsuits that no one has yet tested. The Southaven turbine case (Section 4.5) and the Granbury mine (Section 4.6) rest mostly on allegations and disputed readings, so the cases below are the ones with measurements.

Virginia: JLARC's statewide review. JLARC reviewed local measurements at Virginia data centers that had drawn complaints. It found that "data center noise that has prompted resident complaints ranges from an estimated 40 to 59 decibels." That range is "typically below the 55 or 60 decibel limit that Loudoun, Prince William, and Fairfax allow," and the noise is "rarely loud enough to violate noise ordinances" (Joint Legislative Audit and Review Commission, Virginia 2024). JLARC concluded that "it's data centers' constant noise that some residents consider problematic." Its figures are total sound at the complainant's location, not the data center alone (Joint Legislative Audit and Review Commission, Virginia 2024). The lesson is direct: complaints arise at levels that already meet common 55 to 60 dBA limits.

Great Oak, Prince William County, Virginia. This is the best-documented case. The neighborhood sits about 600 feet from the AWS Tanner Way buildings, by residents' maps (Dale Browne, Great Oak Subdivision (resident), posted by Prince William County 2024). Three kinds of evidence exist:

- **Resident measurements.** Residents report 58 to 65 dBA at homes before a fan retrofit and 48 to 55 dBA after it, a drop of about 10 dBA (Dale Browne, Great Oak Subdivision (resident), posted by Prince William County 2024). The operator has not published its own numbers.
- **County consultant measurements.** Nelson ran two meters for about six days in April 2025. He found it "not possible to discriminate Data Center noise from the traffic noise background with a single spot measurement." A "55 Hz tone appears at all times at all locations," averaging about 51 dB. With about

12 dB lost through a typical house wall at that pitch, he estimated about 39 dB indoors, "likely audible indoors" and "potentially annoying." The data center added an "apparent 2–4 dB increase over traffic background" in the low bands (David A. Nelson, Nelson Acoustics, for Prince William County DCOAG 2025a).

- **Staff account.** County staff told the advisory group that "it took a year of testing to finally capture a clear reading of the Amazon data center noise" (Prince William County, Virginia 2025).

Nelson also traced a strong 90 Hz tone in the early morning to a commuter rail yard, not the data center (David A. Nelson, Nelson Acoustics, for Prince William County DCOAG 2025a). Great Oak teaches three things. Near busy roads, a data center can dominate the low frequencies while traffic sets the dBA level. Single spot readings cannot separate the two. And a steady tone can be audible indoors when outdoor limits are met.

Chandler, Arizona. In 2018 Chandler residents complained of the hum from "industrial air-conditioning units at a nearby data center owned by Cyrus One." A company representative said shutting units off "could cost the company millions" (Arizona Republic (republished by Rose Law Group Reporter) 2018). No decibel readings from that dispute were published. The city's 2022 ordinance that followed is described in Section 8.1.

4.8 How far sound travels, and why rural nights are hardest

Nearly every U.S. permit study predicts sound at homes with ISO 9613-2, the international standard for outdoor sound propagation described in Section 2.8, run in commercial software (Ramboll for Kimley-Horn (posted by Fairfax County Sully District) 2023; Ostergaard Acoustical Associates for Legend Properties (filed with Smithfield Township) 2026; Lewis S. Goodfriend & Associates for Sentinel Green Fig LLC (posted by East Whiteland Township) 2026). The method starts with the source's sound power in octave bands from 63 Hz to 8 kHz. It then subtracts losses from spreading, air absorption, the ground, and barriers (International Organization for Standardization 2024). Knowing how each loss behaves explains most of the disputes about data center noise.

The model's stated limits. ISO 9613-2 predicts levels under conditions that favor sound travel: downwind, or under the kind of ground-based temperature inversion that forms on clear, calm nights (International Organization for Standardization 2024). Its accuracy is usually quoted as plus or minus 3 dB. But the author of the draft standard wrote that "for distances greater than 500 m there is insufficient evidence to support an estimate of accuracy" (Piercy 1993). We did not retrieve the accuracy statement in the current 2024 edition. A prediction for a home more than about 500 meters (1,600 feet) away therefore has no demonstrated accuracy. The method's bands also stop at 63 Hz, so the 30 Hz tone heard in Prince William County falls outside it.

Air absorbs high pitches, not low ones. The air absorption table in the standard's 1996 edition, which we read in a preview copy, shows how strongly the effect depends on frequency. At 10°C and 70% humidity, air removes about 0.1 dB per kilometer at 63 Hz, 0.4 at 125 Hz, 3.7 at 1 kHz, and 32.8 at 4 kHz (International Organization for Standardization 1996). Over one mile, that is about 6 dB at 1 kHz, more

than 50 dB at 4 kHz, and almost nothing at 63 Hz. Distance filters out the hiss and leaves the hum.

Ground and height. Soft ground such as grass and crops absorbs sound, mainly at middle frequencies; pavement, water, ice, and frozen soil do not (International Organization for Standardization 1996). The ground helps least at low frequencies and for rooftop sources, whose sound path stays well above it.

Night inversions and wind. On clear, calm nights the ground cools, the air near it grows colder than the air above, and sound bends back down instead of escaping upward. Wind that strengthens with height does the same downwind. An Arizona Department of Transportation study found that nighttime inversions, common around Phoenix from October through March, raised highway noise by "5 to 8 dB at distances greater than 1/4 mi" (Arizona DOT / FHWA (Saurenman et al.) 2005). The physics is the same for a data center. New South Wales, Australia requires industrial noise studies to assess these "noise-enhancing meteorological conditions" at night unless they occur less than 30% of the time (NSW Environment Protection Authority (Australia) 2017).

Why rural nights are the hardest case. Four facts combine:

1. **The background is low.** An example from Acentech, an acoustics consultancy, near a rural two-lane road had a daytime L90 of 43 dBA and a minimum of 34 dBA; nights are quieter (Building Design + Construction (Alex Odom, Acentech) 2026). A Prince William County advisory group member reported 32 to 35 dB at night in a quiet community (Prince William County, Virginia 2025). Section 3.11 sets these field reports beside the published reference levels for rural areas.
2. **No traffic masks the sound.** At Great Oak, traffic partly covered the data center (David A. Nelson, Nelson Acoustics, for Prince William County DCOAG 2025a). Rural homes lack that cover.
3. **Inversions add several decibels** at a distance on clear, calm nights (Arizona DOT / FHWA (Saurenman et al.) 2005; NSW Environment Protection Authority (Australia) 2017).
4. **Steady tones stand out.** Low-frequency tones lose little to air or to house walls (about 12 dB at 55 Hz by Nelson's estimate) (David A. Nelson, Nelson Acoustics, for Prince William County DCOAG 2025a).

So a fixed limit such as 55 dBA can let a facility raise a rural night's sound by 20 dB or more. A limit tied to the background, or a low night limit with a tonal penalty, controls the rural case. Section 9 develops those options.

More than one facility. Two facilities that each meet a limit can together exceed it at a home between them, since two equal contributions make 3 dB more than one. Prince William County staff said the county "is not able to use cumulative noise to reject approval for a development project" (Prince William County, Virginia 2025). A Great Oak resident wrote that there is "no solution for multiple data centers, aside from a discussion on needing a noise budget" (Dale Browne, Great Oak Subdivision (resident), posted by Prince William County 2025a).

Distance removes the hiss, not the hum

Over a mile, air removes about 6 dB at 1 kHz and almost nothing at 63 Hz, and clear, calm nights add several decibels at a distance. A data center that meets a 55 dBA limit can still be the loudest sound at a rural home at night, and its tones can be heard indoors. The standard prediction method is least proven exactly there: low frequencies, long distances, and night conditions.

4.9 The mitigation hierarchy

Acoustic consultants describe the same order of preference. The earlier a measure is chosen, the cheaper and more effective it tends to be:

1. siting, setbacks, and orientation;
2. equipment selection;
3. enclosures, silencers, and other treatment at the source;
4. barriers and berms between source and homes;
5. operating rules, such as generator test windows and night fan limits;
6. verification through surveys, modeling, testing, and monitoring.

Acentech advises owners to write performance criteria "to avoid substitutions of lower-performing products" (Building Design + Construction (Alex Odom, Acentech) 2026). Companies themselves told JLARC that "reducing noise after a building is operational can be difficult and expensive" (Joint Legislative Audit and Review Commission, Virginia 2024). Exhibit 11 summarizes typical reductions.

1. Siting, setbacks, and orientation. Distance is the one measure that needs no equipment, but it works unevenly. Going from 500 to 1,000 feet buys about 6 dB, and 1,000 to 2,000 feet buys another 6 dB plus some air and ground loss at middle and high pitches. Against a 63 Hz hum, air adds only about 0.1 dB per kilometer (International Organization for Standardization 1996). A roof full of chillers several hundred feet long also behaves more like an area than a point, so sound falls off more slowly close in.

A rule of thumb for reviewers. A reviewer can check whether a proposed setback is plausible with the two rules in the box above. Suppose a campus has 100 to 200 chillers at 96 to 104 dBA sound power each. Together they total about 116 to 127 dBA: 100 units add 20 dB and 200 add 23 dB.

Over flat ground, spreading alone takes about 68 dB off the sound power by 1 kilometer and about 72 dB by 1 mile. That leaves about 48 to 59 dBA at 1 kilometer (3,300 feet) and 44 to 55 dBA at 1 mile. Distance alone does not reliably reach 45 dBA, let alone 40 dBA at night. Barriers, buildings, ground, and quieter fans must do the rest, and a study that claims otherwise should show its octave-band work.

Layout and orientation matter as much as distance. The Smithfield design put the equipment yard on the far side from homes and cut the site so one building sits "about 70 feet lower in elevation" than a neighboring home (Ostergaard Acoustical Associates for Legend Properties (filed with Smithfield Township) 2026). Terrain is one of the few measures that also helps at fairly low frequencies, because

Exhibit 11. Typical reductions from common measures, and where they fall short

Measure	Typical reduction	Frequency caveat and evidence type
Distance	About 6 dB per doubling from a compact source	Air adds almost nothing at 63 Hz. Large campuses lose less close in.
Slower fans (fan law)	83% speed: 4 dB; 60%: 11 dB; 50%: 15 dB (theory)	Field results run smaller: 4 to 5 dBA at 70% and 10 to 13 dBA at 50% for battery fans (practitioner report).
Quiet chiller packages	4–6 dBA at full load; 9–10 dBA at half load	The gain is smallest at full load, which is when hot summer nights test the limit (manufacturer).
Quiet cooling tower fans	4–7 dBA (low sound); 9–15 dBA (super low sound)	These cut fan noise, which dominates far away. They cost about 3% of cooling capacity (manufacturer).
Low-noise transformer	9 dB below the industry standard (documented case)	The 120 Hz hum remains; a tonal penalty may still apply.
Compressor wraps	About 4 dBA new; about 10 dB as a retrofit	The retrofit was "most effective at frequencies above 800 Hz" and much weaker below (consultant).
Silencers and acoustic louvers	4–11 dB at 63 Hz; 13–39 dB at 1 kHz	They are strong at middle pitches and weak at the hum frequencies (manufacturer and applicant data).
Generator enclosure and exhaust silencer	Open parts 100–130 dBA at 1 m become 72–85 dBA at 7 m	Low-frequency exhaust and radiator sound is hardest to treat. Silencer "grades" are not standardized.
Barrier wall	5 dB once it breaks the line of sight; 10 dB "attainable"; 20 dB "nearly impossible"	Walls work best at high pitches. A 63 Hz wave is about 18 ft long, so a 20-ft wall does little against it (federal highway guidance).
Earth berm	1–3 dBA more than a wall of the same height	The same low-frequency limits apply, and berms need more land.
Vegetation	Little real reduction	Planting is "mostly a psychoacoustic effect" (consultant).
Generator test windows	Keeps test noise out of night hours	Single-unit daytime tests met daytime limits in applicant studies.

Source: Generac Power Systems (Michael Hermes) (2016), International Organization for Standardization (1996), ASHRAE TC 9.9 (2021), Solar Power World (Kelly Pickerel) (2025), Johnson Controls / YORK (2021), EVAPCO Inc. (2019), Baltimore Aircoil Company (copy hosted by equipment reseller) (2026), NIOSH (from 1979 noise control manual) (1979), Lewis S. Goodfriend & Associates for Sentinel Green Fig LLC (posted by East Whiteland Township) (2026), MD Acoustics LLC for Town of Marana, AZ (2026), Swegon / Vibro-Acoustics (2026), WorkingBuildings / Cerami for Aligned Data Centers (posted by Village of Coal City) (2026), Cummins Inc. (2018b), Federal Highway Administration (2017a), Federal Highway Administration (2017b), Building Design + Construction (Alex Odom, Acentech) (2026), and Ostergaard Acoustical Associates for Legend Properties (filed with Smithfield Township) (2026). The full list is in the report's data files (Appendix D).

Note: Reductions do not simply add. Once one path is treated, the next-loudest path sets the total.

the “barrier” is very tall. Cummins calls location “the single greatest ally or enemy” and warns that one hard reflecting wall adds 3 dBA and two add 5 dBA (Cummins Inc. 2018b). Pointing radiator discharge and exhaust up and away from homes also helps (Cummins Inc. 2018a).

2. Equipment selection. Quiet equipment is usually the largest and cheapest gain. Because fan sound rises steeply with speed, large slow fans are quieter than small fast ones (ASHRAE TC 9.9 2021). The Department of Energy recommends “oversized cooling towers with VFD-equipped fans,” because larger fans “can be operated at lower speeds” to save energy (U.S. Department of Energy, FEMP 2024). A VFD, or variable-frequency drive, is an electronic control that lets a fan run below full speed. Here energy efficiency and quiet point the same way. YORK reports chiller reductions of “4-6 dBA at full load operation and 9-10 dBA at 50 percent load” from variable-speed fans and compressor enclosures (Johnson Controls / YORK 2021). One Pennsylvania applicant switched to larger chillers with sound-reduction software, cutting the count from 144 to 112 per building (Lewis S. Goodfriend & Associates for Sentinel Green Fig LLC (posted by East Whiteland Township) 2026).

Transformers can be bought quieter too. In a California battery project, the applicant met county limits by specifying a substation transformer at 82 dBA sound power instead of 101 dBA (Tetra Tech (CEQA appendix, San Bernardino County) 2023). Such levels work only if written into purchase specifications and checked.

Liquid cooling is not a noise cure by itself. Liquid cooling moves heat from chips into a water or glycol loop instead of room air. It mainly removes indoor fans: the Department of Energy says it reduces “the size and power consumption of fans serving the data center” (U.S. Department of Energy, FEMP 2024). It does not remove the outdoor equipment, because the heat still leaves the site through dry coolers, towers, or chillers.

Two effects pull in opposite directions. Warm-water loops can drop chillers altogether, which would remove their compressor tones: ASHRAE notes that warm-water cooling “minimizes (or eliminates) the need for chillers” (ASHRAE TC 9.9 2021). Water rules can push the other way. Henrico County, Virginia requires that “any water cooling must use a closed-loop or recycled water system” (Henrico County, Virginia Planning 2026), which favors dry coolers and their larger fan area. We found no source that measures the change in noise at neighbors’ homes from switching to liquid cooling. Because the result depends on the equipment chosen, an ordinance should regulate sound at the home, not the cooling technology.

3. Enclosures, silencers, and source treatment. Source treatment works well at middle and high pitches and poorly at low ones. In one 2026 design for Coal City, Illinois, 60-inch chiller discharge silencers gave 10 dB at 63 Hz but 39 dB at 1 to 2 kHz (WorkingBuildings / Cerami for Aligned Data Centers (posted by Village of Coal City) 2026). Certified data for acoustic louvers show the same pattern: 4 to 11 dB at 63 Hz against 13 to 26 dB at 1 kHz (Swegon / Vibro-Acoustics 2026). Longer silencers give more low-frequency loss, at a cost in fan energy (Building Design + Construction (Alex Odom, Acentech) 2026).

For generators, Cummins gives a lesson in balance. In its example, an industrial-grade muffler brings a generator from 95 to 88 dBA. A critical-grade muffler, twice as strong, reaches only 87 dBA,

because the radiator fan then dominates (Cummins Inc. 2018b). Cummins also warns that muffler grades "are not standardized." Conditions should therefore set a sound level at a stated distance, not an enclosure or muffler grade.

Retrofits show what source treatment can do after the fact. Sound blankets on chiller compressors and piping at one site gave "an overall ∼10 dB reduction," mostly above 800 Hz. MD Acoustics called it "an expensive and labor-intensive project" that reduced, "but [did] not eliminate[,] the nuisance noise" (MD Acoustics LLC for Town of Marana, AZ 2026). At AWS Tanner Way, residents report that fan shrouds gave "little benefit (∼1 dBA)." They report that new fan blades and motors, "wind bands," and control changes over about 11 months then cut about 10 dBA (Dale Browne, Great Oak Subdivision (resident), posted by Prince William County 2024). These are resident reports; the operator has not published results. Low-frequency tones remained afterward (David A. Nelson, Nelson Acoustics, for Prince William County DCOAG 2025a).

4. Barriers and berms. The Federal Highway Administration (FHWA) rates wall performance on a scale: 5 dB is "Simple," 10 dB "Attainable," 15 dB "Very Difficult," and 20 dB "Nearly Impossible" (Federal Highway Administration 2017a). A wall gives about 5 dB once it blocks the line of sight, and about 1 dB more for each added 2 feet of height. A berm gives "an extra 1 to 3 dB(A)" over a wall of equal height. Short walls lose up to 5 dB at their ends (Federal Highway Administration 2017b).

Walls work best against high pitches. Barriers are "more effective in attenuating the higher frequencies" (Federal Highway Administration 2017b), because sound bends over a wall more easily when its wavelength is long. A 63 Hz wave is about 18 feet long (Building Design + Construction (Alex Odom, Acentech) 2026), so a 20-foot wall is only about one wavelength tall at that pitch. Barriers also work best close to the source. Vegetation offers "mostly a psychoacoustic effect with little real noise reduction" (Building Design + Construction (Alex Odom, Acentech) 2026).

5. Operating rules. Operations cost little and are easy to write into permits. Generator test rules can require one unit at a time, weekday midday hours, a maximum duration, notice for annual full-load tests, and coverage of load banks. CyrusOne posts such a schedule for its Aurora, Illinois campus: "Monthly tests: 30 minutes per generator, Monday-Friday, 9 AM-5 PM" (CyrusOne 2025). Night fan limits are a second tool, as in the Fairfax County study's 83% night fan speed (Ramboll for Kimley-Horn (posted by Fairfax County Sully District) 2023) and a Pennsylvania study's 60% chiller fan cap (Lewis S. Goodfriend & Associates for Sentinel Green Fig LLC (posted by East Whiteland Township) 2026). Cooler night air lowers the cooling load, so a permit can often make a night mode the default and require a log.

6. Verification. Verification decides whether the other measures were real (Section 4.13).

4.10 What mitigation costs

No operator has published a total noise mitigation cost for a facility. The supported figures are few.

Barrier walls. FHWA reports that from 2020 to 2022, highway noise barriers cost "$48.76 per square foot," and that about $925 million bought 222 miles of barrier in those years (Federal Highway Administration 2023). At that rate, a 10-foot wall costs about $490 per linear foot, a 20-foot wall about $975, and a 30-foot wall about $1,460. A 1,000-foot wall 20 to 30 feet high would cost about $1.0 to $1.5 million. Highway walls are built to traffic and wind-load standards, so a private screen wall may cost less.

Project figures in the public record. *Scientific American* reported a "$7-million sound wall" at xAI's Southaven turbine site (Scientific American (Austyn Gaffney) 2026). At Tanner Way, a Great Oak resident guessed the retrofit "cost as much as $30 million" (Data Center Knowledge (Peter Cary, Fauquier Times) 2023). One homeowner spent $20,000 on new windows, which "did not help" (Dale Browne, Great Oak Subdivision (resident), posted by Prince William County 2024).

Equipment costs. Makers do not publish price premiums for quiet equipment. They do state other costs: low-sound tower fans take about 3% of capacity and intake treatment about 5% (Baltimore Aircoil Company (copy hosted by equipment reseller) 2026), and silencers add fan energy (Building Design + Construction (Alex Odom, Acentech) 2026). Every source agrees that design-stage measures cost less than retrofits (Building Design + Construction (Alex Odom, Acentech) 2026; Joint Legislative Audit and Review Commission, Virginia 2024; Johnson Controls 2026).

4.11 What design can achieve

Can a large data center meet a given limit? Exhibit 12 collects the applicant studies that answer that question. Each project named in the table is a data center that was proposed when its study was written. Two are in Illinois (Coal City and Minooka) and two in Chantilly, Fairfax County, Virginia (T5 and Chantilly Premier). Two are in Pennsylvania (Smithfield Gateway in Smithfield Township and Sentinel Green Fig in East Whiteland Township), and Raylan is in Kentucky. Every result is a prediction. We found no post-construction measurement confirming any of them.

45 dBA at homes is reachable in models. Several designs reach about 45 dBA at homes a few hundred feet to a mile away using ordinary measures (WorkingBuildings / Cerami for Aligned Data Centers (posted by Village of Coal City) 2026; WorkingBuildings / Cerami for T5 (posted by FFXnow) 2026; Ostergaard Acoustical Associates for Legend Properties (filed with Smithfield Township) 2026; Ramboll for Kimley-Horn (posted by Fairfax County Sully District) 2023). The Coal City study predicts a maximum of 41 dBA "relative to the 44 dBA nighttime limit" (WorkingBuildings / Cerami for Aligned Data Centers (posted by Village of Coal City) 2026). The T5 study cuts its loudest home from 62 to 45 dBA with source treatment alone. Its consultant recommends that operators voluntarily limit their impact "to either 45dBA or the exising [sic] ambient +10dBA" (WorkingBuildings / Cerami for T5 (posted by FFXnow) 2026). Some designs still miss: the Minooka and Sentinel Green Fig studies

Exhibit 12. Predicted levels at homes in applicant noise studies (models, not measurements)

Project	Setting	Main mitigation	Predicted result
Aligned, Coal City, Illinois (2026)	Nearest homes	Discharge silencers, intake louvers, barriers, critical-grade generator silencers	Maximum 41 dBA against a 44 dBA night limit; 63 and 125 Hz bands near 51 dB
T5, Chantilly, Virginia (2026)	Homes nearby	Silencers, louvers, compressor wraps	62 dBA unmitigated cut to 45 dBA; 57 dBC remains
Smithfield Gateway, Pennsylvania (2026)	Several hundred feet, graded cut	20-ft chiller screen, terrain	38–47 dBA at night
Chantilly Premier, Virginia (2023)	Residential boundary	Upgraded fans, air handler silencers	40–42 dBA by day
Equinix, Minooka, Illinois (2025)	North line, now farmland	Attenuation on half of 336 chillers, 6-m (20-ft) walls	45–46 dBA against a 44 dBA night limit; background already 46 dBA
Raylan, Kentucky (2026)	3,200–5,700 ft from homes	Remote siting	45–49 dBA; up to 67 dBC
Sentinel Green Fig, Pennsylvania (2026)	Across a road	Low-speed chillers, roof barriers	49–54 dBA at the north homes

Source: WorkingBuildings / Cerami for Aligned Data Centers (posted by Village of Coal City) (2026), WorkingBuildings / Cerami for T5 (posted by FFXnow) (2026), Ostergaard Acoustical Associates for Legend Properties (filed with Smithfield Township) (2026), Ramboll for Kimley-Horn (posted by Fairfax County Sully District) (2023), Shen Milsom & Wilke for Equinix (posted by Village of Minooka) (2025), ERM for Justified DataPower (Kentucky PSC filing) (2026), and Lewis S. Goodfriend & Associates for Sentinel Green Fig LLC (posted by East Whiteland Township) (2026).

Note: Consultants use different assumptions. The Sentinel Green Fig model leaves out ground and air absorption to be conservative; the Smithfield model includes terrain and ground cover. Results are not directly comparable.

predict levels above 45 dBA (Shen Milsom & Wilke for Equinix (posted by Village of Minooka) 2025; Lewis S. Goodfriend & Associates for Sentinel Green Fig LLC (posted by East Whiteland Township) 2026).

40 dBA at night is at the edge. No study we reviewed shows 40 dBA or less at every home at night. Smithfield predicts 38 to 47 dBA. Coal City comes closest, with a maximum of 41 dBA at its nearest homes (Ostergaard Acoustical Associates for Legend Properties (filed with Smithfield Township) 2026; WorkingBuildings / Cerami for Aligned Data Centers (posted by Village of Coal City) 2026). A 40 dBA night limit probably needs a larger setback, on the order of a mile for a large air-cooled campus by the rule of thumb above, plus the full set of source treatments. Battery storage practitioners describe night limits of "30–40 dBA at the nearest home" as common (Solar Power World (Kelly Pickerel) 2025), so such levels are not unheard of for energy equipment.

Low-frequency limits are where designs run out of room. C-weighted levels run 8 to 15 dB above dBA in the studies and resident data (Ostergaard Acoustical Associates for Legend Properties (filed with Smithfield Township) 2026; WorkingBuildings / Cerami for T5 (posted by FFXnow) 2026; Dale Browne, Great Oak Subdivision (resident), posted by Prince William County 2025b). Most modeled designs stay below 60 dBC. T5 predicts 57 dBC, and Smithfield's results imply roughly 46 to 59 dBC. But Raylan predicts up to 67 dBC about a mile from homes (ERM for Justified DataPower (Kentucky PSC filing) 2026), and Coal City leaves about 51 dB in the 63 and 125 Hz bands (WorkingBuildings / Cerami for Aligned Data Centers (posted by Village of Coal City) 2026). Silencers and louvers give only 4 to 11 dB at 63 Hz (Swegon / Vibro-Acoustics 2026; WorkingBuildings / Cerami for Aligned Data Centers (posted by Village of Coal City) 2026). So a dBC limit set much below the dBA limit plus 15 dB would be the limit a facility hits first, before the dBA limit.

The one retrofit record falls short of the residents' target. At AWS Tanner Way, residents' readings put Great Oak homes at 48 to 55 dBA after the retrofit. Residents wanted 45 dBA. They say the operator's own slide estimated a best case of 49.9 dBA at night, so the operator did not expect to reach 45 either (Dale Browne, Great Oak Subdivision (resident), posted by Prince William County 2024). Tones at 55 Hz and other low frequencies remained (David A. Nelson, Nelson Acoustics, for Prince William County DCOAG 2025a).

45 dBA is reachable; 40 dBA at night and tight low-frequency limits are hard

Applicant models show that a large data center can reach about 45 dBA at nearby homes with ordinary measures. A 40 dBA night limit is at their edge. Most designs stay under 60 dBC, but the tools are weak below about 125 Hz, so a tighter dBC limit would be the one a design fails first. All of these are predictions. The one measured retrofit, by residents' readings, reached 48 to 55 dBA, short of the 45 dBA residents sought; the operator's own best-case estimate was 49.9 dBA. We found no published measured test in the United States showing a large operating data center at 45 dBA or less at homes. The closest is abroad. A 2025 verification report for a Microsoft data center near Sydney, Australia could not measure the facility at nearby receivers, because it was too quiet to separate from background sound there. So the consultants measured the equipment near the source and calculated

about 30 and 32 dBA at two receiver locations, against limits of 36 and 50 dBA (Pulse White Noise Acoustics 2025). A 2026 review of U.S. evidence found that "calibrated, standards-grade acoustic data remain scarce" (Bray and Dominici 2026).

Generators and turbines. Single-unit daytime tests met daytime limits in the applicant studies (Ostergaard Acoustical Associates for Legend Properties (filed with Smithfield Township) 2026; Lewis S. Goodfriend & Associates for Sentinel Green Fig LLC (posted by East Whiteland Township) 2026; WorkingBuildings / Cerami for Aligned Data Centers (posted by Village of Coal City) 2026). Emergency operation of all units usually exceeds night limits and is exempt. Continuous on-site turbines have no verified data center record (Section 4.5).

4.12 Vibration

Ground vibration from an operating data center is unlikely to be felt off site; construction is the real risk.

During operation. Generators, chillers, fans, and pumps sit on rubber pads or steel springs. The Smithfield consultant states that such isolation cuts transmitted vibration by 98%. It says a generator casing at 2 to 6 mm/s would pass up to about 0.12 mm/s, below a perception threshold of about 0.25 mm/s (Ostergaard Acoustical Associates for Legend Properties (filed with Smithfield Township) 2026). That is the consultant's analysis, not a measurement.

At Great Oak, Nelson found the low-frequency levels "not associated with feelable vibration" (David A. Nelson, Nelson Acoustics, for Prince William County DCOAG 2025b). When residents say they feel a data center, low-frequency sound rattling windows is a more likely cause than ground vibration, and it is measured as sound. A standard of "no perceptible vibration at the property line" is therefore likely to be met in operation, based on the consultant analysis and the one field observation we found.

During construction. Pile driving and blasting can be felt and can damage buildings. The Federal Transit Administration (FTA) measures construction vibration as peak particle velocity (PPV), the top speed of a shaking surface (Section 2.9). At 25 feet a typical impact pile driver gives 0.644 inches per second (Federal Transit Administration 2018). FTA's damage criterion for typical houses (non-engineered timber and masonry) is 0.2 inches per second, and 0.12 for buildings "extremely susceptible to vibration damage." Using FTA's distance formula, a typical impact pile driver falls to about 0.2 inches per second at 55 feet and about 0.04 at 160 feet (Federal Transit Administration 2018).

Even 0.04 inches per second is "distinctly perceptible" for continuous sources in Caltrans's scale (California Department of Transportation 2020). Pile driving within about 100 feet of homes deserves a survey and monitoring.

Great Oak residents reported blasting damage to foundations, patios, and walls during site work. The resident presentation says owners "could not prove when damage occurred" (Dale Browne, Great Oak Subdivision (resident), posted by Prince William County 2024). Those are reported claims. The remedy is procedural: a pre-construction condition survey of nearby homes, PPV monitoring with

stop-work thresholds, drilled rather than driven piles where possible, and daytime-only work.

4.13 How to verify the result

Verification turns a model into a commitment. Each of its four parts answers a question the others cannot.

Pre-construction background survey. A baseline survey records the sound before the facility exists, so anyone can later tell whether the facility changed it. Good practice is several days of unattended monitoring at more than one location. The meters log 10-minute Leq, L10, L50, and L90, octave or one-third-octave bands, audio, and weather, and the analysis excludes wind, rain, and unrelated sounds (David A. Nelson, Nelson Acoustics, for Prince William County DCOAG 2025a). The survey should include a weekend and at least one calm night.

Predictive modeling. A reviewer should ask for vendors' octave-band source data, the weather and ground assumptions, octave-band results at homes, and a tonal assessment. The operating cases should include a normal night, a hot-day peak, a generator test, and an emergency. The Smithfield study reported in dBA only and offered octave-band data "upon request" while claiming compliance with New Jersey's octave-band limits (Ostergaard Acoustical Associates for Legend Properties (filed with Smithfield Township) 2026). A reviewer should require those tables. As a New York battery industry group put it, "modeled noise levels do not always reflect operational data" (NY-BEST (New York Battery and Energy Storage Technology Consortium) 2024).

Post-construction testing. Fairfax County, Virginia requires a post-construction noise study before it issues a use permit (Fairfax County, Virginia 2024). Section 8.3.6 lists other local requirements. A test must record the operating state: load, which fans and chillers were running, and outdoor temperature. Without that record, a reading can be dismissed, as the Hood County study was (Section 4.6).

Separating the facility from the background is the hard part. Nelson warned that a single spot measurement cannot "discriminate Data Center noise from the traffic noise background" (David A. Nelson, Nelson Acoustics, for Prince William County DCOAG 2025a). He also noted that a source must be at least 3 dB above the background before the ANSI method can subtract one from the other (Nelson Acoustics for Prince William County 2025). Three methods help: brief on-off tests with equipment shut down, measurements close to the source scaled to the home, and band-level analysis at the tone frequencies.

Continuous monitoring. Fixed monitors near homes collect the evidence that spot checks miss. Useful features are Class 1 meters, one-third-octave bands, and Leq and L90 logged every few minutes. Audio recorded when levels jump, weather data, and an operator log of equipment state complete the record (Svantek 2026; David A. Nelson, Nelson Acoustics, for Prince William County DCOAG 2025a).

4.14 Evidence that cuts against stricter limits

A skeptical planner or applicant will raise the following evidence, and some of it is strong.

- **Complaint levels are moderate.** JLARC's complaint levels of 40 to 59 dB (Section 4.7) sit below most limits and well below levels that damage hearing. The dispute is about constant, audible sound, not loud sound.
- **Infrasound claims lack support** (Section 4.3).
- **Low-band limits are hard to measure.** Nelson cautioned that low limits in the 31.5 and 63 Hz bands can produce "false positives" from traffic and other sources (David A. Nelson, Nelson Acoustics, for Prince William County DCOAG 2025a). Wind on the microphone also inflates low-frequency readings (Section 2).
- **Background may already exceed the limit.** At Minooka, Illinois, it was already 46 dBA against a 44 dBA night limit (Shen Milsom & Wilke for Equinix (posted by Village of Minooka) 2025). A Prince William County staff member warned that ambient sound "in many areas is already at or near the noise levels being set" (Prince William County, Virginia 2025).
- **Models can be too pessimistic as well as too optimistic.** Standard models assume conditions that favor sound travel. In one North Dakota wind filing, a home modeled at 44 dBA in the worst hour "will have an annual average sound level of 29 to 39 dBA" (RSG, filed with North Dakota Public Service Commission 2021). Some consultants leave out ground and air absorption on purpose (Lewis S. Goodfriend & Associates for Sentinel Green Fig LLC (posted by East Whiteland Township) 2026).
- **Pre-construction certification has limits.** The New York battery group argues that liability pushes engineers toward "highly conservative recommendations, such as constructing 23-foot high concrete walls" (NY-BEST (New York Battery and Energy Storage Technology Consortium) 2024). That is advocacy, but a fair point about cost.

None of this shows that data centers are quiet neighbors. It shows that an ordinance should measure what it can enforce, at a stated place and time, with a clear way to separate the facility from everything else. Section 9 turns these findings into model language.

SECTION 05

Legal Foundations

Local governments have regulated noise for more than a century. Federal law leaves data center noise to them.

5 Legal Foundations

This section explains where a local government gets the power to limit noise and vibration, and what limits courts place on that power. It covers the police power, nuisance suits, federal noise law and preemption, federal noise criteria, and constitutional limits. It ends with the 2026 data center lawsuits and lessons for drafters.

The short version is that local noise rules rest on firm legal ground. Congress declared in 1972 that noise control is mainly a state and local job, and no federal law sets or overrides noise limits for data centers. The main legal risk for a local government is not a lack of power. It is an ordinance written in vague words that a court cannot apply. State law decides how much of this power a township, city, or county actually holds; Section 6 covers the states and Section 7 covers Michigan.

5.1 Why local governments can regulate noise

The **police power** is the general power of state government to protect public health, safety, morals, and welfare. It has nothing to do with police departments. States pass parts of it to cities, townships, and counties. A noise ordinance, a zoning rule, and a building code are all uses of the police power.

The U.S. Supreme Court has treated this power as broad for more than a century. In *Hadacheck v. Sebastian* (1915), Los Angeles barred brickyards from a district that had become residential. The owner's brickyard had been there first. The Court upheld the ban anyway, reminding readers that the police power is "one of the most essential powers of government,—one that is the least limitable" (*Hadacheck* 1915, p. 410). It added: "A vested interest cannot be asserted against it because of conditions once obtaining" (*Hadacheck* 1915, p. 410). For noise, the lesson is that a local government may apply new rules to an existing industrial use, within the limits of due process.

Zoning is the division of a community into districts with different rules for land use. The Court upheld comprehensive zoning in *Village of Euclid v. Ambler Realty Co.* (1926) (*Euclid* 1926). It reasoned from nuisance law: "A nuisance may be merely a right thing in the wrong place—like a pig in the parlor instead of the barnyard" (*Euclid* 1926). Among the benefits of separating homes from industry, the Court listed that zoning would "decrease noise and other conditions which produce or intensify nervous disorders" (*Euclid* 1926).

Euclid also set the **standard of review**, meaning how closely a court examines a law, that still protects most land-use rules. If the validity of a zoning classification is "fairly debatable," the legislative judgment controls (*Euclid* 1926). A court will not second-guess a reasonable local choice. Later, in *Village of Belle Terre v. Boraas* (1974), the Court named "the blessings of quiet seclusion" as a proper zoning goal (*Belle Terre* 1974).

The power has an outer edge. In *Nectow v. City of Cambridge* (1928), the Court struck down a zoning line as it applied to one owner's land. A zoning restriction violates the Fourteenth Amendment, the Court held, "if the health, safety, convenience, or general welfare of the part of the city affected will

not be promoted thereby" (*Nectow* 1928). A developer would cite *Nectow* against a poorly reasoned noise rule. The answer is a rule tied to health evidence and to conditions at real homes.

Zoning codes have long regulated noise through **performance standards**, which limit what a use does (its noise, vibration, smoke, or glare at the lot line) rather than only which uses a district allows. In *Harrison v. Indiana Auto Shredders Co.* (1975), for example, the zoning approval for an Indianapolis auto shredder capped its average noise "over any two-hour representative period" at named streets (*Harrison* 1975). The Vermont Supreme Court upheld a town's performance standard against a gravel pit in *In re Ferrera & Fenn Gravel Pit* (2013), discussed under vagueness below (*Ferrera* 2013). What is new for data centers is the equipment, not the legal authority (Section 5.3).

5.2 Nuisance law and why it is a poor substitute for clear rules

Nuisance is a body of judge-made law, also called **common law**, that lets a person sue over an unreasonable interference with land or with rights shared by the public. It still applies alongside any ordinance. This subsection explains what a neighbor must prove, what a court can order, and why a township should not count on these suits.

5.2.1 PRIVATE AND PUBLIC NUISANCE

A **private nuisance** is an interference with a person's use and enjoyment of their own land that does not involve physically entering it. Most states draw on the *Restatement (Second) of Torts*, a 1979 summary of common-law rules that state courts adopt section by section. Its comment on private nuisance explains that the protected interest "comprehends the pleasure, comfort and enjoyment that a person normally derives from the occupancy of land" (*Avery* 2020).

A **public nuisance** is an unreasonable interference with a right common to the general public, such as public health or the use of a public road. A private person may sue for it only if their harm differs in kind from everyone else's (*Krueger* 2018).

5.2.2 WHAT A NEIGHBOR MUST PROVE

A neighbor who sues for private nuisance must usually prove three things: the harm is significant, it is judged by a normal person's standard, and the interference is unreasonable.

On the first point, a federal court in Pennsylvania applied the Restatement's "significant harm" test to noise, light, and vibration from gas drilling. The harm must be more than "slight inconvenience or petty annoyance" (*Tiongco* 2016).

On the second point, the Iowa Supreme Court quoted the Restatement. Rights in land "are based on the general standards of normal persons in the community and not on the standards of the individuals who happen to be there at the time" (*Vagts* 2024). This is the **normal person test**. It screens out unusually sensitive plaintiffs, but it also means a court asks how an ordinary resident would experience a constant hum at night.

On the third point, courts weigh the harm against the usefulness of the conduct. The Supreme Court listed the main factors in *Lucas v. South Carolina Coastal Council* (1992). They are the degree of

harm, the activity's social value and suitability to the locality, and how easily the harm can be avoided (*Lucas* 1992). For round-the-clock facilities, a North Dakota dissent quoted the Restatement: "The gravity of the harm from noises that disturb a person's sleep ... is ordinarily much greater when the noises occur at night" (*Rassier* 1992).

5.2.3 CROSSTEX: THE LEADING COMPRESSOR STATION CASE

The Texas Supreme Court gave the most useful modern summary in *Crosstex North Texas Pipeline, L.P. v. Gardiner* (2016). The case involved a natural gas compressor station whose four engines were each "bigger than mobile homes," with at least one running day and night (*Crosstex* 2016). The court held that "nuisance" refers "not to a defendant's conduct" but "to a type of legal injury" (*Crosstex* 2016). It then listed the factors a jury may weigh. They include the character of the neighborhood, the location of each property, the social value of each use, and the "magnitude, extent, degree, frequency, or duration of the interference" (*Crosstex* 2016). They also include which party can more easily bear the cost of mitigation and which party was there first (*Crosstex* 2016).

The jury found that the company negligently created a permanent nuisance that cut the ranch's market value by more than $2 million (*Crosstex* 2016). The evidence showed that Crosstex chose "hospital-grade" mufflers instead of more effective "critical or super-critical" mufflers and skipped other mitigation for cost reasons (*Crosstex* 2016). It had decided, "based on area sound-level measurements, that noise-mitigation measures were unnecessary" (*Crosstex* 2016).

The verdict did not stand. The intermediate appeals court held the evidence factually insufficient to support the negligence finding, reversed the judgment, and sent the case back for a new trial. The Texas Supreme Court affirmed that judgment and told the trial court to apply its clarified rules (*Crosstex* 2016). The case's lasting value is its definition and factor list. Its practical lesson is that a pre-construction judgment that mitigation was unnecessary did not keep the operator out of years of litigation, a multimillion-dollar jury verdict, and a retrial.

5.2.4 SIMILAR FACTS, OPPOSITE RESULTS

Nuisance plaintiffs do not always win. In *Rassier v. Houim* (1992), a wind generator 40 feet from a neighbor's home measured 50 to 69 decibels. The trial court found no nuisance, and the North Dakota Supreme Court deferred to that finding (*Rassier* 1992). By contrast, in *Rose v. Chaikin* (1982), a New Jersey trial court stopped a residential windmill that measured 56 to 61 dBA, above the city's 50 dBA limit for windmills. Neighbors had reported "nervousness, dizziness, loss of sleep and fatigue" (*Rose* 1982). The *Rose* court required "clear and convincing" proof for an injunction, a higher bar than the usual more-likely-than-not standard, and found it met (*Rose* 1982). Similar sound levels led to opposite results, which is itself a reason to prefer clear rules.

5.2.5 WHAT A COURT CAN ORDER

A court that finds a nuisance can issue an **injunction**, an order to stop or change the activity, or award money damages, or both. For large facilities, courts often choose money. In *Boomer v. Atlantic Cement Co.* (1970), neighbors proved a nuisance from a cement plant's "dirt, smoke and vibration" (*Boomer*

1970). New York's highest court let the plant keep running and ordered permanent damages. Pollution control, it said, "is likely to require massive public expenditure," and a court "should not try to do this on its own as a by-product of private litigation" (*Boomer* 1970).

Courts also give operators time to fix problems. In *Harrison*, a trial court closed the auto shredder over dust, vibration, and noise. The federal appeals court reversed. It held that "the drastic remedy of closing down the operation without endeavoring to launder its objectionable features would be impermissible" (*Harrison* 1975). The usual result of a successful noise suit is a payment or an order to mitigate, not a quiet neighborhood restored overnight.

A defense called **coming to the nuisance** applies when homes are built near an existing industrial use. In *Spur Industries v. Del E. Webb Development Co.* (1972), Arizona's high court stopped a feedlot but made the developer who brought homes to it pay the costs (*Spur Industries* 1972). Data center cases usually run the other way: the new industrial use comes to existing homes.

5.2.6 MEETING AN ORDINANCE IS NOT A COMPLETE DEFENSE

A facility that meets a numeric noise limit can still be sued for nuisance. Compliance helps the defendant, but it does not end the case. A 2026 law firm alert notes that a defendant can point to "compliance with applicable permits, zoning approvals and noise standards" to show its conduct was reasonable. Under the Restatement, such compliance "is generally not a complete defense" (WilmerHale 2026).

In *Williams v. Invenergy, LLC* (2016), a federal court in Oregon wrote that compliance "is evidence in the defendant's favor." But, it added, "the standard for whether a condition constitutes a nuisance is not tied directly to governmental standards" (*Williams* 2016). In *Burch v. NedPower Mount Storm, LLC* (2007), the West Virginia Supreme Court held that a state siting certificate for a wind facility did not bar a nuisance suit (*Burch* 2007). The reverse also holds. An exceedance of a local limit is strong evidence for the neighbor (*Rose* 1982), and an Illinois appeals court let neighbors sue to enforce numeric local limits directly (*Avery* 2020).

5.2.7 WHY NUISANCE SUITS CANNOT REPLACE AN ORDINANCE

Nuisance suits are slow, costly, and after the fact. A neighbor must hire a lawyer and usually an acoustical expert, and the harm has already happened by the time the suit is filed. A Duquesne law school commentary says nuisance law "is typically bilateral and retrospective, focused on individualized interference." Data center noise, by contrast, affects whole neighborhoods (JOULE 2026). The Granbury, Texas bitcoin mine suit, filed in October 2024, still had no final judgment two years later (Section 5.8).

Nuisance results are also unpredictable, as *Rassier* and *Rose* show. A case-by-case reasonableness test leaves operators without a design target and neighbors without a clear promise.

Nuisance law is a backstop, not a noise policy

A neighbor who sues must prove significant, unreasonable harm to a normal person, usually with expert help and after the harm has begun. Courts often award money rather than stop the noise (*Boomer* 1970; *Harrison* 1975). Meeting an ordinance is evidence of reasonableness but not a complete defense (*Williams* 2016; WilmerHale 2026). A clear ordinance gives operators a design target and neighbors a remedy before a lawsuit is needed.

5.3 The federal story: a program Congress created and then stopped funding

Congress built a national noise program in the 1970s, defunded it in the early 1980s, and never repealed it. The result is a set of frozen federal rules and a gap in technical support that local governments still feel.

5.3.1 THE NOISE CONTROL ACT OF 1972

The Noise Control Act of 1972 is the main federal noise statute, codified at 42 U.S.C. §§ 4901–4918. In it, Congress found that "inadequately controlled noise presents a growing danger to the health and welfare of the Nation's population" (U.S. Congress 1972a). It declared a national policy "to promote an environment for all Americans free from noise that jeopardizes their health or welfare" (U.S. Congress 1972a).

The Act also drew the line between federal and local roles. Congress found that "primary responsibility for control of noise rests with State and local governments." Federal action, it said, "is essential to deal with major noise sources in commerce control of which require national uniformity of treatment" (U.S. Congress 1972a). That finding is the starting point for any discussion of federal and local authority over noise.

The Act directed the U.S. Environmental Protection Agency (EPA) to set noise limits for new products that are major noise sources, including "any motor or engine" and "electrical or electronic equipment" (U.S. Congress 1972b). EPA set standards for only a few products: portable air compressors, motorcycles, medium and heavy trucks, and truck-mounted garbage compactors (Shapiro 1991). It also issued labeling rules, most notably for hearing protectors (EPA 2026c). The Act separately covered interstate railroads and truck carriers (U.S. Congress 1972c; U.S. Congress 1972d). EPA's noise office also published the 1974 Levels Document, the source of the 55 dB Ldn residential level discussed in Section 5.5.

5.3.2 THE QUIET COMMUNITIES ACT OF 1978

Congress expanded the program with the Quiet Communities Act of 1978. It directed EPA to "administer a nationwide Quiet Communities Program," including grants to build local "noise control capacity" (U.S. Congress 1978). EPA's Office of Noise Abatement and Control (ONAC) ran 10 regional technical centers and trained 4,000 noise officials. Twenty states incorporated its model state law, and its model local ordinance "was distributed to over 1,200 communities" (Shapiro 1991).

5.3.3 DEFUNDING IN 1981 AND 1982

In early 1981, the White House Office of Management and Budget decided to end ONAC's funding, and Congress agreed (Shapiro 1991; ACUS 1992). EPA's management rejected a $1 million compromise and "decided to eliminate ONAC entirely" (Shapiro 1991). EPA says it "phased out the office's funding in 1982." It adds that the Noise Control Act and the Quiet Communities Act "were never rescinded by Congress" but "are essentially unfunded" (EPA 2026d).

Sidney Shapiro studied the result for the Administrative Conference of the United States (ACUS), a federal agency that studies how agencies work. Of 28 environmental, health, and safety statutes passed between 1958 and 1980, the Noise Control Act "stands alone in being stripped of budgetary support" (Shapiro 1991).

5.3.4 WHAT FOLLOWED: FROZEN RULES AND SHRINKING LOCAL PROGRAMS

Two consequences followed. First, EPA's old rules stayed on the books. ACUS found in 1992 that EPA's standards "have remained in effect, thereby preempting state and local governments from adopting different standards. Thus, the standards remain frozen" (ACUS 1992). The rail, truck, and labeling rules remain in the Code of Federal Regulations as of November 2026 (EPA 2026a; EPA 2026b; EPA 2026c).

Second, state and local programs shrank, though no one knows by exactly how much. Shapiro reports two different counts for 1981. EPA told Congress that year that more than 1,000 municipalities and 27 states had noise laws, but only 13 states and 160 local communities had "on-going active noise control programs" (Shapiro 1991). Elsewhere Shapiro wrote that "available data indicate a decrease in on-going local programs from 300 to 400 in 1981 to 50 to 75 programs today" (Shapiro 1991). The two 1981 figures probably count programs differently. Shapiro himself cautioned that "there is no reliable data concerning the extent of the decline" (Shapiro 1991).

Without federal help, Shapiro observed, communities found it "difficult to know how to write ordinances" for some noise problems (Shapiro 1991). This history helps explain why a planning consultant might say that updating noise rules "hasn't been done before." The federal technical support that once helped local governments write noise rules ended more than four decades ago. The legal authority did not, and courts have upheld local noise rules for more than a century (Section 5.1).

Congress left noise control to state and local governments

The Noise Control Act of 1972 says "primary responsibility for control of noise rests with State and local governments" (U.S. Congress 1972a). EPA's noise office lost its funding in 1981–82. By 1991, local programs had fallen to an estimated 50–75, from somewhere between 160 and 400 a decade earlier (Shapiro 1991). No federal law sets or preempts noise limits for data centers. A township that writes a data center noise rule is doing the job Congress assigned to it.

5.4 What federal law preempts, and what it leaves alone

Preemption means that federal law overrides a state or local law. Under the Constitution's Supremacy Clause, a valid federal law wins any conflict. Preemption can be express, when a statute says so.

It can occupy a field, when federal regulation leaves no room for local rules. Or it can arise from conflict, when a local rule makes it impossible to follow federal law. Courts also distinguish two kinds of challenge. A **facial challenge** claims a law is invalid in every application. An **as-applied challenge** claims it is invalid only as applied to the challenger's particular facts. For noise, federal preemption covers a few specific fields. Data centers are not among them.

5.4.1 AIRCRAFT

Aircraft noise is the clearest federal field. In *City of Burbank v. Lockheed Air Terminal, Inc.* (1973), the Supreme Court struck down Burbank, California's 11 p.m. to 7 a.m. curfew on jet flights. It held that the Federal Aviation Administration (FAA), with EPA, "has full control over aircraft noise, preempting state and local control" (*Burbank* 1973). Land use near airports stays local, however. A federal appeals court said a broad reading of *Burbank* "confuses controlling the source of noise with mitigating its effects," and listed zoning as a tool that remains open to local governments (*Gianturco* 1981). Airport owners may also adopt reasonable noise rules if they follow federal procedures (*National Helicopter* 1998; *East Hampton* 2016).

5.4.2 RAILROADS AND TRUCKS

Once EPA sets a rail or interstate truck noise standard, a state or local standard for the same equipment or operation must be "identical" (U.S. Congress 1972c; U.S. Congress 1972d; EPA 2026b). Preemption here is not total. A federal appeals court held that Delaware's noise statute was "not facially preempted" as applied to a rail-to-truck shipping facility (*Oberly* 1988). Even where federal rail law is "exclusive," local governments may apply health and safety rules that are "settled and defined" and "can be obeyed with reasonable certainty" (*City of Auburn* 1998; *Green Mountain* 2005). That is good drafting advice for any noise ordinance. For a data center, truck traffic on public roads is largely beyond a local noise rule. Loading docks, idling on site, and on-site equipment are not.

5.4.3 FEDERAL PRODUCT STANDARDS

The product-standard clause bars a local limit on noise emitted by a new product EPA has regulated, unless the limit is identical to EPA's (U.S. Congress 1972b). The same section saves the local right "to establish and enforce controls on environmental noise … through the licensing, regulation, or restriction of the use, operation, or movement of any product" (U.S. Congress 1972b).

For data centers this clause has little reach. EPA never set emission standards for chillers, cooling towers, fans, transformers, or stationary generators (Shapiro 1991). Even for a regulated product, a local limit on sound at a property line regulates its use and operation, which the statute saves. This is our reading of the statute; we found no court decision applying the clause to data center equipment.

5.4.4 INTERSTATE NATURAL GAS FACILITIES

Interstate gas pipelines and compressor stations need a certificate from the Federal Energy Regulatory Commission (FERC). After Myersville, Maryland denied rezoning for a compressor station partly over noise, a federal court held that local laws affecting "the siting and operation of the Compressor Station

are null and void" (*Myersville* 2013). FERC's own noise rule applies instead (Section 5.5). This matters only if a data center campus includes a FERC-certificated gas line or compressor. On-site power plants that are not under FERC's jurisdiction are a matter of state siting law (Section 6).

5.4.5 WHAT IS LEFT TO LOCAL GOVERNMENTS

Everything else is left to state and local law, including data centers, battery storage, cryptocurrency mines, and most power plants. Some states limit local control of substations and power plants through utility or siting laws (Section 6). No federal statute or rule sets a noise limit for a data center, and none preempts a local one.

5.5 Federal noise criteria as benchmarks

Several federal agencies use numeric noise criteria in their own programs. None regulates a private data center, and each was written for a different purpose. They matter because they show what agencies treat as acceptable, and because an ordinance can borrow their metrics and methods. Exhibit 13 summarizes them, and this subsection is the report's single full account of them. The metrics used here (Ldn, Leq, dBA, VdB) are defined in Section 2.

5.5.1 EPA: THE LEVELS DOCUMENT

EPA's 1974 Levels Document identified an outdoor day-night average of 55 dB in residential areas as protective against activity interference and annoyance, with 45 dB indoors (U.S. Environmental Protection Agency 1974). The day-night average sound level (Ldn, also written DNL) is a 24-hour average that adds 10 dB to sound between 10 p.m. and 7 a.m. (Section 2.6). EPA said plainly that these were not standards: "Neither Congress nor the Environmental Protection Agency has reached the conclusion that these identified levels should be adopted by states and localities" (U.S. Environmental Protection Agency 1974).

5.5.2 HUD: HOUSING SITES

The U.S. Department of Housing and Urban Development (HUD) uses DNL to decide whether a housing site is suitable for federal funding. Its rules call a site "Acceptable" when exterior noise is "Not exceeding 65 dB." Sites from 65 to 75 dB are "Normally Unacceptable" and need 5 to 10 dB of extra building sound insulation. Sites above 75 dB are "Unacceptable" (HUD 2026a). HUD measures at a point 2 meters (6.5 feet) from the building, facing the main noise source (HUD 2026a).

The same rules set a lower goal: "It is a HUD goal that exterior noise levels do not exceed a day-night average sound level of 55 decibels" (HUD 2026a). A June 2026 HUD rule changed which offices approve projects but kept the 65 and 75 dB thresholds (HUD 2026b; HUD 2026a). A developer may call 65 dB DNL "the federal standard." More accurately, HUD uses 65 dB to decide when it will fund housing without special approvals, and names 55 dB as its goal.

Exhibit 13. Federal noise and vibration criteria, and what each was written for

Agency and rule	Purpose and level	What it is not
EPA Levels Document (1974)	Identifies 55 dB Ldn outdoors in residential areas as protective against activity interference and annoyance, with 45 dB Ldn indoors.	It is not a standard. EPA did not weigh cost or feasibility and did not ask localities to adopt it.
HUD, 24 CFR Part 51	Decides when HUD will fund housing at a noisy site. Up to 65 dB DNL is acceptable; 65–75 dB needs extra sound insulation; above 75 dB is unacceptable. HUD's stated goal is 55 dB DNL outdoors.	The 65 dB figure is a funding threshold that weighs cost. It is not a health finding.
FHWA, 23 CFR Part 772	Decides when a federal-aid highway project has a noise impact that requires a study of abatement. Homes: 67 dBA Leq(h). States also define a "substantial increase" of 5 to 15 dBA over existing levels.	It applies to highway projects, not to private sources.
FTA transit manual (2018)	Assesses transit project impact by comparing project noise with existing noise. For vibration, 72 VdB at homes with frequent events.	It is guidance for federally funded transit projects.
FRA, 49 CFR Part 210	Enforces EPA's rail noise emission standards, such as 65 dB for a stationary switcher locomotive near a rail yard.	It limits rail equipment, not land uses near tracks.
FAA, 14 CFR Part 150	Guides airport noise compatibility plans. Homes are compatible below 65 dB DNL.	FAA says its table is not a federal finding that a land use is acceptable; local authorities decide.
FERC, 18 CFR 380.12(k) and 157.206(b)	Limits new gas compressor stations to 55 dBA Ldn at existing homes, schools, and hospitals, with no "perceptible increase in vibration" (380.12(k)). Blanket-certificate projects must file a noise survey within 60 days of being placed in service (157.206(b)), and individual certificates commonly require one.	It applies only to FERC-certificated gas facilities.
OSHA, 29 CFR 1910.95	Protects workers' hearing. Permissible exposure is 90 dBA over 8 hours; hearing protection programs start at 85 dBA.	It is a hearing-damage limit for workers. It is far too high for homes.

Source: U.S. Environmental Protection Agency (1974); HUD (2026a); FHWA (2026b); Federal Transit Administration (2018); FRA (2026) and EPA (2026a); FAA (2026); FERC (2026b) and FERC (2026a); OSHA (2026).

5.5.3 FHWA, FTA, AND FRA: TRANSPORTATION

The Federal Highway Administration (FHWA) decides when a federal-aid highway project has a traffic noise impact, which triggers a study of abatement. For homes, its criterion is 67 dBA as a one-hour equivalent level, written Leq(h) (FHWA 2026b). A project also has a noise impact when it causes a "substantial noise increase," which state highway agencies define as between 5 and 15 dBA over existing levels (FHWA 2026b). This is a federal precedent for the relative limits, based on existing background sound, that appear in some local data center codes (Section 8).

The Federal Transit Administration (FTA) takes a similar approach. Its manual explains that "communities already exposed to high levels of noise can only tolerate a small increase" (Federal Transit Administration 2018). It also sets vibration criteria, such as 72 VdB at homes exposed to frequent train passbys (Federal Transit Administration 2018). The Federal Railroad Administration (FRA) enforces EPA's rail equipment standards (FRA 2026).

5.5.4 FERC: THE CLOSEST FEDERAL MODEL

FERC's compressor station rule is the closest federal model for a data center ordinance. A compressor station is also a stationary facility with large engines and fans that runs day and night. FERC provides that noise from a new station "must not exceed a day-night sound level (Ldn) of 55 dBA at any pre-existing noise-sensitive area (such as schools, hospitals, or residences)" (FERC 2026b). It adds that new stations "shall not result in a perceptible increase in vibration at any noise-sensitive area" (FERC 2026b).

FERC also requires transparency and follow-up. Applicants must report existing daytime, nighttime, and day-night levels at nearby homes. They must also file "the input and raw output data and all assumptions made when running the model" (FERC 2026b). A **blanket certificate** is FERC's advance approval for a class of small, routine projects. Under one, the operator "must file a noise survey with the Secretary within 60 days of placing the facility in service" (FERC 2026a). A numeric limit at the home, a vibration rule, open modeling, and a post-construction survey are the same four parts that Section 9 recommends.

5.5.5 FAA AND OSHA: PLANNING LINES AND WORKER LIMITS

The FAA treats homes as compatible with airport noise below 65 dB DNL. Its table says this does "not constitute a Federal determination that any use of land ... is acceptable or unacceptable" (FAA 2026). The Occupational Safety and Health Administration (OSHA) limits workers' exposure to 90 dBA over an 8-hour shift and requires a hearing conservation program at 85 dBA (OSHA 2026). Neither is a community limit. OSHA's numbers address hearing damage at work and sit far above the levels that disturb sleep (Section 3).

Federal numbers answer different questions. EPA's 55 dB Ldn is a health-and-welfare level with no cost test. HUD's and FAA's 65 dB lines are funding and planning thresholds. FERC's 55 dBA Ldn is an enforceable limit for one kind of industrial facility. A local ordinance can cite any of them, but it should say which question it is answering.

5.6 Constitutional limits on noise ordinances

Four constitutional limits matter most: clarity, free speech, rational basis, and takings. Of these, vagueness is the one that has actually defeated noise ordinances.

5.6.1 VAGUENESS

The Due Process Clause of the Fourteenth Amendment requires laws to be clear. A law is **void for vagueness** if it does not give "the person of ordinary intelligence a reasonable opportunity to know what is prohibited." It is also void if it fails to "provide explicit standards for those who apply them." Such a law, the Court said, "impermissibly delegates basic policy matters to policemen, judges, and juries" (*Grayned* 1972). The Supreme Court set out this test in *Grayned v. City of Rockford* (1972).

Grayned itself upheld a noise rule. Rockford, Illinois barred willfully making "a noise or diversion that disturbs or tends to disturb the peace or good order" of a school in session (*Grayned* 1972). The Court accepted that "we can never expect mathematical certainty from our language," and the rule survived because it was tied to a specific place and time (*Grayned* 1972).

Business rules get a gentler test: "economic regulation is subject to a less strict vagueness test," partly because businesses "can be expected to consult relevant legislation in advance of action" (*Hoffman Estates* 1982). A data center rule regulates a sophisticated business, which helps the township.

But industrial noise ordinances have failed. In *People v. New York Trap Rock Corp.* (1982), the town of Poughkeepsie, New York convicted a quarry under its "Unnecessary Noise Control Ordinance" for nighttime loading (*Trap Rock* 1982). The ordinance listed 10 subjective factors, such as "intensity" and "usual or unusual," and said violations were "not limited" to those (*Trap Rock* 1982). New York's highest court held it unconstitutional. It gave no "guideline for the perplexed would-be noisemaker" and was "a ready candidate for *ad hoc* and discriminatory enforcement" (*Trap Rock* 1982).

It "was patterned on a so-called Model Local Noise Ordinance drafted by the National Institute of Municipal Officers." The quarry had built a 3,900-foot earthen berm, 30 feet high and topped with trees (*Trap Rock* 1982). The town could not punish it under a rule that gave it no way to know when it had done enough.

Jim Crockett Promotion, Inc. v. City of Charlotte (1983) reached a similar result. Charlotte, North Carolina's 1980 ordinance "followed broadly the Model Ordinance drafted by [EPA]" with the municipal officers' group (*Jim Crockett* 1983). A federal appeals court held the word "unnecessary" unconstitutionally vague. It kept a ban on "unreasonably loud, disturbing" noise, which other courts had upheld (*Jim Crockett* 1983). It also struck a rule that complaints from three households plus a police officer were evidence of a violation, as "so lacking in rationality that it may not be applied" (*Jim Crockett* 1983). Complaints cannot substitute for proof.

Crockett also records why the EPA model invited trouble. EPA left its decibel limits blank, because "there is no single number that can be chosen for each provision that would be appropriate for all types of communities" (*Jim Crockett* 1983). Communities that never filled them in were left with words alone.

Other state courts have struck similar wording. The Supreme Court of Virginia, in *Tanner v. City*

of Virginia Beach (2009), struck an ordinance banning noise that would "disturb or annoy the quiet, comfort or repose of reasonable persons." The court held it failed to give fair notice "because the provisions do not contain ascertainable standards" (*Tanner* 2009). Michigan's Court of Appeals struck a Grand Rapids rule against using premises in a way that "shall destroy the peace and tranquility of the surrounding neighborhood" (314 Mich App 528 (2016)); Section 7 discusses that case.

Fairness requires noting the cases that went the other way. In *State v. Holcombe* (2006), Texas's highest criminal court upheld a ban on noise that "unreasonably" disturbs. It called that word "an objective, reasonable-man standard" that needs no decibel level (*Holcombe* 2006). In *Ferrera*, the Vermont Supreme Court upheld a Middlebury rule that limited noise "to levels that will not be a nuisance to adjacent uses" (*Ferrera* 2013). It noted that its vagueness test "is less strict where the regulation is economic," and it rejected the view "that anything other than a numeric decibel standard is unacceptable" (*Ferrera* 2013).

Ferrera also shows that a numeric figure is not automatically better if it measures the wrong thing. The town declined to rely on a 55-decibel daily average offered by the applicant's expert. It found that peak-hour noise was the more meaningful measure (*Ferrera* 2013). The right averaging period matters as much as the number.

The pattern is clear even if not uniform. Words like "unnecessary," "annoying," and "peace and tranquility," used alone, have failed in several courts. Words like "unreasonably loud" have often survived. Measured limits with a stated method rarely face vagueness problems. Standards that let neighbors hear sound at a set distance ("plainly audible") have generally survived vagueness challenges (*Davis* 2000; *Catalano* 2012), though they fit data center hum poorly.

5.6.2 THE FIRST AMENDMENT

The First Amendment protects speech, including amplified sound. Industrial equipment is not expression, so the First Amendment matters only when a township amends a general noise code that also covers amplified sound. In *Ward v. Rock Against Racism* (1989), the Supreme Court held that a city "has a substantial interest in protecting citizens from unwelcome and excessive noise, even in a traditional public forum" (*Ward* 1989).

Two cautions apply. A permit system that leaves officials unlimited discretion fails (*Saia* 1948). And a rule is **content-based** if it treats speech differently depending on what it says or who says it. The Florida Supreme Court struck a car stereo law as content-based because it exempted business and political vehicles (*Catalano* 2012). An exemption for emergency generators in a data center rule raises no such issue.

5.6.3 RATIONAL BASIS AND EQUAL PROTECTION

A numeric noise limit that does not burden a fundamental right gets **rational basis review**. Under this standard, a court upholds the rule if it is rationally related to a legitimate government purpose, much like the *Euclid* "fairly debatable" test. A limit tied to published criteria, such as EPA's 55 dB Ldn level or FERC's 55 dBA Ldn rule, should pass easily. An as-applied challenge under *Nectow* remains possible if a limit bears no relation to conditions at the site (*Nectow* 1928).

A rule that applies only to data centers draws a line between uses, which raises the question of equal protection. Courts accept such lines when any reasonable basis supports them. In *Rose*, the New Jersey court rejected an equal protection attack on a noise limit that applied only to windmills. It said a city may address a noise problem "one step at a time" (*Rose* 1982). The risk rises if a rule targets one named project. The Supreme Court allows a "class of one" claim, brought by a single person or company, where a government "intentionally treated [a plaintiff] differently from others similarly situated" with "no rational basis" (*Olech* 2000). Rules that apply by category and objective threshold reduce that risk.

5.6.4 TAKINGS

The Fifth Amendment bars government from taking private property for public use without just compensation. A **regulatory taking** occurs when a rule goes so far that it amounts to a taking. Developers sometimes argue that a strict noise limit is one. These arguments usually fail.

Most regulations are judged under *Penn Central Transportation Co. v. New York City* (1978), which weighs the rule's "economic impact," its interference with "distinct investment-backed expectations," and "the character of the governmental action" (*Penn Central* 1978). A noise limit that applies to a whole class of facilities and leaves many uses available weighs against a taking.

Lucas holds that a rule removing "all economically beneficial use" of land is a taking. The exception is a restriction that already inheres in "background principles of the State's law of property and nuisance" (*Lucas* 1992). A noise limit almost never removes all use of land. To the extent it bars what a court would stop as a nuisance anyway, no compensation is owed (*Lucas* 1992). *Hadacheck* also allows a new rule to reach an existing use. Whether a pending project has a **vested right**, meaning a right to proceed under the old rules, depends on state law (Sections 6 and 7).

5.7 Enforcement and proof

A noise limit is only as strong as the proof behind it. In enforcement, the government must prove the violation, and complaint counts cannot substitute for that proof (*Jim Crockett* 1983). In a nuisance suit, the neighbor must prove a substantial and unreasonable interference, usually by a **preponderance of the evidence**, meaning more likely than not (*Rose* 1982).

5.7.1 MEASUREMENTS GET CHALLENGED

Hood County, Texas charged the site manager of the bitcoin mine near Granbury with 12 noise violations. In July 2024, a six-person jury acquitted him after the defense attacked the accuracy of the constable's sound readings (TheEnergyMag 2024). In *Avery v. GRI Fox Run, LLC* (2020), by contrast, an Illinois appeals court let neighbors' claims go forward. Their complaint described tests "conducted according to the testing methods specified in the Noise Ordinances, using properly calibrated sound level meters" (*Avery* 2020).

An ordinance should therefore say who measures, with what, where, and for how long. Naming the sound level meter's accuracy class under IEC 61672-1, the calibration, location, averaging period, and

weather limits gives staff a record that can survive cross-examination (International Electrotechnical Commission 2013). Section 2.7 explains these terms. Appendix B provides model language.

The averaging period deserves special care. The trial court in *Crockett* found Charlotte's exemption for sound "ten (10) per cent of the time in any measurement period" vague because the ordinance never defined the measurement period. The appeals court vacated the injunction on that point without approving the wording (*Jim Crockett* 1983). In *Ferrera*, the town's choice to judge peak-hour noise rather than a daily average shaped the outcome (*Ferrera* 2013).

5.7.2 EXPERT TESTIMONY

In federal court, *Daubert v. Merrell Dow Pharmaceuticals, Inc.* (1993) makes the trial judge a gatekeeper who screens expert testimony for reliability (*Daubert* 1993). *Kumho Tire Co. v. Carmichael* (1999) extended that duty to "technical, or other specialized knowledge," which covers acoustical engineers and noise modelers (*Kumho Tire* 1999). State rules vary, and we did not survey them.

Gatekeeping has already shaped energy noise cases. In *Williams v. Invenergy*, the Oregon federal court excluded "expert testimony regarding the causal link between turbine-produced infrasound and adverse human health effects" (*Williams* 2016). Infrasound is sound below 20 hertz, the conventional lower limit of human hearing (Section 2.4). The court dismissed the infrasound-based theory but sent the neighbors' claims about audible noise and vibration to trial (*Williams* 2016).

The practical point cuts against overstatement. An ordinance built on measured audible sound and low-frequency sound (roughly 10 to 200 hertz, often heard as hum; Section 2.4) stands on firmer evidence than one built on contested infrasound health theories. Section 3 reviews that evidence.

5.8 The 2026 data center and crypto mining lawsuits

In 2026, neighbors began suing data centers, cryptocurrency mines, and the gas turbines that power them. Several are proposed **class actions**, in which a few named residents sue on behalf of everyone similarly affected. These are early cases. As of the latest sources reviewed (through September 2026), none had produced a ruling **on the merits**, meaning a decision on whether the claims are true. None had reached **summary judgment**, a ruling before trial that one side wins on the undisputed facts, or trial (Facilities Dive 2026; WilmerHale 2026). What follows are allegations, not findings.

Microsoft, Mount Pleasant, Wisconsin. On July 1, 2026, residents filed *Ostergaard v. Microsoft Corp.* in federal court in Wisconsin. They seek to represent people within 1.5 miles of the Fairwater data center and allege private nuisance and negligence (*Ostergaard complaint* 2026). The complaint quotes Microsoft's own statement to neighbors: "Although the facility noise levels meet the requirements set by the local ordinance, we take this feedback seriously" (*Ostergaard complaint* 2026). Microsoft added, "[W]e did not expect the tonal quality of the sound to travel as far as it has," and traced the sound to cooling fans running at high speed (*Ostergaard complaint* 2026).

The complaint also alleges that "dBA measures do not effectively detect lower frequency sounds" like those the data center emits (*Ostergaard complaint* 2026). Section 2.3 explains the science. The legal point is that an ordinance with only A-weighted limits can leave tonal and low-frequency complaints

to private lawsuits.

xAI, Southaven, Mississippi, and Memphis, Tennessee. Two federal suits concern gas turbines in Southaven that power xAI's data centers. *Haley v. X.AI Corp.*, filed June 8, 2026 in the Northern District of Mississippi, alleges public and private nuisance, negligence, and emotional distress on behalf of a proposed class of more than 10,000 people (WilmerHale 2026). *Carter v. X.AI Corp.*, a class action filed September 23, 2026 in the Western District of Tennessee, alleges readings "as high as 70 dBA at residents' property lines." It says the plant powers xAI data centers in both cities (U.S. District Court, W.D. Tennessee (copy posted by WREG) 2026). Section 4.5 covers the turbines themselves.

Dowagiac, Michigan. *Valenzuela v. Alliance Cloud Services, LLC*, filed May 26, 2026 in the Western District of Michigan, alleges private and public nuisance and negligence by a computing facility in Dowagiac (WilmerHale 2026; Crowell & Moring 2026). Section 7 discusses the local ordinance context.

Vineland, New Jersey. *Montgomery v. DataOne USA LLC*, filed the same day in federal court in New Jersey, made similar claims. The plaintiffs dismissed it "without prejudice on June 19, 2026," leaving them free to refile (Crowell & Moring 2026).

Granbury, Hood County, Texas. The dispute over the bitcoin mine at the Wolf Hollow gas plant near Granbury shows how long litigation takes. Residents filed a state-court nuisance suit on October 4, 2024 (Earthjustice 2024; WilmerHale 2026). The court denied the company's motion to dismiss in summer 2025 (Earthjustice 2025). Neighbors then filed a federal suit on May 1, 2026, *Seider v. MARA Holdings, Inc.* It alleges that "vibrations and low frequency sounds emissions created by Defendant constitute a nuisance" (*Seider complaint* 2026). Two years after the first filing, our sources show no final judgment. The county's criminal case over the same mine is described in Section 5.7, and Section 4.7 covers the sound measurements.

A separate federal suit over a crypto mine in North Tonawanda, New York, was filed in April 2026 (WilmerHale 2026).

One defense firm warns that plaintiffs "frame the standard of care around theoretical 'best available' technology" (Faegre Drinker 2026). A township that states the required practices in its rule sets that standard itself, rather than leaving it to a jury after the facility is built. Three lessons follow, though no court has yet ruled on the merits. Meeting a local ordinance did not prevent a lawsuit in Wisconsin. The complaints focus on tonal and low-frequency sound that A-weighted limits may not capture. And the suits arrive after construction, when fixes cost the most.

5.9 Lessons for drafters

Courts have struck noise rules that left operators guessing and upheld rules that stated what is measured, where, how, and for how long. Exhibit 14 lists the key decisions.

Five lessons stand out for a data center noise rule.

1. **State the metric and the number.** Name the measure (for example, dBA as a one-hour Leq) and the limit. Measured limits gave operators fair notice in the cases above, while bare words like "unnecessary" did not (*Trap Rock* 1982; *Jim Crockett* 1983).

Exhibit 14. Key court decisions on noise regulation

Case	Year	Court	Holding in plain terms
Hadacheck v. Sebastian	1915	U.S. Supreme Court	A city may apply a new land-use rule to an existing brickyard.
Village of Euclid v. Ambler Realty	1926	U.S. Supreme Court	Zoning is valid, and a "fairly debatable" local choice stands.
Boomer v. Atlantic Cement	1970	New York Court of Appeals	A court found a nuisance but ordered damages instead of closing the plant.
Grayned v. City of Rockford	1972	U.S. Supreme Court	A school-zone noise ban was clear enough; the case sets the modern vagueness test.
City of Burbank v. Lockheed	1973	U.S. Supreme Court	Federal law preempts local curfews on aircraft noise.
Hoffman Estates v. Flipside	1982	U.S. Supreme Court	Business regulation gets a less strict vagueness test.
People v. N.Y. Trap Rock	1982	New York Court of Appeals	A model-based "unnecessary noise" ordinance was void for vagueness.
Jim Crockett v. Charlotte	1983	U.S. Court of Appeals, 4th Cir.	"Unnecessary" was vague, "unreasonably loud" survived, and complaint counts cannot prove a violation.
Ward v. Rock Against Racism	1989	U.S. Supreme Court	A city may control concert sound levels to protect residents from excessive noise.
Lucas v. S.C. Coastal Council	1992	U.S. Supreme Court	A rule that removes all economic use of land is a taking, unless nuisance or property law already barred that use.
State v. Holcombe	2006	Texas Court of Criminal Appeals	A ban on noise that "unreasonably" disturbs was upheld without a decibel limit.
Tanner v. Virginia Beach	2009	Supreme Court of Virginia	A ban on noise that would "annoy" reasonable persons was void for vagueness.
Dominion Transmission v. Myersville	2013	U.S. District Court, D. Md.	Federal gas law preempted a town's noise-based denial of a compressor station.
In re Ferrera & Fenn Gravel Pit	2013	Vermont Supreme Court	A qualitative zoning noise standard was upheld against a gravel pit.
Crosstex v. Gardiner	2016	Texas Supreme Court	In a compressor station noise case, the court held that nuisance is a type of legal injury, listed the factors juries weigh, and sent the case back for a new trial.

Source: *Hadacheck* (1915), *Euclid* (1926), *Boomer* (1970), *Grayned* (1972), *Burbank* (1973), *Hoffman Estates* (1982), *Trap Rock* (1982), *Jim Crockett* (1983), *Ward* (1989), *Lucas* (1992), *Holcombe* (2006), *Tanner* (2009), *Myersville* (2013), *Ferrera* (2013), and *Crosstex* (2016).

2. **State the averaging period.** An undefined "measurement period" drew a vagueness finding at trial in *Crockett*. In *Ferrera*, the town's choice of peak-hour levels over a daily average shaped the outcome (*Jim Crockett* 1983; *Ferrera* 2013).
3. **State the location.** Say where the meter goes, such as the property line or a point near the nearest home. HUD and FERC both tie their criteria to a stated receiving location (HUD 2026a; FERC 2026b).
4. **State the instrument and procedure.** Name the meter class, calibration, and weather limits, and say who measures. Measurement disputes decided the Hood County prosecution (TheEnergyMag 2024).
5. **Avoid undefined subjective standards, or pair them with objective ones.** Words like "annoy" and "peace and tranquility" have failed when used alone (*Tanner* 2009; 314 Mich App 528 (2016)). A qualitative backup can work when tied to defined terms and a measured primary limit (*Jim Crockett* 1983).

Some qualitative standards have survived (Section 5.6). But a measured limit with a stated method is easier to apply to chillers and fans, to design to, and to enforce.

Three further points complete the picture. A data center rule should address tonal and low-frequency sound directly, because those are the complaints in the 2026 suits (*Ostergaard complaint* 2026; *Seider complaint* 2026). It should require a post-construction survey, as FERC does for blanket-certificate projects, because a pre-construction judgment that mitigation was unnecessary did not keep Crosstex out of court (FERC 2026a; *Crosstex* 2016). And it should apply by category and objective threshold, not to one named project, to avoid equal protection claims (*Olech* 2000). Section 9 and Appendix B turn these lessons into model language.

SECTION 06

The Fifty States

Most noise law is local. States matter most where they set siting numbers or take local power away.

6 The Fifty States

This section explains what state law adds to, and takes from, a local government that wants to regulate data center noise. It is written for a planning commissioner, township attorney, or resident who needs two answers before drafting. Has the state already set a number? Has the state limited what the local government may do? The answer differs sharply by state, so the section sorts the fifty states into a few roles rather than walking through them one at a time. Appendix A gives the state-by-state detail.

What the fifty-state survey shows

Only 12 states keep a general statewide noise rule with numbers, and few of them enforce it at the state level. Ten states have written separate sound limits for wind, solar, or storage siting. Most of those limits fall between 39 and 55 dBA at or near a neighbor's home. No state has set a numeric sound limit for data centers. Virginia and California now require sound information before local approval. West Virginia, by contrast, has barred local noise rules for certified data centers since 2025.

6.1 What states do and do not do

The first job of this subsection is to set expectations: in most states, the state says little about noise from fixed sources such as factories, substations, or data centers. Federal funding for the Environmental Protection Agency's noise office ended in 1981 and 1982, after the White House budget office proposed the cut and Congress agreed. State programs lost much of their support with it (Shapiro 1991; EPA 2026d). Section 5 tells that federal story. Oregon is a clear example of what followed. Its Department of Environmental Quality says it has not investigated noise complaints since July 1, 1991, when the legislature ended the state noise program. Its rules still "remain in place" for local governments to use (Oregon Department of Environmental Quality 2026).

The result is that most noise law is local. In 38 states, we found no general statewide numeric limit for fixed sources. Some of those states have a noise statute without numbers. California's Noise Control Act of 1973 declares that "excessive noise is a serious hazard," but it sets no statewide numeric limit (California Legislature 2025). Nevada's statute is a grant of power: it lets county boards "regulate, control and prohibit, as a public nuisance, excessive noise" (Nevada Legislature 2026a).

Other states touch noise only through criminal or vehicle law. Texas makes "unreasonable noise" part of disorderly conduct and presumes noise above 85 decibels unreasonable after a magistrate or peace officer gives notice (Texas Legislature 2026b). Rhode Island's only state decibel limits that we found are for motor vehicles (Rhode Island General Assembly 2026a). A separate Rhode Island statute declares a policy against "unreasonable, excessive and annoying noise levels from all sources" but tests amplified sound only by whether it is plainly audible at set distances (Rhode Island General Assembly 2026b; Rhode Island General Assembly 2026c). None of these rules is designed for a chiller yard running all night.

Where states do act on fixed-source noise, they act in one or more of five ways:

- They keep a **general noise rule**: a statewide table of limits that applies to most sources.
- They set sound limits inside an **energy facility siting law**, the law that governs where and how power plants, wind farms, solar farms, or storage can be built.
- They pass a law aimed at data centers or cryptocurrency mining.
- They preempt local rules, meaning a state law overrides or caps what a local government may adopt (Section 5).
- They define how much power local governments hold in the first place.

Exhibit 15 counts the states in the first four roles and adds one more row: states that set a floor for local rules. Section 6.6 covers the fifth role, which does not reduce to a count. The last row lists the states where we found none of these. A state can appear in more than one row, so the counts add up to more than fifty. The least obvious number is the last one: 23 states fall in no row at all.

Exhibit 15. State roles in noise regulation

Role	States	Which states
General statewide noise rule with numeric limits still on the books	12	Colorado, Connecticut, Delaware, Hawaii, Illinois, Maine, Maryland, Massachusetts, Minnesota, New Jersey, Oregon, Washington
Separate energy facility siting law or rule with a numeric sound limit	10	Illinois (county ceiling), Indiana, Louisiana, Michigan, New Hampshire, New York, North Dakota, Ohio, Vermont, Wisconsin
Enacted data center or cryptocurrency mining law that addresses noise	6	Data centers: California, Virginia, West Virginia. Cryptocurrency mining: Arkansas, Montana, South Carolina
Express state cap or bar on local noise rules for a named energy or computing source	8	Arkansas, Colorado, Illinois, Michigan, Montana, South Carolina, West Virginia, Wisconsin
State sets a floor that local rules must meet or beat	3	Colorado, Connecticut, New Jersey
None of the above found	23	Alabama, Alaska, Arizona, Florida, Georgia, Idaho, Iowa, Kansas, Kentucky, Mississippi, Missouri, Nebraska, Nevada, New Mexico, North Carolina, Oklahoma, Pennsylvania, Rhode Island, South Dakota, Tennessee, Texas, Utah, Wyoming

Source: Statutes, rules, and bills cited in the text and in Appendix A, checked November 24, 2026.

Note: Maine, Massachusetts, Oregon, and Washington apply their general rule or policy in state energy siting. They are counted only in the first row. Maine is not counted as a floor, because a town's own standard may be up to 5 dBA looser than the state's. Several "none found" states protect shooting ranges or farms from noise rules, weigh noise in siting without a number, or have pending bills.

A caution about the method belongs here, once. Each state rests on a research file with a confidence rating, from high (primary text read) to low (absence or secondary sources only). Eleven states rate high and five rate low. Bill searches relied on a public dataset of state bill text, version 1.1.7, with activity through November 22, 2026 (ALEA Institute 2026). It records filed text but not always the outcome. Coverage is thin for some states, including Montana, Nevada, North Dakota, and West Virginia. A finding of "none found" is therefore a finding about our search, not proof that no law exists. A targeted search of the 23 "none found" states for a state administrative noise rule turned up none. Appendix D describes the method in full.

6.2 General state noise rules

This subsection describes the 12 states that still have statewide numeric limits and asks which of them anyone enforces. These rules matter to a local government for two reasons. They may apply to a data center already, and they give a tested set of numbers that a local ordinance can copy or adopt by reference.

How the rules are built. Most of these rules share a design. They classify land by use (residential, commercial, industrial) and set a maximum level for sound that crosses from one class into another, with a lower limit at night. Most use the A-weighted decibel (dBA), which discounts low-pitched sound the way human hearing does. Section 2 explains the scale; for this section it is enough to know that a 10 dB increase sounds about twice as loud. For sound from an industrial site heard at a home, the night limits fall in a narrow band:

- Washington: 60 dBA by day and 50 dBA at night (Washington Department of Ecology 2026).
- New Jersey: 65 dBA from 7 a.m. to 10 p.m. and 50 dBA at night, at the residential property line (New Jersey Department of Environmental Protection 2000).
- Connecticut: 61 dBA by day and 51 dBA at night from an industrial emitter into a residential zone (Connecticut Department of Energy and Environmental Protection 1978).
- Maryland: 65 dBA by day and 55 dBA at night for residential receiving land (Maryland Division of State Documents 2026).
- Delaware: 65 dBA from 7 a.m. to 10 p.m. and 55 dBA at night for residential (Class A) land, from a stationary source on land of any class. It is measured where the complaint arises, inside the receiving property (Delaware Department of Natural Resources and Environmental Control 2026).
- Colorado: 55 dBA by day and 50 dBA at night in residential zones, measured 25 feet or more from the property line (Colorado General Assembly 2024).
- Hawaii: 55 dBA by day and 45 dBA at night in its most protected class, at or beyond the property line (Hawaii Department of Health 2025).
- Minnesota: an hourly L50 (the level exceeded half the time; Section 2.6) of 60 dBA by day and 50 dBA at night for homes (Minnesota Office of the Revisor of Statutes 2003).

Delaware also adds a relative test. Any sound more than 10 dBA above the existing background at the point of complaint counts as a "noise disturbance," whatever the table allows (Delaware Department of Natural Resources and Environmental Control 2026).

Low-frequency sound. A few states go beyond dBA, which matters for the deep hum of large fans, transformers, and generators. Illinois sets limits in each octave band, a slice of the frequency range, from 31.5 Hz to 8,000 Hz (Section 2).

At night in Illinois, sound from industrial (Class C) land into residential land may not exceed 69 dB in the 31.5 Hz band or 41 dB in the 1,000 Hz band. For commercial (Class B) land the limits are 63 and 35 dB (Illinois Joint Committee on Administrative Rules 2018). New Jersey also sets octave-band

limits, including 86 dB at 31.5 Hz at night (New Jersey Department of Environmental Protection 2000). Hawaii's statute requires its health department to use "both the dBC and the dBA" scales for community noise (Hawaii State Legislature 2026). The C-weighted scale (dBC) counts low-pitched sound more fully than dBA.

Tones, infrasound, and vibration. Several rules also penalize tones, which people find more annoying than broadband sound at the same level. Connecticut and Maryland treat a prominent discrete tone as excessive when it exceeds a level 5 dBA below the normal limit (Connecticut Department of Energy and Environmental Protection 1978; Maryland Division of State Documents 2026). Delaware lowers its limits by 5 dBA for a pure tone, a cycling sound, or repeated impulses (Delaware Department of Natural Resources and Environmental Control 2026). Illinois bars prominent tones unless the one-third octave band is 10 dB or more below the allowed octave-band level (Illinois Joint Committee on Administrative Rules 2018). Connecticut and Delaware cap infrasound (very low-pitched sound) and ultrasound at 100 dB (Connecticut Department of Energy and Environmental Protection 1978; Delaware Department of Natural Resources and Environmental Control 2026).

Two states also reach vibration. Maryland bars vibration beyond the property line strong enough for a person to notice it by "sensation of touch or visual observation of moving objects" (Maryland Division of State Documents 2026). Delaware sets a number: a velocity of 0.15 inches per second for a stationary source in a Class A zone, measured at the receiving property (Delaware Department of Natural Resources and Environmental Control 2026).

Three rules that work differently. Massachusetts, Maine, and Colorado depart from the zone-table model in ways a drafter should notice.

Massachusetts treats noise as air pollution. Its rule, 310 CMR 7.10, bars "unnecessary emissions" of sound that "may cause noise," with no number in the rule (Massachusetts Department of Environmental Protection 2026). The number comes from a 1990 policy. A source may violate the rule if it raises the broadband level more than 10 dBA above background. The policy calls background "ambient" and defines it as the L90, the quiet floor of the sound (Section 2.7). A source also violates the policy if it produces a pure tone.

The Massachusetts Department of Environmental Protection's (MassDEP) own 2026 discussion document says the 1990 policy "did not set an enforceable regulatory standard" (Massachusetts Department of Environmental Protection 2026). In March 2026, MassDEP proposed presuming 40 dBA acceptable at sensitive receptors, so the 10 dBA test would apply only above that level. We found no final adopted revision (Massachusetts Department of Environmental Protection 2026).

Maine's limits apply through the Site Location of Development Law, which covers large developments. The limit is 75 dBA at the development's property line. At a protected location in a quiet area it is 60 dBA by day and 50 dBA at night. Where the pre-development background is already low, the limits drop to 55 and 45 dBA (Maine Department of Environmental Protection 2026). A town's own quantified standard replaces the state rule if it is no more than 5 dBA above the state limits (Maine Department of Environmental Protection 2026).

Colorado's statute sets numbers, but exceeding them is only **prima facie evidence** of a public

nuisance. That means the excess is enough to prove a nuisance unless the other side rebuts it; it is not an automatic violation (Colorado General Assembly 2024). Colorado lowers its limits by 5 dBA for "periodic, impulsive, or shrill noises" (Colorado General Assembly 2024). A county or any resident may sue in district court to stop the nuisance (Colorado General Assembly 2024).

Which states enforce them. Our sources show state-level use of these rules in only a handful of states. New Jersey runs one of the few active programs, enforced by local police and health officers whom the state trains and certifies (New Jersey Department of Environmental Protection 2000). Maine and Massachusetts apply their limits in state permit review (Maine Department of Environmental Protection 2026; Massachusetts Department of Environmental Protection 2026). Washington's siting council requires energy facilities to meet the state noise rule, which it adopts by reference (Washington Energy Facility Site Evaluation Council 2025). Oregon's siting council does the same, through rules that the state environment department no longer enforces (Oregon Secretary of State 2026). Colorado's statute is enforced by lawsuits, not inspectors (Colorado General Assembly 2024).

For the other six states with general rules, we confirmed the rules but not whether a state agency enforces them today. Delaware's statute, for example, lets both the state environment department and police enforce it (Delaware General Assembly 2026). Maryland's rule is also inconsistent: it calls its levels "goals" in one place and says a person "may not cause or permit" them in another (Maryland Division of State Documents 2026).

For a local government, the practical lesson is that a state rule on paper is not a state inspector on call. Washington and Oregon say outright that their rules are there for local use (Oregon Department of Environmental Quality 2026; Washington State Legislature 2026). In the other states, a local ordinance that adopts the state table by reference can supply the enforcement the state does not.

6.3 Energy facility siting laws with sound limits

This subsection compares the separate sound limits that 10 states have written for wind, solar, and storage projects. None of these laws covers data centers. They still matter, for two reasons. They are the closest thing to a state-tested number for large outdoor mechanical equipment near homes. They also show how a state legislature picks a metric and a measurement point when developers and neighbors both press their case. Exhibit 16 sets them side by side. Four more states, listed in the note to Exhibit 15, apply their general rule in energy siting instead of writing a separate number.

The numbers cluster. Set the details aside and a pattern appears. For a neighbor's home at night, six states set limits between 39 and 45 dBA. New York, Wisconsin, and North Dakota use 45; Vermont uses 39. New Hampshire and Ohio use 40 or background plus 5, whichever is greater (New York Office of Renewable Energy Siting and Electric Transmission 2024; Wisconsin Legislature 2026a; New Hampshire Site Evaluation Committee 2026; Ohio Power Siting Board 2024; Vermont Public Utility Commission 2017; North Dakota Legislative Branch 2026). Indiana's 50 dBA and Michigan's 55 dBA are the high end, and neither sets a separate night limit (Indiana General Assembly 2022a; Michigan Legislature 2023d). Louisiana alone uses a pure relative test, 10 dBA over the pre-project background (Louisiana Legislature 2025). Since 10 dB sounds about twice as loud, that test allows a clear change

Exhibit 16. State siting sound limits for energy facilities

State and rule	Facilities	Limit and metric	Where it applies
Michigan, MCL 460.1226(8) (2023 PA 233)	Solar, wind, storage under state siting	55 dBA, average hourly; modeled	Nearest outer wall of nearest dwelling on adjacent nonparticipating property
New York, 16 NYCRR 1100-2.8	Wind and solar under state siting office	45 dBA Leq (8-hour); 40 dBA Leq (1-hour) for collector substations; 65 dB Leq (1-hour) at 16, 31.5, and 63 Hz for wind	Outside an existing nonparticipating residence
Wisconsin, PSC 128.14	Wind	50 dBA day (6 a.m.–10 p.m.), 45 dBA night	Outside wall of nonparticipating residence or occupied community building
Ohio, OAC 4906-4-09(E)(2)	Wind and solar certified by the state siting board	Greater of 40 dBA or background L50 plus 5 dBA	Nonparticipating sensitive receptor within one mile of the project boundary
New Hampshire, Site 301.14(f)(2)	Wind; compressor stations	Greater of 45 dBA or L90 plus 5 dBA (8 a.m.–8 p.m.); greater of 40 dBA or L90 plus 5 otherwise	Residential property, at least 7.5 meters from reflecting surfaces
Vermont, PUC Rule 5.700	Wind	Over 150 kW: 42 dBA (7 a.m.–9 p.m.), 39 dBA night, with tonal penalty	100 feet from a nonparticipating landowner's residence
Indiana, IC 8-1-41-13 and 8-1-42-16	Wind and commercial solar	50 dBA hourly average; modeled	Outer wall of an affected dwelling (wind) or dwelling on adjacent nonparticipating property (solar)
Louisiana, R.S. 30:1144(C)	Solar of 75 acres or more	10 dBA above pre-operation background	Facility property line
North Dakota, NDAC 69-06-08-01(4)	Wind	45 dBA (site avoidance criterion)	Within 100 feet of an inhabited residence or community building
Illinois, 55 ILCS 5/5-12020(f)	Wind and solar, county zoning	County limits may be no stricter than state octave-band rules	As in the state rules: at least 25 feet from the property-line noise source

Source: Michigan Legislature (2023d); New York Office of Renewable Energy Siting and Electric Transmission (2024); Wisconsin Legislature (2026a); Ohio Power Siting Board (2024); New Hampshire Site Evaluation Committee (2026); Vermont Public Utility Commission (2017); Indiana General Assembly (2022a) and Indiana General Assembly (2022b); Louisiana Legislature (2025); North Dakota Legislative Branch (2026); Illinois General Assembly (2026a) and Illinois Joint Committee on Administrative Rules (2018).
Note: "Nonparticipating" broadly means a neighbor who has not signed an agreement with the project; each state defines the term in its own way. Leq, L50, and L90 are defined in Section 2.6.

in a quiet rural setting.

The metric matters as much as the number. The same figure can mean different things. New York's 45 dBA is an 8-hour energy average, written Leq (New York Office of Renewable Energy Siting and Electric Transmission 2024). Michigan's 55 dBA is an hourly average (Michigan Legislature 2023d). Ohio and New Hampshire tie the limit to the existing background: the L50 in Ohio and the L90 in New Hampshire. Where the background is louder than the floor, the limit rises with it (Ohio Power Siting Board 2024; New Hampshire Site Evaluation Committee 2026). Wisconsin's rule text states no averaging period (Wisconsin Legislature 2026a). A drafter who borrows "45 dBA" without the metric has borrowed half a rule.

So does the measurement point. The last column of Exhibit 16 shows at least four measurement places. They are the outside wall of a home, a point within 100 feet of a home, the project's own property line, and any sensitive receptor within a mile. A limit at the home wall protects the house but not the yard. A property-line limit protects the whole neighboring parcel. Several laws also allow **modeling**, a computer prediction before construction, in place of measurement. Michigan and Indiana use the phrase "as modeled" (Michigan Legislature 2023d; Indiana General Assembly 2022a). Vermont requires ISO 9613-2 modeling with a 30 dBA contour map (Vermont Public Utility Commission 2017).

Low-frequency sound and tones. Only New York sets low-frequency limits in a siting rule: 65 dB in the 16, 31.5, and 63 Hz octave bands for wind (New York Office of Renewable Energy Siting and Electric Transmission 2024). New York also adds a tonal adjustment, Vermont includes a tonality penalty, and Wisconsin requires prompt corrective action for a steady pure tone (New York Office of Renewable Energy Siting and Electric Transmission 2024; Vermont Public Utility Commission 2017; Wisconsin Legislature 2026a). New Hampshire's rule goes further for gas compressor stations. It caps interstate stations at a day-night level (Ldn) of 55 dBA at noise-sensitive areas. It also limits vibration to "no perceptible increase" or "2.0 peak particle velocity," whichever is less; the rule states no unit for the 2.0 (New Hampshire Site Evaluation Committee 2026).

Waivers are common. Most of these laws let a neighbor sign away the limit. Wisconsin allows waiver by written contract, and Indiana by written consent of each affected owner (Wisconsin Legislature 2026a; Indiana General Assembly 2022a). North Dakota accepts the written consent of the residence or building owner, and Illinois a recorded written waiver (North Dakota Legislative Branch 2026; Illinois General Assembly 2026a). A local data center ordinance that copies these limits should decide on purpose whether it copies the waiver too.

Siting review without a number. Other states fold noise into siting review but set no limit. Arizona's line siting committee must consider "noise emission levels" (Arizona Legislature 2026b). Kentucky's siting board must weigh "anticipated noise levels," and the applicant must certify compliance "with all local ordinances and regulations concerning noise control" (Kentucky General Assembly 2026c; Kentucky General Assembly 2026b). North Carolina requires "a study of the noise impacts of the turbines" for wind permits (North Carolina General Assembly 2026a). Minnesota once had a wind-specific noise route through its siting rules, but the state repealed that rule in 2024 (Minnesota Office of the Revisor

of Statutes 2025).

Kentucky's approach is worth noticing. The state's own process depends on the local noise ordinance, so a county without one leaves the state board with no local standard to check.

Michigan. Michigan's 2023 siting law appears in Exhibit 16. It does not reach data centers. Section 7 explains its standard and its limit on local rules.

6.4 Laws aimed at data centers and cryptocurrency mining

This subsection covers the six states that have enacted a law addressing noise from data centers or from cryptocurrency mining, which uses similar equipment. None of the six sets a numeric sound limit for data centers. The laws fall into three types: disclosure before approval, state preemption, and industry-specific rules for mining.

Disclosure: Virginia. Virginia's 2026 law, Va. Code § 15.2-2209.5, applies to a **high energy use facility**, defined as one expected to need 100 megawatts or more of power (Virginia General Assembly 2026b). Before a locality approves a rezoning, special exception, or special use permit for one, it "shall require" a site assessment. The assessment must examine, "to the extent practicable," "the sound profile" on homes and schools within 500 feet of the property boundary (Virginia General Assembly 2026b). The locality then uses the assessment to check consistency with its comprehensive plan and "compliance with the locality's adopted noise ordinances" (Virginia General Assembly 2026b).

The law sets no number and says it does not "limit, or otherwise supersede existing local zoning authority" (Virginia General Assembly 2026b). It exempts expansions of approved sites that add no more than 100 megawatts (Virginia General Assembly 2026b). The 2026 law came a year after Governor Youngkin vetoed similar site-assessment bills in May 2025, reportedly on the ground that they limited local discretion (Cardinal News 2025).

Disclosure: California. California's 2026 law takes a similar approach. Assembly Bill 1577, Chapter 434 of 2026, adds Government Code § 65909.3 (California Legislature 2026a). An applicant for a discretionary data center permit must give the city or county an estimate of "the expected average and maximum sound levels attributable to the operation of the data center." The estimate is in A-weighted decibels. It is for the point on the property boundary where the average level is highest (California Legislature 2026a).

The rule applies to data centers of 10 megawatts or more, a much lower threshold than Virginia's (California Legislature 2026a). The local agency may use the estimate for land use planning and environmental review (California Legislature 2026a). The law's confidentiality clause covers personal information and a customer's energy use, not the sound estimate (California Legislature 2026a). California also requires every city and county general plan to include a noise element. It must analyze "local industrial plants" and "other ground stationary noise sources" (California Legislature 2026c).

Both laws leave the limit to the local government. What they add is information: a sound estimate on the record before anyone votes. Virginia's version is aimed at homes and schools within 500 feet;

California's at the loudest point on the property line.

Preemption: West Virginia. West Virginia went the other way. House Bill 2014 of 2025, approved by the governor on April 30, 2025, created a state certification program for microgrid districts and "high impact" data centers (West Virginia Legislature 2025). A *certified* high impact data center is one that has met that program's certification criteria. The 2025 law bars counties and municipalities from enforcing rules "which limit, in any way" the construction or operation of a certified microgrid district or data center (West Virginia Legislature 2025).

It then states that these projects "may not be subject to" county or municipal "zoning, horticultural, noise, viewshed, lighting, development, or land use ordinances." The bar applies notwithstanding "any municipality's home rule powers" (West Virginia Legislature 2025). House Bill 5168 (2026) also amended this code section; we could not review its official text directly, so its details remain unverified (West Virginia Legislature 2026). West Virginia's is the only state law we found that names noise and data centers together and removes local power over both.

Cryptocurrency mining: Arkansas, Montana, and South Carolina. Cryptocurrency mines run dense racks of computers with fans and cooling, much like a data center, and three states have legislated their noise.

Arkansas acted first and most fully. The Arkansas Data Centers Act of 2023 (Act 851) bars local governments from limiting "the sound decibels generated from home digital asset mining other than the limits set for sound pollution generally" (Arkansas General Assembly 2023). It also bars imposing a requirement on a mining business that differs from the requirement for a data center (Arkansas General Assembly 2023).

In 2024, Arkansas Act 173 required mining businesses to use noise-reduction techniques, such as liquid or submerged cooling or a fully enclosed building. With local approval, a mine may instead sit at least 2,000 feet from the nearest home or business or in an industrial zone (Arkansas General Assembly 2024a). The same act lets a landowner within 2,000 feet sue to enforce those techniques and recover attorney's fees (Arkansas General Assembly 2024a). Act 174 created state permits, with civil penalties up to $5,000 a day. It keeps local ordinances that are "not inconsistent with" state law and state rules (Arkansas General Assembly 2024b).

Montana's 2023 law bars local rules that impose requirements on a mining business "that are not also requirements for data centers." It also bars rules that prevent home mining at a residence, "except as related to existing noise ordinances" (Montana Legislature 2025b). South Carolina's Senate Bill 163 became Act 208 when the governor signed it on May 19, 2026 (South Carolina General Assembly 2026a). The act applies in areas zoned for industrial use. There, a local government may not place "a specific limit on sound decibels" on a mining business other than limits "generally imposed for sound pollution in that area" (South Carolina General Assembly 2026a).

The parity clauses in Arkansas and Montana deserve attention from data center drafters. Read plainly, they bar a local government from holding a mine to a stricter rule than a data center. A data center noise rule in those states would then set the ceiling for mining as well. Montana's separate 2025 "right to compute" statute requires that government limits on the use of computing resources be

"narrowly tailored to fulfill a compelling government interest" (Montana Legislature 2025a). The statute does not mention zoning, noise, or data centers. Whether it limits county data center noise rules is a matter of reading, not settled law.

What enacted data center laws leave out. Several states passed data center laws in 2025 and 2026 with no noise terms at all. Florida's 2026 data center law, Chapter 2026-65, contains no noise, sound, decibel, or vibration language. A House bill that would have required highway noise controls was laid on the table (Florida Senate 2026). Nebraska's 2026 large-load law has no noise provisions in the text we read (Nebraska Legislature 2026). These laws deal with power costs and grid connections. Noise remains a local question.

6.5 State preemption of local noise rules

This subsection collects the ways states cap or override local noise rules. Preemption is the first thing a local government should check, because a well-drafted ordinance is void where the state has taken the field. Section 5 explains the legal doctrine; this subsection maps where it shows up in state statutes. Exhibit 17 sorts the clauses we found by what they protect.

Exhibit 17. State limits on local noise rules, by protected use

Protected use	States	What the clause does
Farms	Alabama, Georgia, Missouri	Bars nuisance findings against qualifying farms, if they meet conditions such as zoning compliance or a period of prior operation.
Shooting ranges	Arizona, Colorado, Connecticut, Georgia, Idaho, Kansas, Missouri, Texas, Virginia	Exempts ranges from state or local noise rules or noise suits, or freezes the rules in effect when the range was approved. Arizona sets its own 64 dBA Leq (1-hour) standard and preempts local ones.
Wind and solar	Wisconsin, Illinois, Michigan; Indiana (opt-in)	Bars local limits stricter than the state's. Indiana's limits are defaults for counties that opt in.
Electric transmission	Colorado	Bars local standards for lines of 44 kilovolts or more that are stricter than the state process.
Data centers	West Virginia	Removes certified data centers from local noise ordinances entirely.
Cryptocurrency mining	Arkansas, Montana, South Carolina	Bars mining-specific decibel limits or rules stricter than those for data centers.

Source: Alabama Legislature (2026), Georgia General Assembly (2026b), and Missouri Revisor of Statutes (2026b); Arizona Legislature (2026a), Colorado General Assembly (2024), Connecticut General Assembly (2026), Idaho Legislature (2026a), Kansas Office of Revisor of Statutes (2026), Missouri Revisor of Statutes (2026a), Texas Legislature (2026b), and Virginia General Assembly (2026c); Wisconsin Legislature (2026b), Illinois General Assembly (2026a), Michigan Legislature (2023a), and Indiana General Assembly (2022a); West Virginia Legislature (2025); Arkansas General Assembly (2023), Montana Legislature (2025b), and South Carolina General Assembly (2026a).

Note: Indiana's limits are opt-in defaults, not a cap, so Exhibit 15 does not count Indiana as a state that caps local rules.

Old shields: farms and shooting ranges. The oldest preemption laws protect farms and shooting ranges from noise suits and local rules. Shooting range laws are the most widespread. Idaho and Kansas say state and local decibel rules do not apply to protected ranges (Idaho Legislature 2026a; Kansas Office of Revisor of Statutes 2026). Virginia bars any local noise ordinance from holding a range to stricter standards than those in effect when it was approved (Virginia General Assembly 2026c).

These laws do not reach data centers. They show that states have long been willing to shield a favored use from local noise rules.

Ceilings for wind and solar. In the 2010s and 2020s, the shield moved to renewable energy. Wisconsin bars any local restriction on a wind energy system "more restrictive than the rules promulgated by the commission" (Wisconsin Legislature 2026b). Illinois bars a county from setting a wind or solar sound limit "more restrictive than" the state Pollution Control Board's limits (Illinois General Assembly 2026a). Michigan's 2023 law sets a similar ceiling for state-sited projects (Section 7). Indiana takes a gentler route. Its 50 dBA limits are defaults for counties that opt in as "wind energy ready" or solar ready communities, which may adopt less restrictive standards. The statute does not say whether a county outside the program may adopt stricter limits (Indiana General Assembly 2022a).

Ceilings for utility lines. Colorado's general noise statute bars any municipality or county from setting noise standards for electric transmission facilities of 44 kilovolts or more that are "more restrictive than" the state process (Colorado General Assembly 2024). Virginia's civil-penalty statute for noise ordinances excludes "noise generated in connection with the business being performed on industrial property." It also says no local ordinance applies to sound from an area permitted by the state Department of Energy (Virginia General Assembly 2026d). The first clause limits only the civil-penalty schedule, but it matters to a data center sited in an industrial zone.

Ceilings for computing. The newest shields protect computing. West Virginia's 2025 law removes certified data centers from local noise ordinances entirely (West Virginia Legislature 2025). Arkansas, Montana, and South Carolina cap local noise rules for cryptocurrency mining (Arkansas General Assembly 2023; Montana Legislature 2025b; South Carolina General Assembly 2026a).

Floors, not ceilings. Three states push the other way and set a minimum. Colorado says its article does not limit local standards "that are no less restrictive" than the state's (Colorado General Assembly 2024). Connecticut requires a municipal noise ordinance to be "at least as stringent as any state noise control plan," and lets towns adopt stricter standards. A 2022 amendment removed the earlier requirement of state approval (Connecticut General Assembly 2026). New Jersey requires local noise ordinances to be more stringent than the state rule. Its 2000 rule text also requires the state environment department's written approval (New Jersey Department of Environmental Protection 2000). In these three states, the state rule is the starting point a local ordinance must meet.

Maine is a middle case. It lets a town's own standard replace the state's, so long as it is no more than 5 dBA looser (Maine Department of Environmental Protection 2026). That is a bounded allowance, not a floor.

Direction of travel. The pattern over time is clear. States first shielded farms and ranges, then wind and solar, and now data centers and mining. Recent bills extend the trend. Iowa and Nebraska bills would have capped local wind limits at 47 and 50 dBA (Iowa General Assembly 2026; Nebraska Legislature 2025). A Washington bill would treat stricter sound limits for energy projects as "de facto moratoria" for grant purposes (Washington State Legislature 2025). New Hampshire's House passed a bill (HB 639) that would have barred local decibel limits on home mining beyond general limits, but the version signed

in July 2026 dropped that provision (New Hampshire General Court 2025). Virginia and California show that the trend is not one-way: their data center laws add a sound record to local review rather than take power away (Virginia General Assembly 2026b; California Legislature 2026a).

> **How to read a preemption clause.** Three questions sort most clauses. First, which facilities does it cover? West Virginia's clause covers only *certified* microgrid districts and high impact data centers (West Virginia Legislature 2025); Wisconsin's covers wind energy systems (Wisconsin Legislature 2026b). Second, is it a ceiling (no stricter than the state) or a full bar (no local rule at all)? Illinois and Michigan set ceilings; West Virginia sets a bar. Third, does it preserve general rules? Arkansas keeps local "limits set for sound pollution generally," so a neutral, all-sources ordinance survives where a mining-specific one does not (Arkansas General Assembly 2023).

6.6 Local authority: home rule and Dillon's rule

This subsection addresses the question a township attorney will ask first: does our local government have the power to adopt this rule at all? Two labels are common. Under **home rule**, a local government may act on local matters unless state law denies the power. Under **Dillon's rule**, a local government has only the powers the legislature grants expressly or by necessary implication. The labels are useful shorthand, but the label alone does not settle whether a local government may regulate data center noise.

Constitutional and statutory grants. Many states grant broad power in their constitution or statutes. California's constitution lets a county or city "make and enforce" police ordinances "not in conflict with general laws" (California Legislature 2026b). Illinois gives home rule to counties with an elected chief executive and to municipalities over 25,000 people. A home rule unit "may exercise any power and perform any function pertaining to its government and affairs" (Illinois General Assembly 1970).

Indiana and Maine grant broad powers by statute. Indiana lets a unit exercise any power not expressly denied, and Maine any power not denied "either expressly or by clear implication" (Indiana General Assembly 2026; Maine Legislature 2026a). Florida's municipal home rule statute and Idaho's constitution grant similar police power (Florida Legislature 2026; Idaho Legislature 2026b). Oregon's noise statute says a city or county "may adopt and enforce noise ordinances or noise standards otherwise permitted by law" (Oregon Legislature 2026).

Why the label does not settle the question. Three examples show the limits of the label. Virginia is usually described as a Dillon's rule state. Yet its counties hold a general power to promote "health, safety and general welfare," and state law expressly contemplates local noise ordinances (Virginia General Assembly 2026a; Virginia General Assembly 2026d). Its 2026 data center law even assumes localities have "adopted noise ordinances" (Virginia General Assembly 2026b). West Virginia has a municipal home rule program, but its 2025 data center law overrides it by name (West Virginia Legislature 2025). Nevada grants counties a specific noise power by statute, whatever the general label (Nevada Legislature 2026a). Arizona lets larger cities adopt charters, but only "consistent with, and subject to," state law (Arizona Legislature 2026c).

Who holds the power also differs by type of local government. Illinois limits home rule to large counties and cities, so a small Illinois village or a county without an elected executive works from statutory grants (Illinois General Assembly 1970). Kentucky gives cities broad powers by statute; we did not confirm the scope of county power (Kentucky General Assembly 2026d). For states where a current constitutional or statutory grant was not verified directly, Appendix A gives the classification from a fifty-state legal review, with its case citation. That review dates from 2003, so newer statutes can change the answer, as Nevada's 2015 law did (Richardson et al. 2003; Nevada Legislature 2026b). Michigan townships, which hold only statutory powers, are covered in Section 7.

The practical advice is simple. Before adopting a data center noise rule, find the specific statute that grants zoning or police power to this type of local government in this state. Then check whether any statute in Section 6.5 takes it away.

6.7 Bills in 2025 and 2026

This subsection summarizes the pending and failed bills, because they show where state policy may go next and supply drafting ideas a local government may borrow. Most bills that pair noise with data centers did not pass. Exhibit 18 lists the main ones with their status as of the dates of the sources.

What to notice: only the Maryland and South Dakota bills would have set data center numbers, and neither passed.

Virginia's model is spreading. The most common idea is Virginia's sound-profile site assessment. North Carolina's S 730, Tennessee's HB 946, and New Jersey's A 5420 all use a 500-foot radius around homes and schools for facilities of 100 megawatts or more (North Carolina General Assembly 2026b; Tennessee General Assembly 2026; New Jersey Legislature 2026b). None had passed by the dates checked. A local government can adopt the same requirement on its own; it does not need to wait for the state.

Maryland's bill is the most detailed. Maryland's HB 1534 would have directed the state to set data center limits of 45 dBA or 55 dBC at school and residential property. It would also have kept dBC no more than 10 above dBA, a test aimed at low-frequency hum (Maryland General Assembly 2026b). It would have set a vibration limit of 0.02 inches per second at school foundations. It would also have required spring-isolated equipment foundations, cleaner generators within one mile, and no non-emergency generator testing from 7:30 a.m. to 4:30 p.m. on weekdays (Maryland General Assembly 2026b).

The bill received a hearing and no further action (Maryland General Assembly 2026b). A companion bill, HB 1411, would have required projected noise at the property line and at 0.25, 0.5, and 1.0 miles (Maryland General Assembly 2026a). Neither is law, but both are useful drafting sources, and Section 9 draws on similar provisions.

Some bills show what not to copy. As introduced, New Hampshire's SB 439 would have capped data center noise at "5 percent" over ambient; the Senate struck the noise rule before the bill died (New Hampshire General Court 2026). Because decibels are logarithmic, a percentage of a decibel level has no clear acoustic meaning. A drafter should write the increase in decibels. Missouri's SB 1750 called

Exhibit 18. Selected 2025–26 state bills on data center and energy facility noise

State and bill	Noise provisions	Status (source date)
Maryland HB 1534 (2026)	Rules capping data center sound at 45 dBA or 55 dBC at homes and schools; dBC no more than 10 above dBA; 0.02 in/s vibration at school foundations; no weekday daytime generator testing	House hearing March 10, 2026; no later action
North Carolina S 730	Sound-profile site assessment within 500 feet for data centers of 100 MW or more	Passed House June 3, 2026; sent to Senate Rules June 8; no later action
Tennessee HB 946 / SB 962	Same 500-foot sound-profile assessment for 100 MW facilities	Deferred to January 2027
New Jersey A 5373; A 5420	Acoustic barriers and post-operation noise studies; 500-foot sound-profile assessment	Introduced 2026 (A 5373 on September 10)
Pennsylvania HB 2151; HB 2515; HB 2821	Model ordinance; noise transparency; ballot showing estimated decibels	HB 2151 passed House; HB 2515 and HB 2821 in committee; no Senate action reported (May 2026)
South Carolina S. 867; S. 902	"Reasonable measures" on noise and vibration; noise mitigation for cooling and backup power	S. 867 reported by Senate committee April 2026
Michigan HB 6139; HB 6391	Acoustic engineering report (ISO 9613-2); low-frequency, vibration, and tonal assessment	Introduced 2026
Texas SB 338 (prefiled)	State utility commission "may" require data centers to limit noise and set generator distances	Filed November 12, 2026; session opens January 2027
New Hampshire SB 439	As introduced, "5 percent" over ambient at the residential line	Noise rule struck; died on the House table
South Dakota SB 127	45 dB at nearest residential line; one-mile buffer	Killed in committee February 18, 2026
Vermont H. 727	"Community noise levels" as a review criterion for 20 MW data centers	Veto sustained May 29, 2026
Colorado SB26-098	Exemptions from the state noise statute	Passed Senate; postponed indefinitely April 14, 2026
Iowa SF 2447	Cap local wind limits at 47 dBA	Stalled on Senate calendar after March 19, 2026
Nebraska LB 503 (2025)	Cap county renewable limits at 50 dBA	No sign it left committee
Mississippi SB 2528	40 dBA wind limit at nonparticipating property line	Died in committee February 3, 2026
Oklahoma SB 1514	Wind: 35 dBA at a dwelling, 45 dBA at the property line	Referred to committee February 3, 2026

Source: Maryland General Assembly (2026b); North Carolina General Assembly (2026b) and North Carolina General Assembly (2026c); Tennessee General Assembly (2026); New Jersey Legislature (2026a) and New Jersey Legislature (2026b); Pennsylvania General Assembly (2026a), Pennsylvania General Assembly (2026b), Pennsylvania General Assembly (2026c), and Spotlight PA (2026); South Carolina General Assembly (2026b) and South Carolina General Assembly (2026c); Michigan Legislature (2026a) and Michigan Legislature (HB 6391 (2026)); Texas Legislature (2026a); New Hampshire General Court (2026); South Dakota Legislature (2026a) and South Dakota Public Broadcasting (2026); Vermont General Assembly (2026); Colorado General Assembly (2026a); Iowa General Assembly (2026); Nebraska Legislature (2025); Mississippi Legislature (2026); Oklahoma Legislature (2026).

Note: Status is as shown on the cited bill pages or reports, checked through November 24, 2026. "No later action" means none appeared on the page read.

for “harmonic distortion measurements not to exceed fifty decibels,” which mixes an electrical term with an acoustic limit (Missouri Senate 2026).

Two directions at once. The bills pull in opposite directions. One group adds local tools: assessments, disclosure, and in Maryland and South Dakota, numeric caps (Maryland General Assembly 2026b; South Dakota Legislature 2026a). The other group limits local tools. It includes wind ceilings in Iowa and Nebraska, Colorado’s proposed exemptions, and Texas’s plan to give noise standards to the state utility commission (Iowa General Assembly 2026; Nebraska Legislature 2025; Colorado General Assembly 2026a; Texas Legislature 2026a). Vermont’s veto shows that even a bill listing noise only as a review factor can fail over the governor’s objection (Vermont General Assembly 2026). A local government should expect the 2027 sessions to bring more of both.

6.8 What this means for a local government

This last subsection turns the survey into steps. A local government drafting a data center noise rule can use the state picture in four ways.

1. Check state preemption first. Before drafting, confirm that no state statute caps or bars the rule. The main risk is a full bar for the facility type, as West Virginia has for certified data centers (West Virginia Legislature 2025). A second is a parity rule, as in Arkansas and Montana, where a data center rule may also set the ceiling for cryptocurrency mining (Arkansas General Assembly 2023; Montana Legislature 2025b). Where the data center campus includes on-site solar, storage, or transmission, check the wind, solar, and transmission ceilings in Exhibit 17 too. Finally, confirm the specific grant of power for this type of local government, as Section 6.6 explains.

2. Check for a state floor or a state table to adopt. In Colorado, Connecticut, and New Jersey, a local rule must be at least as strict as the state rule (Colorado General Assembly 2024; Connecticut General Assembly 2026; New Jersey Department of Environmental Protection 2000). In New Jersey, the 2000 rule text also requires state approval of local ordinances (New Jersey Department of Environmental Protection 2000). In Washington and Oregon, the state rule exists for local use and can be adopted by reference (Washington Department of Ecology 2026; Oregon Department of Environmental Quality 2026). In Illinois, Minnesota, and New Jersey, the state rule already reaches low-frequency sound or uses statistical metrics that a local ordinance can borrow (Illinois Joint Committee on Administrative Rules 2018; Minnesota Office of the Revisor of Statutes 2003; New Jersey Department of Environmental Protection 2000). Delaware’s rule adds a numeric vibration limit and a tonal penalty (Delaware Department of Natural Resources and Environmental Control 2026).

3. Borrow state siting numbers as precedent. No state has set a data center number, but ten states have set separate numbers for outdoor energy equipment near homes. Those numbers answer the claim that “this hasn’t been done before.” For a neighbor’s home at night, six states use 39 to 45 dBA (New York Office of Renewable Energy Siting and Electric Transmission 2024; Wisconsin Legislature 2026a; New Hampshire Site Evaluation Committee 2026; Ohio Power Siting Board 2024; Vermont Public Utility Commission 2017; North Dakota Legislative Branch 2026). Ohio and New Hampshire add

a background-plus-5 dBA test for quiet places (Ohio Power Siting Board 2024; New Hampshire Site Evaluation Committee 2026). New York adds low-frequency octave-band limits and a tonal adjustment (New York Office of Renewable Energy Siting and Electric Transmission 2024). A local government that cites these rules can show that its numbers sit inside the range states already use. It should copy the metric, the time period, and the measurement point along with the number.

4. Require the sound record the states are starting to require. Virginia and California both require a sound estimate before approval, at 100 and 10 megawatts respectively (Virginia General Assembly 2026b; California Legislature 2026a). A local ordinance can require the same study in any state, with more detail: low-frequency bands, tones, generator testing, and measurement after the facility opens. Section 8 shows how adopted local codes do this, and Section 9 gives model language.

The bottom line for drafters

State law rarely gives a local government a data center noise limit. It often tells the local government what it may not do. Check preemption and local authority first. Then borrow the state siting numbers, with their metrics and measurement points. Six of the ten states with separate siting limits use 39 to 45 dBA at a neighbor's home at night, and two use 50 or 55 dBA. None of them sets a number for data centers.

SECTION 07

Michigan

Michigan townships already hold the tools to write data center noise rules, and several have used them.

7 Michigan

This section is written for a Michigan planning commission that is drafting a data center ordinance, and for the township board, attorney, planner, and residents who work with it. It answers four questions. Which Michigan body can adopt which kind of noise rule? What does state law already say about sound limits? What have Michigan courts held? And what have Michigan local governments actually adopted?

The short answer is that a Michigan planning commission does not need new state authority to write numeric noise and vibration standards for data centers. The Michigan Zoning Enabling Act lets it put those standards, the studies behind them, and the conditions that enforce them into the zoning ordinance. By November 2026, nine Michigan local governments had data center zoning with numeric sound limits: eight confirmed from adopted or final-reading text, one more reported. A 2025 consent judgment also set a court-ordered limit for one project in Saline Township. Their texts show both what works and what to avoid.

Section 5 covers the general law of police power, nuisance, and vagueness that underlies this section. Section 8 compares Michigan's rules with those of other states, and Section 9 turns the lessons into model language. Acoustic terms such as dBA, dBC, Leq, Lmax, octave band, tonal penalty, and peak particle velocity are defined in Section 2. This section defines only terms that are specific to Michigan law.

7.1 Why Michigan, and why now

Michigan saw a wave of data center proposals in 2025 and 2026, and local governments answered with moratoria and new ordinances. Our inventory of local moratoria lists about 150 Michigan records, such as moratoria, extensions, and related actions. Almost all date from late 2025 through 2026, and 36 of them name noise among the reasons for the pause (Bommarito Consulting 2026). Examples include Genoa Charter Township, Brandon Township, East Lansing, and Sterling Heights, all in Michigan (Bommarito Consulting 2026). A **moratorium** is a temporary pause on approving a land use. It sets no sound limit. It buys time to write one.

Specific projects brought the issue to individual town halls. In Saline Township (Washtenaw County, Michigan), a data center was approved through a court consent judgment in October 2025 after the township board denied a rezoning (Washtenaw County Circuit Court 2025). Lyon Charter Township (Oakland County, Michigan) reviewed a large project under its general noise ordinance and commissioned its own sound study (Lyon Charter Township 2026). A September 2026 draft would make any use over 100,000 square feet or 5 megawatts a special land use. It would also require a study of tonal, low-frequency, and infrasound content, but its numeric sound rules were still under review (Charter Township of Lyon 2026). On November 9, 2026, Saginaw Charter Township adopted a data center ordinance, and the City of Romulus (Wayne County, Michigan) adopted a 180-day moratorium (Michigan Public 2026).

Noise is the impact that Michigan's most careful neutral analysts singled out. The Citizens Research Council of Michigan, a nonpartisan research group, concluded in June 2026 that "the most concerning negative impact of data centers is noise pollution" (Citizens Research Council of Michigan 2026). Section 7.6 returns to that report.

The Legislature has also taken notice. Members introduced many data center bills in 2025 and 2026, and two of them would require acoustic studies (ALEA Institute 2026). None had passed either chamber as of November 2026. For now, the rules that protect Michigan residents from data center noise are local rules.

7.2 Who decides what in a Michigan township

A Michigan township has two separate legal tools for noise. Each comes from a different statute, and each is adopted by a different process. Knowing which tool belongs to which body answers the most common question a planning commission asks: "Is noise our job?" For data centers, the answer is yes, and it is also the board's job.

7.2.1 ZONING: THE PLANNING COMMISSION DRAFTS, THE BOARD ADOPTS

Michigan zoning comes from the **Michigan Zoning Enabling Act**, 2006 PA 110, MCL 125.3101 to 125.3702. ("PA" means public act, and "MCL" means Michigan Compiled Laws, the official code.) The Act lets a township "provide by zoning ordinance for the regulation of land development" to "promote public health, safety, and welfare" (MCL 125.3201). Since July 1, 2011, a township's planning commission holds the zoning commission's powers (MCL 125.3301).

A zoning text amendment, such as a new data center use with noise standards, moves through four steps.

1. **The planning commission drafts.** It recommends "the text of a zoning ordinance with the necessary maps and zoning regulations" (MCL 125.3305).
2. **The planning commission holds a public hearing.** At least one hearing with published notice is required before it sends its recommendation (MCL 125.3306).
3. **The planning commission sends the text to the board.** It transmits "a summary of comments received at the hearing and its proposed zoning ordinance" (MCL 125.3308).
4. **The township board adopts.** The board may send amendments back to the planning commission for comment. It adopts by "a majority vote of the members of the legislative body," and the amendment takes effect seven days after its notice is published, unless a later date is set (MCL 125.3401).

The planning commission is therefore the author of zoning text, and the township board is the decision maker. A planning consultant advises the commission. The consultant controls neither step.

7.2.2 SPECIAL LAND USES AND CONDITIONS

Most Michigan data center ordinances adopted in 2025 and 2026 treat a data center as a **special land use**: a use allowed in a district only after a separate review against standards written into the ordinance.

Two sections of the Act govern this review, and both support noise standards.

MCL 125.3502 requires the ordinance to state "the requirements and standards for approving a request" and "the procedures and supporting materials required for the application" (MCL 125.3502). The phrase "supporting materials" is the legal hook for requiring an acoustic study with the application. The approving body "may deny, approve, or approve with conditions" (MCL 125.3502).

MCL 125.3504 says the standards "shall be specified in the zoning ordinance." They must "insure" that the use "shall be compatible with adjacent uses of land, the natural environment, and the capacities of public services and facilities" (MCL 125.3504). A township may attach reasonable conditions that protect nearby residents, relate to the police power, and are "necessary to insure compliance with those standards." Once recorded, conditions "remain unchanged except upon the mutual consent of the approving authority and the landowner" (MCL 125.3504).

Three practical points follow from these two sections.

- **Put the number in the ordinance, not only in a condition.** A condition must tie to a standard stated in the ordinance. A numeric sound limit in the data center section gives later conditions, such as monitoring or generator testing hours, something to attach to (MCL 125.3504).
- **Other ordinances count.** An application must comply with "other applicable ordinances" to be approved (MCL 125.3504). A weak general noise ordinance therefore weakens zoning review too.
- **Recorded conditions last.** Because they change only by mutual consent, a monitoring and complaint-response condition can run for the life of the use (MCL 125.3504).

The Act itself assumes that zoning can regulate noise. Its mining section says the mining rules do not limit "a local unit of government's reasonable regulation of hours of operation, blasting hours, noise levels, dust control measures, and traffic" (MCL 125.3205). The Act never uses the phrase "performance standard" (Section 5.1). It does not need to. The general zoning power, plus the special land use sections, is how Michigan townships write limits on what a use does at its edges.

A zoning violation "is a nuisance per se," and a court "shall order the nuisance abated" (MCL 125.3407). **Nuisance per se** means the township need not prove that the noise is unreasonable in fact. It proves only that the ordinance was violated.

7.2.3 THE GENERAL NOISE ORDINANCE BELONGS TO THE BOARD

A township's general noise ordinance does not come from the Zoning Enabling Act. It comes from the police power (Section 5.1). A general law township acts under 1945 PA 246. Its board "may adopt ordinances regulating the public health, safety, and general welfare of persons and property" (MCL 41.181). A charter township acts under 1947 PA 359. Its board "may enact ordinances considered necessary to provide for the public peace and health and for the safety of persons and property" (MCL 42.15).

Neither statute requires a planning commission recommendation or a zoning hearing. In a general law township, an ordinance with a penalty takes effect 30 days after first publication (MCL 41.184). In a charter township, it takes effect on publication unless a later date is stated (MCL 42.22).

The board may make a violation a **municipal civil infraction**, a non-criminal violation that carries a civil fine (MCL 41.183; MCL 42.21). Otherwise the penalty is capped at a $500 fine or 90 days in jail (MCL 41.183; MCL 42.21). An authorized township official may issue a citation on personal observation or after investigating a witness's complaint (MCL 600.8707). The district court decides responsibility by "a preponderance of the evidence" (MCL 600.8701).

7.2.4 THE KEY DIFFERENCE: EXISTING USES

The two tools reach different sources. Zoning protects uses that already exist. If a use "is lawful at the time of enactment of a zoning ordinance or an amendment," it "may be continued" even if it does not conform (MCL 125.3208). Such a use is called a **nonconforming use**. A new zoning noise standard therefore applies mainly to new data centers, expansions, and new approvals. It generally does not reach an existing substation or factory. How far an expansion of a nonconforming use can be regulated depends on each township's ordinance.

A general ordinance has no such limit. In *Natural Aggregates Corp. v. Brighton Township* (1995), the Michigan Court of Appeals held that a township could regulate an existing gravel mine under its general ordinance power. Such an ordinance is not zoning, so a prior nonconforming use has no right to continue free of it (213 Mich App 287 (1995)). The mine operator even conceded that "limitations on hours of operation, requirements for dust control, smoke and noise abatement" were permissible (213 Mich App 287 (1995)).

Exhibit 19 sets out the tools side by side.

7.2.5 WHAT THIS MEANS FOR A PLANNING COMMISSION

A planning commission can write data center noise rules into zoning directly. Through a text amendment it drafts and recommends, it can do all of the following (MCL 125.3305; MCL 125.3306; MCL 125.3401):

- Make a data center a special land use in named districts, with accessory substations, batteries, and generators covered (MCL 125.3502).
- State numeric sound limits as approval standards, including a lower night limit, a low-frequency limit, and a tonal penalty (MCL 125.3504).
- Require a background sound survey and an acoustic model with the application, as "supporting materials" (MCL 125.3502).
- Authorize conditions for post-construction testing, monitoring, generator testing hours, and mitigation (MCL 125.3504).
- Set equipment placement, setbacks, berms, and screening, which are ordinary zoning subjects (MCL 125.3201).

The zoning power has one outer limit that matters for strict sound rules. MCL 125.3207 says a zoning ordinance "shall not have the effect of totally prohibiting the establishment of a land use." The rule applies where there is "a demonstrated need for that land use" in the township or the surrounding area. The exceptions are a use that is unlawful and a township with no location where the use "may

Exhibit 19. Michigan township tools for regulating data center noise

Tool	Who adopts	What it reaches	Pros	Cons
Zoning performance standards (MCL 125.3201, .3502, .3504)	Planning commission drafts, holds the hearing, and recommends. Township board adopts by majority vote.	New data centers, expansions, and new approvals. Existing lawful uses may continue.	The planning commission controls the text. Standards bind every future applicant. A violation is a nuisance per se.	It does not reach existing sources. It takes a hearing and two bodies to adopt.
Special land use or planned unit development (PUD) conditions (MCL 125.3502–.3504)	The approving body named in the ordinance, often the board on the planning commission's recommendation.	One project at a time.	Conditions can require monitoring, mitigation, and complaint response. Recorded conditions bind later owners.	A condition must tie to a standard already in the ordinance. It cannot supply a missing number.
General noise ordinance (MCL 41.181; 42.15 for charter townships)	Township board alone. No planning commission hearing is required.	Every source in the township, including existing ones.	It reaches existing sources. It can be enforced by civil infraction citation.	The planning commission cannot adopt or amend it. Old ordinances often use vague "disturbing" standards.
Temporary moratorium	Township board, best through the zoning amendment process.	New applications during the pause.	It buys time for studies and drafting.	It sets no standard. One adopted by resolution alone was held void in 2018.

Source: MCL 125.3201, 125.3208, 125.3305–.3308, 125.3401, 125.3407, 125.3502–.3504, 41.181, 41.183, 42.15, 42.21 (MCL 125.3201; MCL 125.3208; MCL 125.3401; MCL 125.3504; MCL 41.181; MCL 42.15); *Natural Aggregates* (213 Mich App 287 (1995)); *Tuscola Wind III v. Ellington Township* (Tuscola Wind III v. Ellington Twp. (E.D. Mich. 2018)).

be appropriately located" (MCL 125.3207). A very low limit that no site in the township could meet invites that challenge. A township that chooses strict limits should therefore show in its findings where a compliant data center could locate.

Amending the general noise ordinance is a parallel board action. The planning commission cannot adopt it, though it may recommend changes. The two can and often should move together. If they use the same metric and measurement method, a data center that passes zoning review will not violate the general ordinance on its first night.

A township has three ways to sequence the work. The first, within the planning commission's control, is to put the full noise standard in the data center section. The second is to move both at once, with the attorney keeping the two texts consistent. The third is to cross-reference only ("shall comply with the township noise ordinance"). That is the weakest choice if the general ordinance has only a "disturbing the peace" standard, because zoning then supplies no number.

Noise is within the planning commission's zoning power

The Michigan Zoning Enabling Act lets a planning commission draft numeric noise and vibration standards, required acoustic studies, and enforcement conditions for a data center special land use. The township board adopts them (MCL 125.3502; MCL 125.3504; MCL 125.3401). The board separately controls the township's general noise ordinance, which can reach existing sources that zoning cannot (MCL 41.181; 213 Mich App 287 (1995)). The two actions are complementary, and a township gets the most protection when they share one metric and one measurement method.

Counties can also zone in Michigan, but a county's zoning does not apply in a township that has its own zoning ordinance (MCL 125.3209). That is why many older Michigan wind ordinances with sound limits are county ordinances (Michigan State University Extension 2020).

7.3 What Michigan state law says

Michigan has no general state noise standard for factories or data centers. It does have one numeric sound limit for large energy facilities, and that limit now comes with a court ruling on local power. This subsection covers both, then the state's data center laws and bills, and the Right to Farm Act as a warning about preemption.

7.3.1 NO GENERAL STATE NOISE STANDARD

We found no Michigan statute that sets a general noise limit for stationary sources (Appendix D describes the searches) (Michigan Legislature 2026e). The statutes that mention noise are source-specific: vehicles, motorboats, security alarms, shooting ranges, solid waste rules, PA 233, and oil and gas wells. For oil and gas wells, the supervisor of wells may act "to prevent regular or recurring nuisance noise" (MCL 324.61506). None reaches a data center. The Citizens Research Council reached the same conclusion: "no federal or state regulations govern noise pollution" (Citizens Research Council of Michigan 2026). The state's workplace rule, MIOSHA Part 380, adopts the federal OSHA noise standard by reference (Michigan Department of Licensing and Regulatory Affairs 2026). It protects workers

inside a facility. It does not limit sound at a neighbor's home (Michigan State University Extension 2007).

7.3.2 PA 233 OF 2023: THE STATE'S SOUND LIMIT FOR ENERGY FACILITIES

In plain terms, PA 233 sets one state number: 55 dBA, averaged over an hour, at the outer wall of a neighbor's home. It covers only large solar, wind, and storage facilities, not data centers. A township that wants to keep local control of those projects through a compatible ordinance may not set a stricter limit.

The details follow. 2023 PA 233 created a state siting path for large energy facilities. It took effect November 29, 2024. It covers solar of 50 megawatts or more and wind of 100 megawatts or more. It also covers energy storage of 50 megawatts and 200 megawatt-hours or more (MCL 460.1222). The Michigan Public Service Commission (MPSC) applies the statute's test. Each facility must be one that "does not generate a maximum sound in excess of 55 average hourly decibels as modeled at the nearest outer wall of the nearest dwelling located on an adjacent nonparticipating property" (MCL 460.1226). The modeling "shall use the A-weighted scale" (MCL 460.1226). The citations are MCL 460.1226(8)(a)(iv) for solar, (8)(b)(iv) for wind, and (8)(c)(iii) for storage.

Four features of that text matter to a planning commission.

1. **Metric.** "Average hourly decibels" on the A scale is a one-hour Leq. The MPSC said so directly in a 2026 order: "measuring the 55 hourly decibels at 1-hour Leq" (MPSC Case U-21932, Aug. 27, 2026 order).
2. **Modeled, not measured.** The statute tests the limit with a model before approval. It does not set a measurement procedure for an operating facility.
3. **Receptor.** The limit applies at the outer wall of a home on nonparticipating property. Under PA 233, that is adjacent land the applicant does not own and whose owner has no agreement to be paid by the applicant for the facility (MCL 460.1221). PA 233's limit does not apply at the property line. (The model ordinance in Appendix B defines the term differently.)
4. **One number.** The statute has no separate night limit and no low-frequency limit.

The MPSC added three protections when it implemented the statute in an October 10, 2024 order (MPSC Case U-21547, Oct. 10, 2024 order). First, sound models must apply a "+ 5 dB tonal penalty to source sound power," removable only if the facility would have no tonal prominence at a home. The order notes that "emissions from transformers, energy storage units, and inverters are typically tonal" (MPSC Case U-21547, Oct. 10, 2024 order).

Second, models must add "+6 dB to modeled free field outer wall sound pressure level" to account for sound reflecting off the home (MPSC Case U-21547, Oct. 10, 2024 order). This correction applies to modeled predictions, not to measurements. A meter placed at the wall already picks up the reflection, so adding 6 dB to a measured level would count it twice. Third, the order requires pre-construction monitoring of existing sound and post-construction monitoring within the first year, with a mitigation schedule if results exceed the limit (MPSC Case U-21547, Oct. 10, 2024 order).

Utilities objected. DTE Electric argued that the tonal penalty plus the wall adjustment "could lead to an effective requirement of 44 dBA" (MPSC Case U-21547, Oct. 10, 2024 order). The MPSC adopted both anyway. It found the tonal penalty "based on ANSI standards" and the wall method consistent with the statute's plain language (MPSC Case U-21547, Oct. 10, 2024 order). That ruling is useful precedent for a township. A Michigan state agency, over industry objection, adopted a tonal penalty for transformer and inverter hum, and data centers use the same kinds of equipment.

The MPSC has since applied these rules in a certificate. On August 27, 2026, it approved a settlement for the 90-megawatt Acceleration Solar project in three Ingham County, Michigan townships (Michigan Public Service Commission 2026a). The settlement requires one-hour Leq modeling with the tonal and wall corrections, a complaint process, and corrective action that "may include operational changes, including curtailment, stoppage of particular equipment, replacement of equipment" (MPSC Case U-21932, Aug. 27, 2026 order).

7.3.3 COMPATIBLE ORDINANCES AND THE 2026 COURT RULINGS

PA 233 gives a developer two paths: local approval or an MPSC certificate. Which path is open depends on whether the township has a **compatible renewable energy ordinance** (CREO). MCL 460.1221(f) defines a CREO as an ordinance whose requirements "are no more restrictive than the provisions included in section 226(8)" (MCL 460.1221). A township with a moratorium on energy facilities is treated as having no CREO (MCL 460.1221).

The Michigan Court of Appeals read that definition strictly. In a published opinion on May 7, 2026 (Docket No. 373259), it held that a CREO may contain only the requirements listed in section 226(8). Any extra requirement, the court said, "would inherently be more restrictive" (In re PA 233, Mich. Ct. App. No. 373259 (2026)). The townships asked the Michigan Supreme Court to review that ruling, and on November 20, 2026 (No. 170249) the Court declined (Mich. Sup. Ct. No. 170249, Nov. 20, 2026 order).

The Supreme Court did agree to hear argument in January 2027 on a separate question raised by the MPSC and energy companies. That question is the deadline in MCL 460.1223(3) for a township to tell a developer it has a CREO (Mich. Sup. Ct. No. 170249, Nov. 20, 2026 order). For now, the Court of Appeals ruling stands. A township that wants a compatible ordinance may not set a sound limit stricter than PA 233's.

For large wind, solar, and storage projects, the result is a trade-off. A township may keep a stricter sound limit, such as 45 dBA at night. But it then lacks a CREO, and the developer may apply to the MPSC instead. If the MPSC issues a certificate, it preempts local rules that impose "additional or more restrictive requirements" (MCL 460.1231).

7.3.4 PA 233 DOES NOT COVER DATA CENTERS

PA 233 applies only to the solar, wind, and storage facilities that meet its thresholds (MCL 460.1222). A data center is none of these. PA 233 therefore does not limit a township's sound standard for a data center, and the CREO ruling does not reach data center ordinances.

One drafting caution follows. A data center campus may include a large battery plant or on-site solar. If an ordinance writes one sound standard for "data centers and accessory energy facilities," a covered energy portion might fall under PA 233. Drafters should keep the data center standard separate and state that PA 233 governs covered energy facilities to the extent it applies.

7.3.5 DATA CENTER STATUTES AND PENDING BILLS

Michigan's enacted data center laws are tax laws with no noise rules. 2024 PA 181 (Senate Bill 237 of 2023) amended the Use Tax Act exemption, and 2024 PA 207 (House Bill 4906 of 2023) amended the General Sales Tax Act exemption (SB 237 of 2023 (2024 PA 181); Michigan Senate Fiscal Agency 2024). Neither section contains the word "noise," and neither preempts local zoning or noise rules (MCL 205.54ee; MCL 205.94cc).

Several 2025–26 bills would change the picture. Each bill below was in committee as of November 22, 2026, the last date in our bill data, with no passage in either chamber (ALEA Institute 2026).

- **HB 6139** (introduced June 25, 2026) would require a data center building permit application to include "an acoustic engineering report conducted by an acoustic engineer" (Michigan Legislature 2026a). The report would cover baseline sound at the property lines and nearby homes and an operational model under ISO 9613-2. It would also compare the results with the local noise ordinance.
- **HB 6391** (introduced September 24, 2026) would require an "acoustic impact assessment" of "low-frequency sound, vibration, tonal noise, resonance, or transformer hum" for large data centers (HB 6391 (2026)). It would let local units set sound limits, require a monitoring agreement, and address generator testing hours (HB 6391 (2026)).
- **HB 4085** (introduced February 13, 2025) points the other way. For cryptocurrency mining in industrial zones, a local unit "shall not set a specific limit on decibels" beyond "any applicable general limits set for sound pollution that apply to industrial zones" (HB 4085 (2025)).

HB 6139 and HB 6391 track what a township can already require in zoning. Neither supplies a number; both defer to the local limit. HB 4085 shows that state preemption of local decibel limits has been proposed in Michigan. If that idea spread to data centers, a township's general noise limits for industrial zones could become the ceiling. That is a reason to set those general limits deliberately now. Other pending bills would impose a statewide moratorium on new data center approvals (HB 5594) or set rules for local data center moratoria (HB 5882) (HB 5594 (2026); HB 5882 (2026)).

7.3.6 THE RIGHT TO FARM ACT: A WARNING ABOUT PREEMPTION

The Michigan Right to Farm Act shows what state preemption of local noise rules looks like. A farm that "conforms to generally accepted agricultural and management practices" shall not be found a public or private nuisance (MCL 286.473). These practices, called **GAAMPs**, are set by the state Commission of Agriculture and Rural Development. Since 2000, the Act has barred any local ordinance that "conflicts in any manner with this act" or with GAAMPs (MCL 286.474). Michigan courts have enforced that bar against township zoning, including in a dispute where neighbors complained of noise (267 Mich App 92 (2005); 302 Mich App 483 (2013)).

The GAAMPs themselves set no numeric sound limit. In the 2026 GAAMP documents, noise appears only as advice, such as to "provide noise control for engine driven pumping units" (Michigan Department of Agriculture and Rural Development 2026). A farm that follows GAAMPs is shielded from nuisance claims with no state decibel standard behind the shield. The lesson for data centers is that once the Legislature declares a field preempted, even existing local rules stop working against covered operations (MCL 286.474).

7.4 What Michigan courts have said

Michigan courts have approved numeric noise limits in zoning, struck a vague noise rule, and shown what happens when an ordinance leaves out its metric. We found no Michigan appellate decision on data center noise. The cases below come from other industries, but their lessons carry over.

7.4.1 DECIBEL AND OCTAVE-BAND LIMITS IN ZONING

City of Rochester v. Superior Plastics, Inc. (1991) is the closest Michigan appellate analogue to a data center performance standard. The court called it "the first published case in Michigan to address a zoning ordinance that regulates excessive noise by setting maximum decibel levels for land adjacent to residential areas" (192 Mich App 273 (1991)). It held that a Michigan city may regulate industrial noise through zoning, using maximum decibel and octave-band levels at a property line next to homes, so long as the ordinance is reasonable (192 Mich App 273 (1991)). An octave-band limit controls low-pitched sound directly (Section 2.3). The case is 35 years old. Numeric industrial noise limits in Michigan zoning are not new.

Measured noise evidence also supports land-use decisions. In *American Aggregates Corp. v. Highland Township* (1986), the court upheld a refusal to rezone for gravel mining. The trial court had relied on expert testimony that each passing gravel truck "would result in a noise level of eighty-four to one hundred four decibels" (151 Mich App 37 (1986)).

7.4.2 STATE THE METRIC: TUSCOLA WIND III V. ALMER CHARTER TOWNSHIP

Almer Charter Township (Tuscola County, Michigan) denied a special land use permit for wind turbines. Its ordinance said turbine noise "shall not exceed forty-five (45) decibels on the DBA scale as measured at the nearest property line of a non-participating property owner or road" (Tuscola Wind III v. Almer Charter Twp. (E.D. Mich. 2017)). It named no averaging period. The developer modeled a one-hour Leq. The township board read the limit as a maximum that could never be exceeded. The federal district court for the Eastern District of Michigan upheld the denial in November 2017 (Tuscola Wind III v. Almer Charter Twp. (E.D. Mich. 2017)).

On reconsideration in March 2018, the court went further. It held that "the best interpretation of § 1522(C)(14) is that it unambiguously provides for a Lmax standard," meaning the highest level reached rather than an average (Tuscola Wind III v. Almer Charter Twp. (E.D. Mich. Mar. 2018)). In the alternative, the court held that Michigan law defers to a township's reasonable reading of its own ordinance (Tuscola Wind III v. Almer Charter Twp. (E.D. Mich. Mar. 2018)). The district court resolved the last remaining claim in August 2018 and closed the case (Tuscola Wind III v. Almer Charter Twp.

(E.D. Mich. Aug. 2018)). The public docket shows no appeal, and a later Sixth Circuit opinion cites the district court ruling, not an appellate one (United States Court of Appeals for the Sixth Circuit 2021). This report therefore cites only the district court rulings.

The case carries two lessons. First, a Michigan township's 45 dBA property-line limit survived a federal court challenge. Second, leaving out the metric invited a lawsuit over what the number meant. The silence favored the township here, but it might not next time. An Lmax limit and a one-hour Leq limit at the same number are very different rules, because an hourly average lets brief peaks run well above the number. A data center ordinance should name its metric on purpose.

7.4.3 VAGUE WORDS FAIL: CITY OF GRAND RAPIDS V. GASPER

In *City of Grand Rapids v. Gasper* (2016), the Court of Appeals struck down part of the Grand Rapids, Michigan noise ordinance as unconstitutionally vague (314 Mich App 528 (2016)). The provision barred using premises in a way that "shall destroy the peace and tranquility of the surrounding neighborhood." Because it gave no "explicit standards," the court held, "law enforcement officers and finders of fact are necessarily vested with 'virtually complete discretion' " (314 Mich App 528 (2016)). Other sections of the same ordinance set decibel limits and were not at issue.

The same court had earlier upheld a ban on "loud or boisterous conduct" as precise enough (213 Mich App 338 (1995)). That case concerned personal conduct, not machinery. The lesson for drafters is practical as well as legal. A subjective standard gives an enforcement officer nothing to measure at a cooling yard. A numeric limit with a stated metric, location, and method is both easier to defend and easier to apply (Section 5).

7.4.4 DEFINE WHERE YOU MEASURE

Capitol Properties Group, LLC v. 1247 Center Street, LLC (2009) shows why the measurement location must be defined. A Lansing, Michigan ordinance set 55 dBA at a "residential real property boundary." The court read that phrase to mean residentially zoned land only, so it did not protect a neighbor zoned for business (283 Mich App 422 (2009)). The court also held that alleging sound above the ordinance limit did not by itself plead a nuisance (283 Mich App 422 (2009)). A data center ordinance should say precisely whether it measures at the property line, at a home, or at any receiving property, whatever that property's zoning.

7.4.5 NUISANCE SUITS AND PREEMPTION

Michigan nuisance law offers neighbors only a slow, uncertain remedy. In a 1968 case over a gun range in Plymouth Township, the Michigan Supreme Court held that noise is a nuisance only if it causes "actual physical discomfort to persons of ordinary sensibilities" (380 Mich 526 (1968)). In a 1992 nuisance case, it required significant harm and held that fear-based loss of property value is not enough (440 Mich 293 (1992)). Data center nuisance suits are now being filed, including a May 2026 federal suit over a computing facility in Dowagiac, Michigan (Section 5.8). Such suits arrive after construction, when fixes are most expensive.

As for preemption, a Michigan ordinance is invalid if it is "in direct conflict with the state statutory

scheme" or if the state occupies the field (401 Mich 314 (1977)). No Michigan statute occupies the field of stationary-source or data center noise (Section 7.3). A township data center noise standard would face only a direct-conflict question, such as with PA 233 for a covered energy facility.

Finally, a moratorium should follow the zoning process. In *Tuscola Wind III v. Ellington Township* (2018), a federal court held void a wind moratorium that a Michigan township board adopted by resolution. "Because the moratorium is void," the court said, "the operative law in Ellington Township is the existing zoning ordinance" (Tuscola Wind III v. Ellington Twp. (E.D. Mich. 2018)).

7.5 It has been done: adopted Michigan data center noise rules

By November 24, 2026, nine Michigan local governments had data center zoning with numeric sound limits: eight confirmed from adopted or final-reading text, one more reported. Exhibit 20 names them and marks the evidence for each. For Berkley, the text read is the version proposed for adoption at second reading, and the adoption itself comes from the city clerk's published synopsis. The reported rule, Summit Township's, rests on a news report and the township's posted pre-adoption draft. Saline Township's 2025 consent judgment also set a court-ordered limit for one project, so the table has ten rows.

7.5.1 WHAT THE ADOPTED RULES SHOW

Wixom shows that a Michigan city can write a complete low-frequency and tonal package. The City of Wixom (Oakland County, Michigan) is the only adopted Michigan text we found with both dBA and dBC hourly limits by day and night (City of Wixom 2026). It also subtracts 10 dB from each limit for tonal sound: "If data center equipment produces tonal sound, a 10-dB penalty applies" (City of Wixom 2026). The table gives its other features. One weakness: its ambient comparison uses levels "provided in the post construction noise study," which are hard to measure once the facility runs (City of Wixom 2026).

Pittsfield Charter Township shows how to cap low-pitched sound without an octave-band table. Its ordinance (Washtenaw County, Michigan) caps the gap between dBC and dBA at 20 dB, because a large gap signals strong low-frequency content (Pittsfield Charter Township 2026). It also adds dBC limits of 65 at all times and 55 at night next to homes, which its June 2026 draft lacked (Pittsfield Charter Township 2026). Like several others, the text states "Leq" without an averaging period.

Saginaw Charter Township shows that a low number is not enough without a stated metric. Its Ordinance 814 (Saginaw County, Michigan) says: "In no case shall the noise from a data center exceed 40 decibels as measured at the boundaries of the property" (Saginaw Charter Township 2026). That ties for the lowest adopted continuous limit, and it is the only one that applies at 40 by day as well as at night. But the text names no weighting and no averaging period. The dBA reading rests on the planning memo, not the ordinance, and *Tuscola* suggests a court would read the limit as an Lmax (Saginaw Charter Township 2026; Tuscola Wind III v. Almer Charter Twp. (E.D. Mich. Mar. 2018)). The township also declined the MTA sample's 65 dBC cap, so the ordinance has no low-frequency limit (Saginaw Charter Township 2026).

Berkley's adopted text needs a careful read. The City of Berkley (Oakland County, Michigan) adopted 60 dBA Leq continuous by day and 40 at night (City of Berkley 2026). Its day limit is the

Exhibit 20. Adopted Michigan data center noise provisions, as of November 24, 2026

Jurisdiction, adoption, source	Sound limits	Low-frequency and tonal	Vibration, generators, and studies
Confirmed from adopted or final-reading text			
Saginaw Charter Twp. (Saginaw Co.). Ord. 814, adopted Nov. 9, 2026. Adopted text read.	40 "decibels" at the property line, day or night; weighting and averaging not stated (planning memo: dBA). Design target: baseline ambient.	None; the Michigan Townships Association (MTA) sample's 10-minute Leq and 65 dBC cap were dropped.	PPV 0.01 in/s at the property line, with continuous monitors. Generator testing 9 a.m.–5 p.m. weekdays, two at a time, Tier 4. Baseline study, then studies at peak operation and yearly for five years.
Pittsfield Charter Twp. (Washtenaw Co.). ZOA 26-236, adopted Oct. 28, 2026. Adopted text read.	50 dBA Leq at the property line at all times; 40 at night (10 p.m.–7 a.m.) next to homes. No averaging period stated.	65 dBC Leq at all times; 55 at night next to homes. dBC minus dBA at most 20 dB. Octave bands at 16–125 Hz analyzed, with no limit. A 5 dB tonal penalty.	0.10 mm/s RMS vibration at the property line. Generator testing 8 a.m.–6 p.m. weekdays, at most 100 hours a year, with 2 hours' public notice. Pre- and post-occupancy studies and a public dashboard.
City of Wixom (Oakland Co.). Ord. 2026-01, adopted Aug. 25, 2026. Adopted text read.	Hourly Leq of 55 dBA by day (8 a.m.–6 p.m.) and 45 dBA at night, at or beyond the nearest receiving property line. Where ambient is lower, the limit is ambient plus 1 dB.	Hourly Leq of 70 dBC by day and 60 dBC at night. A 10 dB tonal penalty, tested by one-third-octave bands.	No perceptible ground-borne vibration at property lines. Generator testing 9 a.m.–5 p.m. weekdays; outages also subject to the limits. Initial, final, peer-review, and post-construction studies.
City of Berkley (Oakland Co.). Ord. O-14-26, adopted Nov. 16, 2026 (clerk's synopsis). Second-reading text read.	60 dBA Leq continuous by day (7 a.m.–7 p.m.) and 40 at night, at the property line. Impulse limits are 50 by day and 30 at night.	Tonal sources capped at 65 dBC (10-minute Leq) at any time.	No perceptible vibration; monitors spaced "no less than" 250 ft apart near sensitive uses (probably meant "no more than"). Generator testing 9 a.m.–6 p.m. weekdays, 60 dBA. Post-installation study may be required.
Henrietta Twp. (Jackson Co.). Art. XXIV.2, adopted Feb. 11, 2026. Compiled ordinance read.	Baseline ambient plus 5 dBA at the property line, with day and night baselines. No absolute number.	Baseline ambient plus 5 dBC.	No numeric vibration limit. Generator testing 9 a.m.–4 p.m. weekdays. Study by a Michigan-licensed engineer under ISO 9613, and a post-development study within 6 months.
City of Saginaw (Saginaw Co.). Ord. O-281, adopted Sept. 28, 2026. Adopted text read.	55 "decibels" at the nearest residential or sensitive property line, with ambient as the design target. Weighting and averaging not stated.	None.	No vibration limit found. Non-emergency generator use 9 a.m.–5 p.m. weekdays with 72 hours' notice. Study within 30 days of occupancy, then annually for five years.
Clinton Twp. (Lenawee Co.). Ord. 25, adopted Feb. 9, 2026 (minutes, 5–0 vote). Township's posted text read.	55 dBA at the nearest property line, measured for at least 10 minutes.	None.	No numeric vibration limit. Generator testing in daylight, at most weekly. Fines of $1,500 per day for a first offense.
Clark Twp. (Mackinac Co.). Ord. 2026-02, adopted Aug. 19, 2026. Adopted text read (a).	Lower of 45 dBA Leq or ambient L90 plus 5 by day, and of 40 or L90 plus 5 at night, at the nearest home, farm, or conservation district or the lakeshore.	65 dBC at homes and other sensitive receptors. A 5 dBA penalty for tones, impulses, or hum.	PPV 0.035 in/s. Generator testing 9 a.m.–5 p.m. weekdays. Baseline study for later tests. Fines of $500–$5,000 per day.
Reported; adopted text not read			
Summit Twp. (Jackson Co.). Adopted Nov. 10, 2026. News report; adopted text not posted.	55 dB hourly average by day (7 a.m.–9 p.m.) and 45 at night (news). September draft: one 55 dBA limit.	Unknown.	Generators limited to 80 dB, with testing 8 a.m.–9 p.m. weekdays (news).
Court-ordered limit for one project			
Saline Twp. (Washtenaw Co.). Consent judgment entered Oct. 15, 2025. Court order read.	55 dB "at all times" at all property lines. Weighting and averaging not stated.	None.	Generators for emergencies and testing only, testing in daylight at most weekly. This is a court order for one project, not an ordinance.

Source: Adopted ordinance texts, notices, minutes, news report, draft, and court order (Saginaw Charter Township 2026; Pittsfield Charter Township 2026; City of Wixom 2026; City of Berkley 2026; Henrietta Township 2026; City of Saginaw 2026; Clinton Township (Lenawee County) 2026b; Clinton Township (Lenawee County) 2026a; Clark Township 2026a; Clark Township 2026b; MLive 2026; Summit Township (Jackson County) 2026; Washtenaw County Circuit Court 2025). All jurisdictions are in Michigan. PPV is peak particle velocity; RMS is root mean square. (a) Copy posted by another local government; the township says a true copy is at the clerk's office.

highest among the adopted ordinances that state a weighting. Its impulse limits are lower than its continuous limits, at 50 by day and 30 at night. That is unusual, and a drafter copying Berkley should check what was intended. An earlier planning commission draft had set 30 dBA by day (City of Berkley 2026).

Several adopted texts tie limits or targets to ambient sound, the ordinances' word for the sound already present (Section 2.7 explains the related term background sound). Henrietta Township (Jackson County, Michigan) uses it as the sole limit, capping sound at the measured baseline plus 5 dBA and plus 5 dBC at the property line (Henrietta Township 2026). Its wording, "shall not exceed 5 dBA and 5 dBC of baseline ambient sound levels," is ambiguous; we read it as baseline plus 5. Wixom and Clark Township also bind facilities to ambient-based caps where existing sound is quiet (ambient plus 1 dB in Wixom; L90 plus 5 dBA in Clark Township), while the City of Saginaw and Saginaw Charter Township set baseline ambient as a design target alongside their fixed caps (City of Wixom 2026; Clark Township 2026a; City of Saginaw 2026; Saginaw Charter Township 2026). A limit tied to background protects quiet rural places best, but it depends on a careful baseline study before construction.

Summit Township (Jackson County, Michigan) borrowed the state energy standard. According to a news report, it set 55 and 45 dB "to be consistent with state noise limits on solar farms and battery storage facilities" (MLive 2026). PA 233 actually sets one 55 dBA hourly limit at a home's wall, with no night limit (Section 7.3). The township's September 2026 draft had matched that: one 55 dBA hourly limit "as modeled at the nearest outer wall of the nearest dwelling" (Summit Township (Jackson County) 2026). The adopted text was not posted when we checked. A township that borrows the PA 233 number should also borrow its metric and its tonal and wall corrections, or say why not.

Three texts leave the weighting unstated: Saginaw Charter Township, the City of Saginaw, and the Saline Township consent judgment. The Saline judgment says "The sound emitted from the operation of the Data Center shall at all times not exceed 55db at all property lines" (Washtenaw County Circuit Court 2025). It binds one project by court order. It is not a township ordinance.

Other Michigan governments acted without a data center noise number. Ypsilanti Charter Township adopted an ordinance in December 2025 that governs data center definitions and districts. Its adopting resolution cites "managing noise from mechanical equipment and generators," but we found no numeric limit (Charter Township of Ypsilanti 2025). Lyon Charter Township applied its general noise ordinance. Its published Q&A gives limits of "60 dB(A) during daytime hours, 50 dB(A) during nighttime hours" at homes, with "a 5dB penalty for tonal or impulsive noise" (Lyon Charter Township 2026). News reports describe 65 dBA conditions proposed in Gaines Charter Township, which in August 2026 paid for a baseline noise study before deciding, and a 67 dBA general limit in Van Buren Charter Township (WWMT 2026; WOOD TV8 2026; Planet Detroit 2026). Livonia's planning commission recommended rules in November 2026 that require a sound study for sound below 200 Hz (Livonia Thrive 2026).

"This hasn't been done before" is not accurate in Michigan

The nine Michigan local governments in Exhibit 20 show that the rule has been written here. Adopted continuous limits range from 40 to 60 decibels (Berkley's impulse limits go to 30). Wixom, Pittsfield Charter Township, and Clark Township added fixed dBC limits (Henrietta uses ambient plus 5 dBC,

and Berkley caps tonal sources at 65 dBC), and Pittsfield also requires octave-band analysis. Saginaw Charter Township (0.01 in/s), Pittsfield (0.10 mm/s), and Clark Township (0.035 in/s) set numeric vibration limits (City of Wixom 2026; Pittsfield Charter Township 2026; Saginaw Charter Township 2026; Clark Township 2026a; Henrietta Township 2026; City of Berkley 2026). Michigan wind siting guidance has suggested numeric sound limits since at least 2007, and county wind ordinances adopted them (Michigan State University Extension 2007; Michigan State University Extension 2020). We found no enforcement history or court test for any Michigan data center noise provision, so these rules are proven in adoption, not yet in court. The nearest case is the City of Dowagiac (Cass County, Michigan). In 2026 it cited an operating data center under its general noise ordinance of 65 dB by day and 55 at night, and the operator challenged the city's readings (Watershed Voice 2026; WXYZ 2026).

7.5.2 DRAFTS, PENDING ORDINANCES, AND MODELS

More Michigan rules are in the pipeline, and several drafts go further than the adopted texts. Exhibit 21 summarizes them. None of these had been adopted as of November 24, 2026.

The Howell Township draft is the most detailed low-frequency proposal from an official Michigan source. It adds a Z-weighted (flat, unweighted) limit and a cap on one-third-octave bands at or below 200 Hz (Howell Township 2026). The planning commission held its hearing on November 17, 2026, and "the ordinance has not been adopted" (WILX 2026a). Genoa Charter Township took a different path. It extended its moratorium in August 2026 to gather township-wide baseline sound data before setting final numbers (Bommarito Consulting 2026).

The two circulating models deserve caution. The Michigan Townships Association sample ordinance is widely used. Saginaw Charter Township copied its vibration language word for word, and Berkley adopted a near copy of its tonal cap (Michigan Townships Association 2026). But its octave-band clause reads, in full, "Octave Bands (dBz) will be maintained at acceptable levels" (Michigan Townships Association 2026). That sets no number and gives an enforcement officer nothing to measure against, the problem the court identified in *Gasper* (314 Mich App 528 (2016)). A township using the MTA sample should either put a number in that clause or delete it.

The Livingston County model uses a 24-hour metric with a 60 dBA limit at sensitive properties (Livingston County Planning Department 2026). A 24-hour average, even with a night penalty, can let a loud hour pass if the rest of the day is quiet.

Planning consultants reuse language across townships. Pittsfield's June draft is the base of the Dexter and Genoa drafts, and Cohoctah and Ogden share a template (Dexter Township 2026; Genoa Charter Township 2026; Cohoctah Township 2026; Ogden Township 2026). A township's consultant has likely drafted noise standards for another Michigan community already.

7.5.3 OLDER PRECEDENT: MICHIGAN WIND AND SOLAR LIMITS

Michigan local governments have written numeric sound limits into zoning for energy facilities for nearly two decades. Michigan State University (MSU) Extension summarized the state's advisory wind siting guidelines in 2007. They suggested that "a decibel level of 55 dB(A) measured at the property

Exhibit 21. Michigan data center noise drafts and model ordinances, not adopted as of November 24, 2026

Jurisdiction and status	Draft limit	Notable features
Howell Twp. (Livingston Co.). Nov. 16, 2026 draft, heard Nov. 17; not adopted, further legal review before the board.	55 dBA, 55 dBC, and 70 dBZ at the property line.	No one-third-octave band at or below 200 Hz may exceed 60 dBZ, or 55 dBZ with a tone. A 5 dB tonal or impulsive penalty. PPV 0.01 in/s. Monthly monitoring in the first year.
City of Howell (Livingston Co.). "High resource demand facilities" ordinance introduced Nov. 23, 2026; final vote expected at the next meeting.	Not read.	Noise and vibration rules and resource studies, per news report.
Lowell Charter Twp. (Kent Co.). Committee draft v1.7, Nov. 16, 2026.	The operating dBA Lmax limit is left blank. Generators 70 dBA Lmax at property lines.	PPV 0.01 in/s. No detectable vibration beyond the property line.
Mackinac County. Draft sent to county counsel Nov. 12, 2026.	55 dB (7 a.m.–7 p.m.) and 45 dB (7 p.m.–7 a.m.) at the line shared with non-industrial property.	PPV 0.035 in/s; based on the MTA sample.
Genoa Charter Twp. (Livingston Co.). June 2026 draft; moratorium extended to about February 2027 for baseline sound data.	50 dBA Leq by day and 40 at night at any property line.	dBC minus dBA no more than 20 dB. A 5 dBA tonal penalty. Pre- and post-construction studies. An acoustics consultant was engaged after this draft.
Dexter Twp. (Washtenaw Co.). May 2026 draft; hearing noticed for Dec. 8, 2026.	50 dBA Leq by day and 40 at night, as in Pittsfield's June draft.	Failure to monitor or report may be grounds to revoke approvals.
Solon Twp. (Kent Co.). Draft 5, May 2026; Draft 7 hearing set for Dec. 16, 2026.	45 dBA Lmax at any property line.	The planning commission may lower the limit for tonal, low-frequency, or infrasound noise.
Williamstown Twp. (Ingham Co.). March 2026 consultant draft; tabled July 22, 2026.	45 dBA Lden at all property lines.	The only Lden standard found in Michigan. Surveys after 12 months and annually under ANSI S12.18 and S12.9 Part 3.
Cohoctah Twp. (Livingston Co.) and Ogden Twp. (Lenawee Co.). Proposed and interim texts.	45 dBA Lmax at the property line of any adjacent parcel.	Shared template language.
Michigan Townships Association sample, Version 1.0. Model.	55 dBA by day and 45 at night (10-minute Leq) at the property line.	Steady tonal sources capped at 65 dBC. Octave bands "maintained at acceptable levels," with no number. PPV 0.01 in/s. Generator testing 9 a.m.–5 p.m. weekdays.
Livingston County Planning model. Model.	60 dBA community noise equivalent level at a property with a sensitive receptor; 70 elsewhere.	Offers the option of using the municipality's existing noise rules.

Source: Draft and model texts and news reports (Howell Township 2026; WILX 2026a; WHMI 2026; Lowell Charter Township 2026; The St. Ignace News 2026; Genoa Charter Township 2026; Dexter Township 2026; Solon Township 2026; Williamstown Township 2026; WILX 2026b; Cohoctah Township 2026; Ogden Township 2026; Michigan Townships Association 2026; Livingston County Planning Department 2026); status from the moratorium inventory (Bommarito Consulting 2026). All jurisdictions are in Michigan.
Note: dBZ is unweighted (flat) sound level. Lden is a 24-hour average with penalties for evening and night sound.

line should not be exceeded for more than 3 minutes in any hour." They also called for measurement after installation "by a qualified third party" (Michigan State University Extension 2007).

MSU Extension's 2020 sample wind zoning compared Michigan ordinances. As summarized there, limits ranged from 35 dBA (Schoolcraft County, for nonparticipating land) through 45 dBA (Huron and Mason Counties) to 55 dBA (Gratiot County) (Michigan State University Extension 2020). Ellington Township (Tuscola County) used 40 dBA or 50 dBC, an early Michigan low-frequency limit, and Long Lake Township used 10 dB over ambient (background, in this report's terms) (Michigan State University Extension 2020). MSU advised that test methods be detailed enough that "if two acousticians are tasked with compliance testing at the same location at the same time, they would end up with similar results" (Michigan State University Extension 2020).

A 2024 University of Michigan comment to the MPSC quoted solar limits of 40 dBA in Shiawassee County and Aurelius Township, and 45 dBA at night in Adrian Township (University of Michigan Center for EmPowering Communities 2024). It also flagged a drafting gap: "many of these ordinances do not include explicit descriptors—Leq, Lmax—which are also consequential" (University of Michigan Center for EmPowering Communities 2024). Some of these ordinances may have changed since PA 233. A data center ordinance differs in one important way. Solar is quiet at night and wind varies, but a data center runs all night, so its night limit is the one that matters most.

7.6 The Citizens Research Council's view

The Citizens Research Council of Michigan's Report 426, released June 15, 2026, gives a neutral Michigan view of data center noise. The report reviews many claims made against data centers and judges several of them "often overstated." It finds that Michigan's water supply and power grid "appear capable" of handling substantial development under current policy (Citizens Research Council of Michigan 2026). Noise is the exception. "Protecting nearby residents from harmful impacts of data center noise is feasible but requires particular attention from local permitting agencies," it concludes (Citizens Research Council of Michigan 2026).

The report explains why existing local rules fall short. Ordinances written for "barking dogs and loud parties" made "a 55 dBA limit" seem "reasonable" (Citizens Research Council of Michigan 2026). Tonal penalties are "more protective" but miss low-frequency energy. A dBC-minus-dBA test "reduces risk of annoyance" but "discounts the potential for high-pressure infrasound" (Citizens Research Council of Michigan 2026). Outdoor-only measurement misses low-frequency sound inside homes.

Its recommendation is direct: "Standing local noise ordinances are likely insufficient to protect against data center noise pollution and quality-of-life impacts. Local governments should require a full-spectrum sound study during the design phase" (Citizens Research Council of Michigan 2026). It adds that site approval should depend on "the most stringent limitations justified by applicable standards and known state of the science," with operational monitoring near homes (Citizens Research Council of Michigan 2026).

The report is candid about the limits of the evidence. It says health links to long-term low-frequency sound and infrasound "remain inconclusive" (Citizens Research Council of Michigan 2026). It also notes that data center noise at homes is "far less than within an industrial setting" (Citizens Research

Council of Michigan 2026). Section 3 reviews that evidence. The report gives no numeric limit. Its value is that a skeptical, nonpartisan Michigan source names noise as the main local issue.

7.7 Lessons for a Michigan township

The Michigan statutes, cases, and adopted ordinances point to eight practical lessons. Section 9 turns them into tiered model language.

1. **State the weighting, metric, averaging period, and measurement location in the ordinance.** *Tuscola* shows that an unstated metric invites litigation, and *Capitol Properties* shows that an undefined location can leave neighbors unprotected (Tuscola Wind III v. Almer Charter Twp. (E.D. Mich. Mar. 2018); 283 Mich App 422 (2009)). Two adopted Michigan ordinances and the Saline consent judgment still say only "decibels" or "db." Write "dBA, one-hour Leq" or "dBA Lmax" on purpose.
2. **Add a low-frequency limit with a real number.** Wixom, Pittsfield Charter Township, and Clark Township set dBC limits, and Pittsfield adds a dBC-minus-dBA cap of 20 dB (City of Wixom 2026; Pittsfield Charter Township 2026; Clark Township 2026a). An octave-band clause without a number, as in the MTA sample, risks the vagueness problem of *Gasper* (Michigan Townships Association 2026; 314 Mich App 528 (2016)).
3. **Tie the limit to existing sound where the township is quiet.** Wixom's background-plus-1 dB rule, Henrietta's background-plus-5 rule, and Clark Township's cap at L90 plus 5 dBA protect rural areas that an absolute limit would not (City of Wixom 2026; Henrietta Township 2026; Clark Township 2026a). Each depends on a careful baseline survey before construction.
4. **Require independent studies before and after construction, at the applicant's expense.** MCL 125.3502 lets the ordinance require supporting materials, and the MPSC already requires pre- and post-construction sound studies for energy facilities (MCL 125.3502; MPSC Case U-21547, Oct. 10, 2024 order). Wixom adds peer review by an independent acoustic consultant (City of Wixom 2026). If the ordinance measures at a home's outer wall, as PA 233 does, models should add the MPSC's 6 dB wall correction; measurements should not.
5. **Set generator testing windows.** Almost every Michigan text limits testing to weekday daytime hours, and Pittsfield caps testing at 100 hours a year with public notice (Pittsfield Charter Township 2026; Saginaw Charter Township 2026). Wixom also applies its limits during outages (City of Wixom 2026).
6. **Include a numeric vibration limit.** Saginaw Charter Township uses 0.01 in/s PPV, Clark Township 0.035 in/s PPV, and Pittsfield 0.10 mm/s RMS under ANSI S2.71 (Saginaw Charter Township 2026; Clark Township 2026a; Pittsfield Charter Township 2026). A "no perceptible vibration" rule is better than none but harder to enforce.
7. **Coordinate zoning with the board's general noise ordinance, and leave room for the use.** The planning commission writes the zoning standards; the board alone can update the general ordinance, which reaches existing sources (MCL 125.3504; 213 Mich App 287 (1995)). Both should use the same metric and method. Because MCL 125.3207 bars zoning that totally excludes a needed use, findings for strict limits should show where a compliant data center could locate (MCL 125.3207).

8. **Confirm that PA 233 does not apply, and watch for state preemption.** PA 233 covers large solar, wind, and storage, not data centers, so its CREO limits do not cap a data center standard (MCL 460.1222; In re PA 233, Mich. Ct. App. No. 373259 (2026)). Bills such as HB 4085 show that the Legislature could someday cap local decibel limits at a township's general limits for industrial zones, so those general limits should be set deliberately (HB 4085 (2025)).

None of these lessons requires new state law. Each rests on statutes, published opinions, or adopted local texts that a township attorney can check.

SECTION 08

Local Codes and a Taxonomy

What local governments have actually adopted, how to sort it, and which drafting mistakes to avoid.

8 Local Codes and a Taxonomy

This section is for a planning commissioner, township board member, attorney, planner, or resident who wants to know what other places have already written into law. It shows what local governments in the United States have adopted for data center noise, how those rules differ, and where they fall short. It also gives a common vocabulary, a **taxonomy**, for comparing a rule in Georgia with one in Virginia, Iowa, or Michigan.

The section moves from history to the numbers in adopted rules, then to an eleven-part classification, common drafting errors, comparable codes for other sources, and the limits of the survey.

The measurement terms used here (dBA, dBC, Leq, L90, octave band, tonal sound) are defined in Section 2; the one fact to carry forward is that dBC counts the low-pitched hum that dBA discounts. Section 7 covers Michigan rules in depth, so this section uses them only as examples. A dagger (†) marks the few texts we could read only through a secondary copy (Section 8.6).

It has been done before

By November 2026, at least 30 local governments outside Michigan had adopted data center noise rules with numeric limits, testing schedules, or both. In Michigan, nine local governments had data center zoning with numeric sound limits: eight confirmed from adopted or final-reading text, one more reported. Separately, a court consent judgment in Saline Township set a limit for one project (Washtenaw County Circuit Court 2025). Some rules use dBC limits, tonal penalties, or limits tied to measured background sound. The underlying tools are older still: octave-band limits date to Chicago's 1955 performance-standard research and appear in Virginia zoning codes, including a 2024 Warrenton text† (American Society of Planning Officials 1955; Town of Warrenton 2024; Fauquier County 2015). What is new in 2025 and 2026 is the testing schedule, not the metric.

8.1 A short history of local noise limits

The metrics are about 70 years old; data-center-specific rules date to 2022.

The 1950s: performance standards. Industrial noise limits in zoning began as performance standards (Section 5.1): rules that limit what a use emits, such as noise, smoke, or vibration, instead of naming which uses are allowed. A September 1955 report of the American Society of Planning Officials describes Chicago paying the Armour Research Foundation to develop such standards for its industrial districts (American Society of Planning Officials 1955). The report notes that "only in the Chicago and Clarkstown ordinances is there a breakdown of intensity limits for different portions of the sound spectrum" (American Society of Planning Officials 1955). That breakdown is an **octave-band limit**: a separate cap for each slice of the frequency range, from low rumble to high hiss.

Octave-band zoning is still on the books. The Town of Warrenton, Virginia's zoning ordinance† sets octave-band limits at residential district boundaries. They run from 64 dB in the 63 Hz band down to

30 dB in the 8,000 Hz band, with 5 dB deductions for tones, impulsive sound, and night hours (Town of Warrenton 2024). Fauquier County, Virginia's performance standards† set similar limits starting at 66 dB in the 31.5 Hz band (Fauquier County 2015). Illinois state rules also use octave-band limits (Section 6).

Paired dBA and dBC limits are two decades old. Hilliard, Ohio has set paired limits in its general noise ordinance since 2003. For homes, the limits are 60 dBA and 70 dBC by day and 50 dBA and 60 dBC at night (City of Hilliard 2003). New York City's 2005 noise code added octave-band limits measured inside homes, including 70 dB at 31.5 Hz and 61 dB at 63 Hz (City of New York 2026).

2022 and 2023: the first data-center-specific rules found. Chandler, Arizona's city council tentatively approved Ordinance 5033 on December 5, 2022 and passed and adopted it on December 8 (City of Chandler 2022). It is the earliest data center noise rule in this survey. After a third-party baseline study, the data center may not exceed "the ambient noise levels that were observed in the baseline study" at the nearest residential property line (City of Chandler 2022). Generators may be tested only on weekdays from 9 a.m. to 5 p.m. In July 2023, Groton, Connecticut voted unanimously for data center regulations that apply the state's commercial-emitter noise limits (Baxtel 2023; Town of Groton Planning and Zoning Commission 2026).

dBC limits came before Prince William County. Prince William County, Virginia is often described as the first place to use dBC for data centers. It was not. King George County, Virginia added dBC limits to its general noise ordinance on December 19, 2023 (King George County 2023; King George County Board of Supervisors 2023). Its nighttime limit at residential land is 65 dBC for continuous sound. Prince William County followed in October 2025 (Prince William County Board of County Supervisors 2025b). It may be the first to aim a dBC limit at "steady tonal sound" in particular.

2025 and 2026: rapid spread. The pace picked up after 2024. Frederick County, Maryland adopted studies, biennial measurements, and a vibration rule in May 2025 (Frederick County Council 2025a; Frederick County Council 2025b). Three Virginia counties (York, Stafford, and Prince William) and Coweta County, Georgia adopted rules later in 2025. In 2026, rules spread to new states, many of them after a moratorium expired. Six Georgia governments adopted rules, and six more came from six Midwestern states. Pennsylvania, North Carolina, Alabama, and Arizona each added at least one. Michigan's adoptions are described in Section 7.5.

Three figures that do not match adopted text. Summaries of Virginia county rules have repeated three figures that the adopted texts do not support. Planners should drop them.

- **York County, Virginia does not set 75/65 dB.** Its rule is the greater of 55 dBA or the existing background sound measured between 11 p.m. and 5 a.m., at the boundary of the data center property (York County Board of Supervisors 2025).
- **Chesterfield County, Virginia has no data center noise number.** Its new zoning ordinance, effective January 1, 2026, lists data centers as a conditional use only. Noise is one factor weighed case by case (Chesterfield County 2026).

- **Prince William County's 73/68 dBC is narrow.** The limits of 73 dBC by day and 68 dBC at night apply only to "steady tonal sound" received at homes in residential districts (Prince William County Board of County Supervisors 2025b; Prince William County Public Works 2026). The A-weighted table was not changed for industrial land, which stays at 79 dBA by day and 72 dBA at night. The county's octave-band table is advisory.

Two other figures check out: Stafford County, Virginia's 55 dBA at the project boundary and Loudoun County, Virginia's 55 dBA at residential lot lines at all hours (Stafford County Board of Supervisors 2025; Loudoun County 2023b).

Some places are having second thoughts. On October 20, 2026, the Prince William County board voted to revive the stricter version its consultants had first proposed. The rule had been in force for about six months, with 19 complaints and no violations found (Prince William Times 2026; Patch 2026). Linn County, Iowa adopted an 18-month moratorium on new data center rezonings, effective July 1, 2026, to test whether its February rules are strong enough (Linn County, Iowa 2026). Loudoun County, Virginia takes up a second phase of standards in February 2027 (Loudoun Wildlife Conservancy 2026).

8.2 What adopted rules look like

The survey coded 79 provisions outside Michigan, covering about 59 local governments in 23 states, plus state rules and models used for comparison. About 45 of the provisions are adopted local rules that govern data centers. Exhibit 23 shows 20 representative provisions.

The numbers. A-weighted limits at or near homes fall in a narrow band.

- **Daytime: 50 to 65 dBA** in nearly all rules. Henry County, Virginia sets 50 dBA at all hours (Henry County Board of Supervisors 2026). White County, Indiana sets 50 dBA at a home's outer wall (White County Area Plan Commission 2026). Floyd County, Georgia and Augusta-Richmond County, Georgia sit at the top, at 65 dBA (Floyd County 2026; Augusta-Richmond County Planning and Development 2026).
- **Nighttime: 45 to 60 dBA.** Griffin and Oglethorpe County, Georgia set 45 dBA (City of Griffin 2026; Oglethorpe County 2026). Augusta-Richmond County sets 60 dBA (Augusta-Richmond County Planning and Development 2026).
- **Most common value: 55 dBA.** Loudoun and Stafford Counties, Virginia; Linn County, Iowa; and Lower Saucon Township, Pennsylvania all use it. York County, Virginia uses it as a floor (Loudoun County 2023b; Stafford County Board of Supervisors 2025; Linn County Board of Supervisors 2026; Lower Saucon Township Council 2026; York County Board of Supervisors 2025).

Michigan's adopted continuous limits are similar, with a lower floor. They range from 40 to 60 decibels, and several set 40 dBA at night (Section 7.5). One outlier deserves mention. Port Washington, Wisconsin sets "70 decibels" at the property line, with no weighting stated (City of Port Washington 2025).

C-weighted limits. Where a rule pairs dBA and dBC limits, both must be met. A reading that meets the dBA limit but not the dBC limit signals unusual low-frequency content. The gap between the two limits is not standard. It ranges from 5 to 25 dB, most often 10 or 15, as Exhibit 22 shows. Linn County, Iowa and Oglethorpe County, Georgia use 10 dB (Linn County Board of Supervisors 2026; Oglethorpe County 2026). Floyd County, Georgia uses 5 by day and 15 at night (Floyd County 2026). Pittsfield Charter Township and the City of Wixom, Michigan, and Doylestown Township, Pennsylvania use 15 dB (Pittsfield Charter Township 2026; City of Wixom 2026; Doylestown Township 2026b). Clark Township, Michigan sets one 65 dBC cap at all hours, 20 dB above its day limit and 25 above its night limit (Clark Township 2026a). Measured and modeled C-weighted levels near data centers run 8 to 15 dB above their A-weighted levels (Section 4.11). A 10 dB gap therefore makes the dBC limit more likely than a 15 dB gap to be the limit a facility fails first.

Exhibit 22. The gap between paired dBA and dBC limits in adopted rules

Jurisdiction and form	dBA / dBC limits at homes	Gap (dBC minus dBA)
Linn Co., Iowa (data center)	55 / 65, all hours.	10 dB.
Oglethorpe Co., Ga. (data center)	55 / 65 by day; 45 / 55 at night.	10 dB.
Floyd Co., Ga. (data center)	65 by day and 55 at night / 70 at all hours.	5 dB by day; 15 dB at night.
Pittsfield Charter Twp., Mich. (data center)	50 / 65 by day; 40 / 55 at night.	15 dB.
Wixom, Mich. (data center)	55 / 70 by day; 45 / 60 at night.	15 dB.
Clark Twp., Mich. (data center)	45 / 65 by day; 40 / 65 at night (or L90 plus 5 dBA if lower).	At least 20 dB by day; 25 dB at night.
Doylestown Twp., Pa. (data center)	55 / 70 by day; 45 / 60 at night.	15 dB.
King George Co., Va. (general ordinance)	65 / 75 by day; 60 / 65 at night.	10 dB by day; 5 dB at night.
Hilliard, Ohio (general ordinance)	60 / 70 by day; 50 / 60 at night.	10 dB.
St. Joseph Co., Ind. (general ordinance)	60 / 70 by day; 55 / 65 at night.	10 dB.
Tippecanoe Co., Ind. (wind)	50 / 65 near a home.	15 dB.

Source: Adopted texts (Linn County Board of Supervisors 2026; Oglethorpe County 2026; Floyd County 2026; Pittsfield Charter Township 2026; City of Wixom 2026; Clark Township 2026a; Doylestown Township 2026b; King George County 2023; City of Hilliard 2003; St. Joseph County 2026; Tippecanoe County 2011).

Note: All limits are in decibels at residential land; Clark Township measures dBA at the nearest home, farm, or conservation district or the lakeshore. Prince William County, Virginia is left out because its dBC limits apply only to steady tonal sound.

Low-frequency tools are a minority outside Michigan. Of about 45 adopted local data center provisions outside Michigan, roughly 9 to 12 include a dBC limit, a tonal penalty or ban, an octave-band table, or an infrasound cap. The range depends on whether the older Virginia octave-band standards are counted. Among the nine Michigan governments, five of the eight with confirmed texts use such a tool, Clark Township among them (Section 7.5). No adopted data-center-specific rule found anywhere uses a binding octave-band table.

The main tool is a use-specific zoning standard. Most 2025 and 2026 rules are written for data centers alone and attached to a special or conditional use permit or a dedicated district. Most rows of Exhibit 23 take this form. General noise ordinances still matter. Prince William County amended its general ordinance rather than zoning (Prince William County Board of County Supervisors 2025b). St. Joseph County, Indiana, home of a large Amazon campus, rewrote its industrial noise ordinance instead of writing a data center standard (St. Joseph County 2026).

Some places regulate by process alone. A group of local governments requires noise studies but sets no number. Fairfax County, Virginia requires pre- and post-construction studies showing compliance with its general noise ordinance (Fairfax County, Virginia 2024). Birmingham, Alabama; Williams County, North Dakota; Massillon, Ohio; and Independence, Missouri require studies without a limit of their own (City of Birmingham Department of Planning, Engineering and Permits 2026; Williams County 2026; City of Massillon 2026; CivicSearch 2026). This works only if the rule the study must satisfy is itself enforceable.

Testing schedules are the real innovation. The limits mostly borrow older numbers; the schedule for checking them is new.

- **After construction.** Augusta-Richmond County, Georgia tests within 60 days of full operation, and Stafford County, Virginia within 90 days of occupancy. Loudoun County, Virginia allows 1 to 12 months (Augusta-Richmond County Planning and Development 2026; Stafford County Board of Supervisors 2025; Loudoun County 2023b).
- **Periodically.** Stafford retests every summer for 10 years, and Henry County, Virginia every year for the life of the use. Others retest every 2 to 5 years (Stafford County Board of Supervisors 2025; Henry County Board of Supervisors 2026; Frederick County Council 2025a; Linn County Board of Supervisors 2026).
- **When something changes.** Augusta also retests after an expansion and after 10 complaints in 6 months. Oglethorpe County, Georgia retests on complaint or a material change (Augusta-Richmond County Planning and Development 2026; Oglethorpe County 2026). York County lets its zoning administrator order studies at the owner's cost (York County Board of Supervisors 2025).

Nearly every data-center-specific rule also limits when backup generators may be tested, and most exempt emergency operation from the sound limits (Section 8.3.7).

Additional adopted rules. Additional rules adopted through November 2026 include two added to Exhibit 23. Doylestown Township, Pennsylvania adopted 55 dBA by day and 45 at night for homes in October 2026, as one-hour Leq at the nearest property line, with 70 and 60 dBC. Every study must assume that all generators, cooling units, and other machines run at once (Doylestown Township 2026b; Doylestown Township 2026a). Dorrance Township, Pennsylvania caps the 24-hour average at 50 dBA, with maximums of 65 by day and 55 at night, and requires measurements in late fall or winter, "when the leaves are off the trees" (Dorrance Township 2025). Faulkner County, Arkansas limits cryptocurrency mines to 60 dBA by day and 55 at night at the receiving property line, and it requires a noise study after completion. A federal judge declined in October 2024 to block its enforcement (Faulkner County Quorum Court 2023; Arkansas Democrat-Gazette 2024). Arkansas law also limits how far such local rules may go (Section 6.4). Louisa County, Virginia allows 65 dB by day and 60 at night in its technology district (Louisa County 2023). News reports describe 65 and 55 decibels in Van Buren, Arkansas; 55 decibels at property lines in Lancaster Township, Pennsylvania; 67 and 57 dBA in Coffee County, Tennessee; and a 65-decibel cap in Colleton County, South Carolina (Talk Business & Politics 2026; Butler Eagle 2026; Tullahoma News 2026; Live 5 News 2026). Hermantown, Minnesota worked through a permit instead: the applicant committed to 47 dBA at night at the nearest homes,

below the state's 50 dBA night standard (City of Hermantown 2026).

8.3 A taxonomy of noise provisions

This subsection gives a way to sort any noise provision, so that two rules can be compared on more than their headline number. The scheme has eleven dimensions, shown in Exhibit 24. A reader short on time should check four of them first: the weighting (part of limit type), the time basis, the measurement location, and the testing schedule (part of process controls). Those four decide whether a number can be enforced. Most provisions take more than one value on some dimensions; a rule can set both a fixed dBA limit and a tonal penalty, for example.

The subsections below cover all eleven dimensions with two groupings: time of day is discussed under limit type, and receiving land under measurement location (with measurement location placed before time basis, and vibration before enforcement). For each category they give a plain definition and examples. Exhibit 25 then sets out the main strength, the main weakness, and the enforcement difficulty of each common form. "Enforcement difficulty" is our judgment of the staff time, equipment, and legal risk needed to prove a violation. It is not a measured quantity.

8.3.1 LEGAL FORM

Legal form decides who adopts the rule and how it is enforced. A zoning ordinance usually needs a planning commission hearing; a general ordinance does not. Section 7.2 explains who adopts what in Michigan.

General noise or nuisance ordinance. This is a rule in the general code that applies to everyone, usually enforced by police, sheriff, or code staff after a complaint. Prince William and King George Counties, Virginia; Hilliard, Ohio; and St. Joseph County, Indiana all use this form (Prince William County Board of County Supervisors 2025b; King George County 2023; City of Hilliard 2003; St. Joseph County 2026). It needs trained staff with meters. Prince William County budgeted for new staff and meters and delayed the effective date by six months for that reason (Prince William County Board of County Supervisors 2025a). General ordinances also tend to exempt the very sources at issue. Fauquier County, Virginia's noise ordinance exempts the principal business use on industrially zoned land (Fauquier County 2025).

District performance standard. This is a zoning rule for every use in a district, the 1950s form described above. Loudoun County, Virginia's 55 dBA residential standard is one, and so are the Warrenton and Fauquier octave-band tables (Loudoun County 2023b; Town of Warrenton 2024; Fauquier County 2015). New Albany, Ohio bars industrial sound louder than "the average intensity of street traffic noise in the nearest residential districts" (City of New Albany 2025). Older standards can be hollow, though. Fauquier's cites an instrument standard from 1961 (Fauquier County 2015). Jerome Township, Ohio's standard says only that "noise standards of the Ohio Environmental Protection Agency shall be adhered to," but Ohio EPA has no general community noise limit (Jerome Township 2024).

Exhibit 23. Representative adopted data center noise provisions, 2022–2026

Jurisdiction, year	Day / night limit and metric	Low-frequency or tonal tool	Where measured	Studies and testing
Chandler, Ariz., 2022	No increase over baseline background; no metric named.	None.	Nearest residential property line.	At occupancy, then yearly for 5 years.
King George Co., Va., 2023 (general ordinance)	65 / 60 dBA at homes, continuous sound of 10 minutes or more.	75 / 65 dBC.	Within the receiving property.	On complaint; Type 2 meter calibrated yearly.
Loudoun Co., Va., 2023	55 dBA at all hours; fast response, 15-second samples.	None.	Receiving lot line.	Study 1–12 months after first occupancy.
Frederick Co., Md., 2025	55 at homes at all hours; weighting not stated.	None.	Within an adjacent property line.	Within 6 months, then every 2 years.
York Co., Va., 2025 (a)	Greater of 55 dBA or measured night background.	None.	Data center property boundary.	As ordered by the zoning administrator, at owner cost.
Stafford Co., Va., 2025	55 dBA at all hours.	52 dBA if a prominent tone (ISO 1996-2 test).	Project boundary, 1.5 m high.	Within 90 days, then yearly for 10 years at peak cooling.
Prince William Co., Va., 2025 (general ordinance)	60 / 55 dBA Leq at homes.	73 / 68 dBC, steady tonal sound only.	Receiving residential property.	On complaint; Type 1 meter.
Coweta Co., Ga., 2025	Background plus 10 / plus 5 dBA, for sound lasting over 60 seconds.	None.	Line shared with residentially zoned land.	72-hour baseline; county-hired reviewer.
Dorrance Twp., Pa., 2025 (c)	50 dBA 24-hour average; maximum 65 / 55 dBA.	None.	Any property line; leaves off.	As-built study; monitoring if required.
Linn Co., Iowa, 2026	55 dBA hourly Leq at all hours.	65 dBC hourly Leq.	Wall of an occupied home on adjacent residential land.	At end of construction, then every 5 years.
Aurora, Ill., 2026	56 / 46 dBA (posted exhibit says 57 / 47).	None.	Facility property line.	Before occupancy; yearly published reports.
Augusta-Richmond Co., Ga., 2026 (b)	65 / 60 dBA Leq over 15 minutes.	5 dB tonal adjustment; one-third-octave data logged.	No closer than 100 ft from a home.	Within 60 days, every 3 years, after expansion, after 10 complaints.
Oglethorpe Co., Ga., 2026 (b)	55 / 45 dBA.	65 / 55 dBC; tonal nuisance barred.	Any property line.	Within 90 days of each phase; on complaint.
Floyd Co., Ga., 2026	65 / 55 dBA next to homes, over 30 minutes.	70 dBC over 30 minutes.	Property lines.	County inspection at intervals it sets.
Henry Co., Va., 2026	50 dBA at all hours.	Clearly audible pure tone barred.	Exterior property line.	Within 90 days, then yearly for life.
Morton Co., N.D., 2026	Background Leq plus 3 dB at a home.	Tones barred; infrasound cap 90 dBZ.	Receiving property boundary.	48-hour baseline before approval.
Lower Saucon Twp., Pa., 2026	55 / 50 dBA; 50 all weekend; 55 in outages.	None.	Property line of the use.	As-built study 6 months after occupancy.
Doylestown Twp., Pa., 2026 (c)	55 / 45 dBA one-hour Leq at homes, all equipment running.	70 / 60 dBC one-hour Leq.	Nearest property line.	As-built study within 180 days.
Wixom, Mich., 2026	55 / 45 dBA hourly Leq.	70 / 60 dBC; 10 dB tonal penalty.	Nearest receiving property line.	Studies before and after construction; peer review.
Pittsfield Charter Twp., Mich., 2026	50 / 40 dBA Leq next to homes.	65 / 55 dBC; dBC minus dBA at most 20 dB; 5 dB tonal penalty.	Property line.	Pre- and post-occupancy; yearly report; public dashboard.

Source: Adopted texts (City of Chandler 2022; King George County 2023; Loudoun County 2023b; Frederick County Council 2025a; York County Board of Supervisors 2025; Stafford County Board of Supervisors 2025; Prince William County Board of County Supervisors 2025b; Coweta County 2025; Dorrance Township 2025; Doylestown Township 2026b; Linn County Board of Supervisors 2026; City of Aurora 2026b; City of Aurora 2026d; Augusta-Richmond County Planning and Development 2026; Oglethorpe County 2026; Floyd County 2026; Henry County Board of Supervisors 2026; Morton County 2026; Lower Saucon Township Council 2026; City of Wixom 2026; Pittsfield Charter Township 2026). Exact quotations are in the report's data files (Appendix D).

Note: "Day / night" gives the daytime and nighttime limits. "Background" is the level measured before construction. (a) Adopted text read: York County, Virginia Ordinance No. 25-16(R), June 17, 2025. (b) Text read is the last posted final version, not a signed copy. (c) Scanned copy, read by text recognition.

Exhibit 24. Eleven dimensions for classifying noise and vibration provisions

Dimension and question	Categories	Example
Legal form: what instrument holds the rule?	General noise ordinance; district performance standard; use-specific zoning standard; permit condition or proffer; development agreement; state siting rule; model or guidance; exclusion of the use.	Stafford Co., Va. writes its limit into a data center zoning standard.
Scope: what does it cover?	All sources; a class of uses; one facility type; one sound character; one equipment type; one activity.	Prince William Co., Va. targets steady tonal sound.
Limit type: what test decides compliance?	No number; subjective or comparative; fixed dBA; dBC; octave band; relative to background; "greater of" hybrid; tonal or impulsive penalty; infrasound cap.	Linn Co., Iowa pairs 55 dBA with 65 dBC.
Time of day: do limits change by hour?	One limit at all hours; day and night; weekday and weekend; 24-hour weighted average; periods undefined.	Lower Saucon Twp., Pa. applies its night limit all weekend.
Time basis: over what span is sound computed?	Maximum level; short Leq; hourly Leq; long Leq; statistical level (L10, L50, L90); duration test; not stated.	Augusta-Richmond Co., Ga. uses a 15-minute Leq.
Receptor and location: where is it measured?	Source property line; receiving property; residential district boundary; outer wall of a home; fixed distance; inside a home; any building within a radius.	Linn Co., Iowa measures at a home's outer wall.
Receiving land: does the limit depend on it?	One limit for all; limits by receiving zone; by emitter and receiver class; by receptor sensitivity.	Morton Co., N.D. sets different margins for homes, churches, and vacant land.
Process controls: what studies and tests?	Baseline survey; predictive model; qualified preparer; independent review at applicant cost; post-construction test; periodic retest; continuous monitoring; complaint or expansion retest; none.	Stafford Co., Va. retests yearly for 10 years.
Generator rules: how are backup generators treated?	Testing hours; testing caps; staggered tests; testing or emergencies exempt; limits apply to generators; siting or enclosure.	York Co., Va. allows 1 hour of testing a week.
Enforcement: who enforces, and how?	Misdemeanor; civil fine; permit suspension or revocation; owner pays testing; instrument class named; standing limits; cure period; neighbor waiver; escrow.	Morton Co., N.D. suspends the permit automatically.
Vibration: is it regulated, and how?	None; perceptible-without-instruments test; numeric limit; studies or monitoring.	Loudoun Co., Va. sets peak particle velocity limits.

Source: Classification developed for this report from adopted texts (Stafford County Board of Supervisors 2025; Prince William County Board of County Supervisors 2025b; Linn County Board of Supervisors 2026; Lower Saucon Township Council 2026; Augusta-Richmond County Planning and Development 2026; Morton County 2026; York County Board of Supervisors 2025; Loudoun County 2023b). Coded examples are in the report's data files (Appendix D).

Use-specific zoning standard. This is a zoning rule written for one use, usually a condition of a special or conditional use permit or a standard in a dedicated district. It is the main form for data center rules adopted from 2024 to 2026, including Stafford County, Virginia's and Linn County, Iowa's (Stafford County Board of Supervisors 2025; Linn County Board of Supervisors 2026). It binds the applicant at approval, when the local government has the most bargaining power, but usually reaches only new or expanding facilities. Stafford County exempts projects already approved, and Augusta-Richmond County, Georgia exempts one named project (Stafford County Board of Supervisors 2025; Augusta-Richmond County Planning and Development 2026). A rule aimed at one industry also needs a record that explains why that use is different.

Permit condition or proffer. Here the limit is set case by case, in a special use permit, a conditional rezoning, or a **proffer** (Virginia's term for conditions an applicant offers in a rezoning). The City of Brevard, North Carolina allows data centers only by conditional zoning, so it can set conditions "on a case-by-case basis" (City of Brevard 2026). A King George County, Virginia data center proffer ties its limit to the industrial zoning standard and measures it "1.5 meters above ground at the property line per ANSI S1.13-2020" (King George County 2025).

Development agreement. A contract with the developer, often paired with tax incentives. It can carry remedies such as liquidated damages, but binds only the signer and its successors. Griffin, Georgia records its special use conditions in one (City of Griffin 2026).

State siting rule. A state statute or agency rule that sets sound limits for a class of facility. Several states, including Ohio, New York, and Indiana, have them for wind or solar. None found sets limits for data centers. Section 6.3 compares them.

Model or guidance. A non-binding model a local government may adopt. The New York State Energy Research and Development Authority (NYSERDA) battery storage model law leaves the limit in brackets, "[60] dBA," for each town to fill in (New York State Energy Research and Development Authority 2023). The Tri-County Regional Planning Commission model is the only Pennsylvania model found with paired dBA and dBC limits (Doylestown Township adopted paired limits of its own in October 2026) (Tri-County Regional Planning Commission 2026; Doylestown Township 2026b). Models spread errors as fast as good language (Section 8.4). The Michigan Townships Association sample is discussed in Section 7.5.

Exclusion. Some places bar the use or confine it so tightly that no noise number is needed. St. Charles, Missouri defined data centers without listing them in any district, so they "are therefore effectively prohibited" (City of St. Charles 2026). Henderson County, North Carolina bars operation from 9 p.m. to 6 a.m. and on Sundays, a condition no data center could meet (Henderson County Board of Commissioners 2026). Exclusion is a common response to noise concerns.

8.3.2 WHAT IS REGULATED

A rule may cover all sources, as in Boulder, Colorado, or a class of uses, such as St. Joseph County, Indiana's industrial property. It may cover one facility type, as in Linn County, Iowa, or one sound

character, type of equipment, or activity (City of Boulder 2007; St. Joseph County 2026; Linn County Board of Supervisors 2026).

Two narrow scopes deserve attention. Prince William County, Virginia does not name data centers in its dBC rule. It regulates a sound character, steady tonal sound, that data centers commonly produce (Prince William County Board of County Supervisors 2025b). That answers the charge of targeting one industry, at the cost of a judgment call: an officer must first decide that a sound is "steady" and "tonal." The county's guidance says only Type 1 meters that measure A-weighted, C-weighted, and one-third-octave levels may be used (Prince William County Public Works 2026). New York City takes the equipment route. Its 42 dBA indoor limit applies to "circulation devices" such as fans and air conditioners, and the city's environmental agency has applied it to battery storage (City of New York 2026; New York City Department of Environmental Protection 2025).

8.3.3 LIMIT TYPE

The limit type is the test that decides compliance. It is the core of the scheme, and a single rule can combine several types.

No number. The rule requires a study or names a goal but sets no limit of its own, as in the process-only rules described in Section 8.2. It works in Fairfax County, Virginia because the general ordinance it points to has a number (Fairfax County, Virginia 2024). Without one, there is nothing to verify. Massillon, Ohio has the applicant's own expert certify the expected "peak decibels," and a city staff member called the provision "very vague" on the record (City of Massillon 2026).

Subjective or comparative standard. A test based on human perception or a comparison, not a meter reading. Variants include "plainly audible," "unreasonable noise," and "no louder than street traffic." Chicago's current code bars amplified sound "louder than average conversational level at a distance of 100 feet or more" (City of Chicago 2025). Henry County, Virginia bars any "clearly audible pure tone" at residential property lines (Henry County Board of Supervisors 2026). Oglethorpe County, Georgia bars tonal or low-frequency noise "that creates a nuisance" (Oglethorpe County 2026). Such tests are the easiest to attack as vague (Section 5.6).

Fixed A-weighted limit. A set dBA level that may not be exceeded. It is the most common type. Loudoun County sets 55 dBA and Henry County 50. Griffin, Georgia sets 55 by day and 45 at night, and Social Circle, Georgia 60 and 50 (Loudoun County 2023b; Henry County Board of Supervisors 2026; City of Griffin 2026; City of Social Circle 2026). Because A-weighting discounts low-frequency hum, a facility can meet a dBA limit and still be heard indoors (Section 4.3).

C-weighted limit. A dBC limit, usually paired with a dBA limit so that both must be met (Exhibit 22). Critics in Prince William County argued that its 73/68 dBC was looser than the octave-band design its consultants proposed (Prince William Times 2025).

Octave-band limit. A table of limits, one for each frequency band. Warrenton and Fauquier County, Virginia use this form, as did Chicago's prior code, which set 72 dB in the 31.5 Hz band at residential

district boundaries (Town of Warrenton 2024; Fauquier County 2015; eNoise Control 2014). New York City applies octave-band limits inside homes, and meeting the A-weighted limits is no defense (City of New York 2026). Portland, Oregon uses its octave-band table when its noise officer finds A-weighting inadequate (City of Portland 2026). Tables copied from mid-century codes may be set too low to measure above background sound.

Limit relative to background. The limit is the background sound measured before construction plus a fixed margin. Ordinances usually call this "ambient," though Section 2.7 explains why "background" is the more precise term. Four adopted rules show the range of margins. Coweta County, Georgia allows 5 dBA over background at night and 10 by day, based on a 72-hour survey (Coweta County 2025). Morton County, North Dakota allows 3 dB over background at a home, 5 at a park or church, and 7 at vacant land (Morton County 2026). New York City allows 7 dBA over background at night and 10 by day (City of New York 2026). Chandler, Arizona allows no increase at all (City of Chandler 2022).

This type protects quiet rural places, where a fixed 55 dBA could allow a large change, and it matches research showing that annoyance tracks change as well as level (Section 3.5). Once a facility runs, though, background without it can be measured only during a shutdown, and very quiet sites can produce limits near 30 dBA that are hard to verify.

"Greater of" hybrid. The limit is the greater of a fixed number and a background-based number. York County, Virginia uses the greater of 55 dBA or measured night background (York County Board of Supervisors 2025). Ohio's siting board uses the greater of 40 dBA or background plus 5 (Ohio Power Siting Board 2024). The fixed floor avoids impossibly low limits at quiet sites. But a "greater of" test sets a floor, not a ceiling, so it permits more sound where the background is already loud.

Tonal and impulsive penalties or bans. A rule that lowers the limit, usually by 5 dB, for tonal or impulsive sound, or bars tones outright. Stafford County, Virginia cuts its limit from 55 to 52 dBA when a prominent tone is present (Stafford County Board of Supervisors 2025). Its test, from ISO 1996-2 Annex K, flags a one-third-octave band that stands above both neighbors. The margin is 15 dB in the low bands (25 to 125 Hz), 8 dB in the middle (160 to 400 Hz), and 5 dB above that (Arup 2026).

Other codes use a flat penalty. Fort Collins, Colorado† reduces its limits "by five (5) dB(A)" for a pure tone (CityRuleLookup 2026). Portland, Oregon and Connecticut apply 5 dBA penalties (City of Portland 2026; State of Connecticut 2025). Henry County, Virginia and Morton County, North Dakota bar tones outright (Henry County Board of Supervisors 2026; Morton County 2026). Section 2.5 explains the tests.

Infrasound cap. A limit on sound below about 20 Hz. Morton County, North Dakota caps infrasound at 90 dBZ (unweighted) at the property boundary (Morton County 2026). Connecticut caps infrasound and ultrasound at 100 dB (State of Connecticut 2025). Both sit far above levels usually measured near such facilities, so they are backstops, not working limits. Section 3.8 reviews the evidence on infrasound.

Time-of-day structure. Limits may be the same at all hours, split by day and night or by weekday and weekend, or folded into a 24-hour average such as CNEL (Section 2.6). Data centers run around the clock, so the night limit is the one that matters most. A single all-hours limit set at a night level, as in Loudoun, Stafford, Henry, and Linn Counties, is simple and fits a constant source (Loudoun County 2023b; Stafford County Board of Supervisors 2025; Henry County Board of Supervisors 2026; Linn County Board of Supervisors 2026). A 24-hour average is hard to enforce on a complaint. Franklin County, Pennsylvania uses 57 dBA CNEL, which a single night reading cannot test (Franklin County Board of Commissioners 2026). Where the split is used, "night" starts anywhere from 7 p.m. in Aurora, Illinois to 11 p.m. in Social Circle, Georgia (City of Aurora 2026b; City of Social Circle 2026).

Exhibit 25. Strengths, weaknesses, and enforcement difficulty of common forms

Form	Main strength	Main weakness	Enforcement difficulty
General noise ordinance	Reaches existing facilities.	Relies on complaints and trained staff; often exempts industry.	Medium to high.
District performance standard	Treats data centers like other industry.	Old texts may cite outdated standards.	Medium.
Use-specific zoning standard	Pairs the limit with studies, tests, and escrow.	Reaches only new or expanding facilities.	Low to medium with required testing.
Permit condition or proffer	Fits the site.	Varies by negotiation; terms are easily forgotten.	Medium.
No number	Avoids choosing a number.	Nothing to verify.	High.
Subjective or comparative	Needs no meter.	Open to vagueness challenges.	Low to apply, high to defend.
Fixed dBA	Simple and familiar.	Discounts low-frequency hum.	Low, if time basis and location are stated.
dBC	Captures hum with standard meters.	Picks up wind; does not name the problem frequency.	Low to medium.
Octave band	Most precise tool for tonal hum.	Needs precision meters, trained staff, and calm weather.	High.
Relative to background	Protects quiet rural places.	Baseline can be disputed.	Medium to high.
Tonal penalty or ban	Targets the sound most tied to complaints.	Needs one-third-octave data.	Medium with a defined test, high without.
Generator test hours and caps	Logs show compliance.	Does not limit loudness.	Low.
Sound limits during tests	Limits the loudest routine event.	Must be measured during a short test.	Medium.

Source: Our judgment, based on the adopted texts discussed in Sections 8.3.1, 8.3.3 and 8.3.7.

8.3.4 WHERE SOUND IS MEASURED

The measurement point can change the result as much as the number does. Adopted rules use at least seven points.

- **The source's property line.** Stafford, Henry, and York Counties, Virginia, and most Georgia rules (Stafford County Board of Supervisors 2025; Henry County Board of Supervisors 2026; York County Board of Supervisors 2025). This is the easiest point to reach and protects future homes on vacant land.
- **The receiving lot line or anywhere on the receiving land.** Loudoun and King George Counties, Virginia (Loudoun County 2023b; King George County 2023).
- **A residential district boundary.** Warrenton, Virginia and Chicago's prior code (Town of Warrenton

2024; eNoise Control 2014).

- **A home's outer wall.** Linn County, Iowa and White County, Indiana (Linn County Board of Supervisors 2026; White County Area Plan Commission 2026). This protects existing homes but not yards or vacant land, and it may require entry onto private property.
- **A fixed distance.** Augusta-Richmond County, Georgia measures no closer than 100 ft from a home. Henderson County, North Carolina measures within a 100-ft buffer from the facility's edge (Augusta-Richmond County Planning and Development 2026; Henderson County Board of Commissioners 2026).
- **Inside a home.** New York City measures its 42 dBA limit 3 ft from an open window (City of New York 2026). Indoor limits best match the sleep evidence but need the resident's cooperation.
- **Any building within a radius.** Ohio's siting rule reaches nonparticipating buildings within one mile (Ohio Power Siting Board 2024).

Receiving land. Many rules vary the limit by the land that receives the sound. Loudoun County varies limits by receiving zone, setting 55 dBA at residential land, 65 at commercial, and 70 at industrial (Loudoun County 2023b). Connecticut varies by both emitter and receiver class. Groton, Connecticut treats data centers as commercial rather than industrial emitters, which applies the stricter limits of 55 dBA by day and 45 at night at homes (Town of Groton Planning and Zoning Commission 2026; Connecticut Department of Energy and Environmental Protection 1978). Morton County varies by the sensitivity of the receptor (Morton County 2026). A rule that applies only at a line shared with residentially zoned land, such as Coweta County's, can leave homes on agricultural land unprotected (Coweta County 2025).

8.3.5 TIME BASIS

The time basis is the span over which a changing sound becomes one number (Section 2.6). Adopted rules use a maximum reading, as in Loudoun County's fast-response 15-second samples (Loudoun County 2023b). Some use a short Leq: 15 minutes in Augusta-Richmond County and St. Joseph County (Augusta-Richmond County Planning and Development 2026; St. Joseph County 2026). Others use an hourly Leq (Linn County) or a long average (New York's 8-hour siting limit) (Linn County Board of Supervisors 2026; New York Office of Renewable Energy Siting and Electric Transmission 2024). A few rules use a duration test. Floyd County, Georgia counts only sound lasting more than 30 consecutive minutes, and King George County defines continuous sound as 10 minutes or more (Floyd County 2026; King George County 2023).

Many adopted rules state no time basis at all. Henry County, Virginia; Griffin, Georgia; Stafford County, Virginia; and Port Washington, Wisconsin are examples (Henry County Board of Supervisors 2026; City of Griffin 2026; Stafford County Board of Supervisors 2025; City of Port Washington 2025). For a steady fan, a maximum reading, an Leq, and L90 come out close together. For a generator test they do not: an hourly Leq can hide a loud 20-minute run. A silent rule leaves the method to the first dispute.

8.3.6 PROCESS CONTROLS

Process controls decide whether a limit is ever checked, and adopted rules vary more on process than on the number. Each control below makes enforcement easier, because the operator produces compliance data on a schedule.

Baseline survey before application. A measurement of existing sound before anything is built. Coweta County, Georgia requires 72 hours of logging (Coweta County 2025). Morton County, North Dakota requires 48 hours, and Aurora, Illinois a week (Morton County 2026; City of Aurora 2026b). A baseline is essential for any limit tied to background sound and useful for any other. A short survey may miss seasonal changes, though, and the applicant usually chooses the time.

Predictive model. A computer prediction of sound at nearby homes, made before approval. Henry County, Virginia requires a model of the worst case, including peak cooling and generator testing, with contour maps (Henry County Board of Supervisors 2026). White County, Indiana requires the ISO 9613 method, and Frederick County, Maryland requires normal, testing, and emergency scenarios (White County Area Plan Commission 2026; Frederick County Council 2025a). Modeling catches design problems when they are cheapest to fix. Models can be wrong, which is why they need a check after construction (Section 4.13).

Qualified preparer. Fairfax County, Virginia requires a licensed acoustical engineer or one certified by the Institute of Noise Control Engineering (INCE). Linn County, Iowa and Morton County, North Dakota use similar terms (Fairfax County, Virginia 2024; Linn County Board of Supervisors 2026; Morton County 2026).

Independent review at the applicant's cost. A study paid for and directed by the applicant answers to the applicant. Oglethorpe County, Georgia has its own consultant review the study, with the applicant reimbursing the cost through escrow (Oglethorpe County 2026). Coweta County, Georgia has a county-hired firm set the scope and review the report, but does not say who pays (Coweta County 2025). Stafford County, Virginia has county staff or a county-chosen consultant do the tests, also without saying who pays (Stafford County Board of Supervisors 2025).

Tests after opening. A test after the facility opens catches modeling errors; Section 8.2 gives the windows and retest schedules. Two details are worth adding. Phoenix, Arizona withholds the final certificate of occupancy until the test is passed (City of Phoenix Planning and Development Department 2025). Stafford County's yearly tests in June through August capture the loudest normal condition, peak cooling, which matters because campuses build in phases and equipment wears (Stafford County Board of Supervisors 2025).

Continuous monitoring. Permanent meters that log sound or vibration at all times. Colorado requires continuous noise monitoring during oil and gas drilling near homes (Colorado Energy and Carbon Management Commission 2025). Aurora, Illinois requires continuous vibration monitors along property lines near homes, schools, and hospitals, and publishes yearly third-party reports (City of Aurora

2026b). Pittsfield Charter Township, Michigan requires a public dashboard (Pittsfield Charter Township 2026). Monitoring gives the best record but costs the most.

No process. Some rules, such as Social Circle, Georgia's, rely on a yearly city inspection and complaints (City of Social Circle 2026).

8.3.7 GENERATOR RULES

Backup generators are the loudest equipment on most data center sites (Section 4.4). Exempting true emergencies is common and defensible, since outages are rare. Exempting routine testing is harder to justify, because testing is scheduled and frequent. Adopted rules use six tools.

- **Testing hours.** Weekday daytime windows are standard, such as 8 a.m. to 5 p.m. next to homes in Loudoun County, Virginia and 10 to 4 in White County, Indiana (Loudoun County 2023a; White County Area Plan Commission 2026). York County, Virginia instead allows testing only from 5 to 8 p.m. on weekdays (York County Board of Supervisors 2025).
- **Caps on testing.** York County allows 1 hour a week (York County Board of Supervisors 2025). Griffin, Georgia allows 2 hours a day, Mayodan, North Carolina 2 hours a week per generator, and Oglethorpe County, Georgia 8 hours a month (City of Griffin 2026; Town of Mayodan 2026; Oglethorpe County 2026).
- **Staggered tests.** Aurora, Illinois allows no more than two generators at once; Morton County, North Dakota allows one (City of Aurora 2026a; Morton County 2026). Frederick County, Maryland allows one per building, for at most 60 minutes (Frederick County Council 2025a).
- **Exemptions.** Henry County, Virginia excludes generators from its noise limit during emergencies and testing (Henry County Board of Supervisors 2026). Social Circle, Georgia says testing "shall not, by itself, constitute a violation" (City of Social Circle 2026).
- **Limits that apply to generators.** Oglethorpe County applies its limits even in emergencies (Oglethorpe County 2026). Lower Saucon Township, Pennsylvania sets 55 dBA during power outages with all generators running (Lower Saucon Township Council 2026). Wixom, Michigan applies its limits to all generator noise, including outages (City of Wixom 2026).
- **Siting and enclosure.** Fairfax County requires generators and other ground equipment to be 300 ft from a residential district or shielded by the building. Aurora keeps generators 1,000 ft from homes, schools, and hospitals (Fairfax County, Virginia 2024; City of Aurora 2026b).

The most protective rules combine these tools: weekday business hours, a cap on hours, staggered units, and a limit that still applies during tests.

8.3.8 VIBRATION

Most data center rules surveyed have no vibration limit. Where one exists, it is usually inherited from an industrial performance standard and takes one of three forms.

Perceptible-without-instruments test. A ban on vibration a person can feel at the property line. Oglethorpe County, Georgia; Warrenton, Virginia; and Lower Saucon Township, Pennsylvania use one (Oglethorpe County 2026; Town of Warrenton 2024; Lower Saucon Township Council 2026). It is easy to state but rests on human judgment.

Numeric limit. A cap on peak particle velocity (PPV, defined in Section 2.9) or on displacement. Loudoun County, Virginia sets 0.003 in/s for continuous vibration at a residential boundary, halved at night (Loudoun County 2023b). Fauquier County sets 0.02 in/s in residential districts (Fauquier County 2015). Morton County, North Dakota uses a displacement table, and Aurora, Illinois a formula by frequency (Morton County 2026; City of Aurora 2026c). Saginaw Charter Township, Michigan sets 0.01 in/s at the property line (Saginaw Charter Township 2026). Frederick County, Maryland sets 2 in/s (Frederick County Council 2025a). That figure is far above what people feel. It works as a building-damage threshold, not a comfort limit.

Studies and monitoring. Lower Saucon Township requires vibration studies before and after construction within 1,000 ft of homes, and monitoring during construction and early operation (Lower Saucon Township Council 2026).

Operating data centers rarely produce ground vibration that neighbors feel. The "vibration" residents report is often low-frequency sound rattling windows and walls, which a dBC or octave-band limit addresses better than a PPV limit (Section 4.12). Construction, such as pile driving, is the more likely source of ground vibration.

8.3.9 ENFORCEMENT

Enforcement answers who measures, with what, and what happens on a violation. The trend is toward permit-based remedies.

Criminal and civil penalties. Prince William County, Virginia lowered its first-offense penalty from a Class 2 to a Class 4 misdemeanor in 2025 and allows a civil penalty of $250 or $500 instead (Prince William County Board of County Supervisors 2025b). King George County, Virginia fines $250 and then $500, and makes a third offense a Class 2 misdemeanor (King George County 2023). Floyd County, Georgia allows fines up to $1,000 a day (Floyd County 2026). In Michigan, Clark Township allows $500 to $5,000 a day, according to its published summary (Clark Township 2026b). Criminal cases need a higher burden of proof, and a small fine is small next to a large facility's revenue.

Permit remedies. Morton County, North Dakota suspends the permit automatically on noncompliance and revokes it if the problem is not fixed within 60 days (Morton County 2026). Henry County, Virginia gives 48 hours to fix a problem, after which the use may not begin (Henry County Board of Supervisors 2026). Oglethorpe County, Georgia can withhold permits, draw on the applicant's financial guarantee, or revoke the permit (Oglethorpe County 2026). Permit remedies carry more weight than fines.

Who pays and what meter. Augusta-Richmond County has the owner pay for all testing, and St. Joseph County, Indiana makes the owner reimburse testing costs when a violation is found (Augusta-Richmond

County Planning and Development 2026; St. Joseph County 2026). Few rules name the meter class (Section 2.7). Augusta requires a Type 1 meter with one-third-octave logging, and King George County a Type 2 meter calibrated every 12 months (Augusta-Richmond County Planning and Development 2026; King George County 2023). Naming the class heads off a common defense, that the county's meter was not good enough.

Escrow and bonds. Lower Saucon Township releases final escrow only after the as-built sound study (Lower Saucon Township Council 2026). Money held back is the simplest way to make sure a test happens.

Waivers and standing. Linn County, Iowa lets adjacent owners waive the limit by recorded agreement (Linn County Board of Supervisors 2026). Morton County allows a written waiver by the owner and occupant of a home (Morton County 2026). St. Joseph County limits complaints to adjacent owners or those within 500 ft (St. Joseph County 2026). A waiver shifts protection from a public standard to a private deal and may bind later buyers, so a drafter should decide on purpose whether to allow one.

Compare the method, not the number

Two rules that both say "55 dBA" can differ by 10 dB or more in practice. Stafford County, Virginia's 55 dBA applies at the project boundary, drops to 52 with a tone, and is tested every summer for 10 years (Stafford County Board of Supervisors 2025). Linn County, Iowa's 55 dBA is an hourly average at the wall of a home on adjacent residential land, and neighbors may waive it (Linn County Board of Supervisors 2026). Port Washington, Wisconsin's "70 decibels" states no weighting, time basis, or test (City of Port Washington 2025). Before comparing numbers, check four things: the weighting, the time basis, the measurement point, and the testing schedule.

8.4 Drafting errors to avoid

Exhibit 26 lists drafting errors found in adopted and model texts, with the fix for each. Each weakens a rule that otherwise looks sound, and several have spread through shared templates.

Three errors matter most for a first rule. The first is a missing weighting or time basis. A rule that says only "55 decibels" leaves the officer to choose dBA or dBC, and a maximum reading or an hourly average, choices that can move the reading by 10 dB or more. The second is a clause that names a tool but sets no number, such as the Michigan Townships Association sample's octave-band clause (Michigan Townships Association 2026). Such a clause may be read as vague (Section 5.6). The third is copied error. The nonexistent "ANSI S1.4-2104" appears in more than one Pennsylvania text (Lower Saucon Township Council 2026; Mifflin County 2026). A commission adapting another community's text should check each cited standard and number.

8.5 Comparators: energy facility and general-purpose codes

Data center drafters borrow from local codes for other energy facilities and from general noise ordinances. State siting rules are covered in Section 6.3.

Exhibit 26. Drafting errors found in adopted and model noise provisions

Error	Examples	Fix
No weighting stated	Port Washington, Wis. ("70 decibels"); Frederick Co., Md.; Monroe Co., Ga. operations clause ("65 decibels") (b); Henderson Co., N.C. ("50 decibels (cumulative)"); Saginaw Charter Twp. and the City of Saginaw, Mich.; Saline Twp., Mich. consent judgment.	Say dBA, dBC, or both.
No time basis	Henry Co., Va.; Griffin, Ga.; Stafford Co., Va.; Port Washington, Wis.	Name the descriptor (Leq, maximum level, L90) and the period.
Day and night undefined	Mayodan, N.C. (b) sets 60 dBA "during daytime hours" and 50 at night but never defines either.	State clock hours, including weekends and holidays.
Octave-band clause with no numbers	The Michigan Townships Association sample says octave bands "will be maintained at acceptable levels." Prince William Co., Va.'s octave table is advisory only.	Adopt a table of band limits or delete the clause.
Background undefined	Coweta Co., Ga. does not say whether L90 or Leq sets the baseline. Chandler, Ariz. names no metric. Phoenix, Ariz. allows "5%" over ambient, which has no clear meaning for decibels.	Define background as a stated statistic (for example, L90) from a survey of stated length, season, and conditions.
Measurement point misses homes	Coweta Co., Ga. applies only at a line shared with residentially zoned land. Henderson Co., N.C. measures within 100 ft of the facility's own edge.	Measure at the source property line and at nearby homes, on any zoning.
Missing or wrong instrument standard	Most rules name no meter class. A Pennsylvania template cites "ANSI S1.4-2104," a standard that does not exist, in Lower Saucon Twp. and Mifflin Co. (b) texts. Fauquier Co., Va.† cites a 1961 standard.	Cite IEC 61672-1 class 1 (ANSI/ASA S1.4) and require calibration.
Conflicting numbers	Aurora, Ill. voted 56/46 dBA, but the posted exhibit says 57/47. Mifflin Co., Pa.'s final text (b) reads "57 55 dBA." King George Co., Va. keys its day table to the source district and its night table to the receiving district.	Check the codified text against the vote, and use one table structure.
Deference to a rule that does not exist	Jerome Twp., Ohio defers to Ohio EPA, which has no community noise limit. Upper Burrell Twp., Pa.'s draft leaves infrasound to the "FCC," which does not regulate it.	Write the number into the ordinance.
Ambiguous tonal wording	Augusta-Richmond Co., Ga. (b) says the limit is "adjusted by (minus) five decibels." New Albany, Ohio bars "best frequency," apparently meaning beat frequency.	Say "the limit is reduced by 5 dB" and name the tone test.
Exemptions that swallow the rule	Fauquier Co., Va.'s noise ordinance exempts the principal business use on industrial land. Social Circle, Ga. says generator testing does not "by itself" violate the rule.	Exempt true emergencies only.

Source: Adopted, draft, and model texts (City of Port Washington 2025; Frederick County Council 2025a; Monroe County Board of Commissioners 2026; Henderson County Board of Commissioners 2026; Saginaw Charter Township 2026; City of Saginaw 2026; Washtenaw County Circuit Court 2025; Henry County Board of Supervisors 2026; City of Griffin 2026; Stafford County Board of Supervisors 2025; Town of Mayodan 2026; Michigan Townships Association 2026; Prince William County Board of County Supervisors 2025b; Coweta County 2025; City of Chandler 2022; City of Phoenix Planning and Development Department 2025; Lower Saucon Township Council 2026; Mifflin County 2026; Fauquier County 2015; City of Aurora 2026d; City of Aurora 2026b; King George County 2023; Jerome Township 2024; Upper Burrell Township 2026; Augusta-Richmond County Planning and Development 2026; City of New Albany 2025; Fauquier County 2025; City of Social Circle 2026).

Note: (b) Matching Exhibit 23, text read is the last posted final version, not a signed copy. Upper Burrell Township's text is a draft. † Text read through a secondary copy (Section 8.6).

Wind. Local wind ordinances are the oldest source of facility-specific sound limits. Tippecanoe County, Indiana's 2010 wind rule, amended in 2011, is the most complete local low-frequency design found (Tippecanoe County 2011). Within 25 ft of a nonparticipating home, it sets 50 dBA and 65 dBC as one-hour Leq values. It adds octave-band limits of 70 dB at 31 Hz and 60 dB at 63 Hz. It applies a 5 dB penalty to the measured sound level for a prominent tone and another 5 dB when dBC exceeds dBA by more than 20 dB (Tippecanoe County 2011). Lawrence County, South Dakota sets a simpler 50 dBA on adjacent property (Lawrence County 2014). Michigan wind and solar limits are summarized in Section 7.5.

Battery storage. Battery storage limits cluster at 60 dBA, from the NYSERDA model, looser than most data center night limits (New York State Energy Research and Development Authority 2023). Rensselaer, New York measures a one-hour average at the outside wall of a nonparticipating home, and Yolo County, California measures at the property line of the nearest offsite home (City of Rensselaer 2020; Yolo County 2022).

Oil and gas. Colorado's oil and gas rule is a state rule, but its design is a useful model. It sets 55 dBA by day and 50 at night in residential areas, plus 60 dBC in all zones, measured over at least one hour (Colorado Energy and Carbon Management Commission 2025). It requires a 72-hour A- and C-weighted baseline survey and continuous monitoring during drilling near homes. It cuts limits by 5 dB for "periodic, impulsive, or shrill noise" (Colorado Energy and Carbon Management Commission 2025).

Cryptocurrency mining. Mining facilities use the same kinds of fans and transformers as data centers. Some rules cover both. Henderson County, North Carolina's rule, first adopted in 2023 and amended in July 2026, covers both mining and data centers of 4,000 square feet or more (Henderson County Board of Commissioners 2026). Oglethorpe County, Georgia's ordinance also covers digital computing facilities, including mining (Oglethorpe County 2026).

General ordinances with low-frequency or tonal tools. Several general-purpose codes met earlier in this section already contain the tools data center drafters are debating. They include Hilliard, Ohio's paired dBA and dBC limits, Chicago's prior octave-band table, and Portland, Oregon's tonal penalty and octave-band table. New York City has gone furthest. Its 42 dBA indoor limit on fans and air conditioners now also covers battery storage. Where background is above 42 dBA, the limit is background plus 4 dBA (City of New York 2026; New York City Department of Environmental Protection 2025). The lesson is that a data center rule need not invent its metrics. Tonal penalties, dBC pairs, octave-band tables, and indoor limits have all been adopted for other sources.

8.6 Gaps and limits of this survey

This survey is a sample, not a census. Its counts and ranges describe what was read, subject to four limits. Appendix D describes the methods.

Blocked code hosts and secondary copies. Municode, American Legal, and several county servers blocked automated reading for most of the research period. Three texts were therefore read only

through a secondary copy or a search provider's stored copy, and this section marks each with a dagger (†). They are the Warrenton and Fauquier County, Virginia zoning texts and the Fort Collins, Colorado tonal rule. The Warrenton link has since stopped working, and no archived copy exists. A drafter who cites these three should first confirm the current text with the local government.

Unsigned versions. Several entries rest on the last posted final draft, not a signed copy. These are marked (b) in the tables. They include three Georgia counties (Augusta-Richmond, Oglethorpe, and Monroe). Mayodan, North Carolina and Birmingham, Alabama are in the same position. Adoption dates for those come from minutes or news reports.

Regions reached selectively or not at all. Targeted follow-up checks added several jurisdictions, including the rules described in Section 8.2. In Virginia, an applicant's study in Hanover County applies the county's general limits of 57 dBA by day and 52 at night at neighboring agricultural land. Spotsylvania County's June 2026 draft requires a study of a data center's "sound profile" at homes and schools within 500 feet. Its numbers come from proffers, the conditions an applicant offers at rezoning, such as 60 dBA day and night. Frederick County, Virginia repealed data centers as a use in September 2026, and the applicant in Warren County withdrew (Hanover County 2026; Spotsylvania County 2026; Spotsylvania County 2025; Frederick County 2026; Warren County 2026). Hood County, Texas has no noise rule, because "Texas counties lack authority to enforce noise limits" (Texas Tribune 2025b). We found no adopted data center noise rule in Oregon, Washington, Nevada, or Idaho. Phoenix's codified text, Tucson's general noise code, Culpeper County, Virginia's proffer numbers, Mount Pleasant, Wisconsin, and two Maryland counties were not reviewed.

Moving targets. Rules were changing during the survey, as the Prince William and Linn County stories above show. Prince William County's revival had no hearing date as of mid-November 2026 (Patch 2026). A data center developer sued Groton, Connecticut on the date its rules took effect; we did not check the outcome (Baxtel 2023). Dorrance Township, Pennsylvania faced a validity challenge to its 2025 amendment, whose limits Section 8.2 describes (FOX56 2026; Dorrance Township 2025). We found no court decision on any data center noise limit.

These limits cut both ways. More rules exist than this survey found, so the count of adopted rules is a floor. But the lack of enforcement history means these rules are proven in adoption, not yet in court or in long-term operation. The one Michigan citation we found, against an operating data center in Dowagiac in 2026, came under a general noise ordinance, and the operator challenged it (Section 7.5).

8.7 What this means for a drafter

The adopted record gives a planning commission three practical points beyond the fact that precedent exists. Section 9 turns them into model language.

1. **Write out the method.** Weighting, time basis, measurement point, background definition, and instrument class belong in the text, not in a consultant's later judgment.
2. **Put the testing on a schedule.** The strongest rules require a baseline, a model, a test after opening, periodic retests at peak cooling, and retests after expansion or complaints. They also have someone

independent of the applicant review the results, at the applicant's cost.

3. **Treat generator testing as routine operation.** Limit testing to weekday hours, cap it, stagger units, and decide on purpose whether sound limits apply during tests.

SECTION 09

Recommendations

Eight drafting principles, three tiers of limits, and honest answers to the usual objections.

9 Recommendations

This section turns the evidence in Sections 2 to 8 into advice a local government can act on. It is written for the planning commissioner, board member, attorney, planner, or resident who must choose numbers and procedures for a data center noise rule. It first sets out eight principles that any sound rule should follow. It then offers three tiers of limits, called Baseline, Recommended, and Most protective, and explains what each tier costs, how achievable it is, and what legal risk it carries.

The tiers are a menu, not a ranking of virtue. A township next to an interstate highway and a township of quiet farms face different facts. The right tier depends on the measured background sound, the distance to homes, and how much risk the community will accept. Appendix B turns the tiers into model ordinance text, with each number in brackets so a drafter can choose.

9.1 Eight principles

These principles come from the definitions, health evidence, engineering record, case law, and adopted codes reviewed in this report, and they gather the lessons that end Sections 5, 7 and 8. Each applies to every tier. They matter more than the choice of number, because two rules that both say "50 dBA" can differ by 10 dB or more in practice (Section 8).

1. State the metric, weighting, averaging period, and location. A limit must say what is measured (for example, the equivalent sound level, Leq) and with which frequency weighting (dBA or dBC). It must also say over what period (such as 15 minutes) and where (such as the property line, 5 feet above grade). Exhibit 4 shows that the same hour of sound can produce numbers 20 dB apart depending on the metric.

Leaving these points open invites litigation. In *Tuscola Wind III v. Almer Charter Township*, a Michigan township's "45 decibels on the DBA scale" named no averaging period, and the dispute over its meaning reached federal court. The township won, but only after costly litigation. The court held that the text unambiguously set a maximum level (Lmax, the highest level reached) and, in the alternative, deferred to the township's reading (Tuscola Wind III v. Almer Charter Twp. (E.D. Mich. 2017); Tuscola Wind III v. Almer Charter Twp. (E.D. Mich. Mar. 2018)). A stated metric would have left nothing to dispute (Section 7.4). In *Capitol Properties*, an undefined measurement location left a business-zoned neighbor unprotected (283 Mich App 422 (2009)). Two adopted Michigan ordinances and the Saline consent judgment still say only "decibels" (Section 7.5).

2. Protect the night. Sleep disturbance and annoyance carry the health case, and both are worse at night (Section 3.3). A data center runs all night. Rural backgrounds fall lowest on clear, calm nights, which are also the nights when temperature inversions carry sound farthest (Section 4.8). WHO's 1999 guidelines say night levels "should be 5–10 dB lower than during the day" (Berglund et al. 1999). Every tier below therefore sets a night limit 5 dB below its day limit. A single 24-hour metric, such as Ldn or CNEL, should not be used alone, because a loud night can hide inside a quiet average (Section 2.6).

3. Control low-frequency and tonal sound with numbers. A-weighting discounts the hum that fans, compressors, and transformers make (Section 2.3). The 2026 nuisance suits focus on exactly that sound, including the Mount Pleasant, Wisconsin suit described in Section 5.8 (*Ostergaard complaint* 2026). A complete rule adds a C-weighted (dBC) limit or octave-band limits, and a tonal penalty with a named test. The number must be in the text. The Michigan Townships Association sample's octave-band clause states no number, which gives an inspector nothing to measure (Section 7.5).

4. Tie limits to measured background where the place is quiet. A fixed limit of 55 dBA can let a facility raise a rural night by 20 dB or more (Section 4.8). Annoyance tracks how far a new source stands out above existing sound, and the same sound annoys more in a quiet place (U.S. Environmental Protection Agency 1974). The federal highway noise rule and New York's environmental review both pair an absolute limit with a limit on the increase (FHWA 2026b; New York State Department of Environmental Conservation 2001).

A limit tied to background works only if someone measures the background before construction, by a stated method. In every tier, "background" means the L90: the level the sound stays above 90 percent of the time, measured while the facility is not running, under ANSI/ASA S12.100. The L90 captures a place's quiet floor, not its passing cars. The Most protective tier goes one step further. It uses that standard's ANS-weighted L90, which leaves out the highest-pitched bands so that summer insects and rustling leaves do not make a quiet place look louder than it is (Acoustical Society of America 2014). Many ordinances call this quantity "ambient"; this report and the model ordinance call it background (Section 2.7).

5. Make the applicant pay for independent studies. Sound studies are expensive, technical, and prepared to win approval. The township needs its own expert to check them. Oglethorpe County, Georgia requires the applicant to fund county consultant review through an escrow account (Oglethorpe County 2026). The City of Wixom, Michigan requires peer review by an independent acoustic consultant (City of Wixom 2026). FERC requires compressor applicants to file "the input and raw output data and all assumptions made when running the model" (FERC 2026b). A reviewer cannot check a model without its inputs.

6. Test after construction, and keep testing. Every applicant study in Exhibit 12 is a prediction. The one measured retrofit series, at Tanner Way in Prince William County, Virginia, reached 48 to 55 dBA by residents' readings, short of the 45 dBA they sought (Section 4.11). *Crosstex* shows the cost of deciding before construction that mitigation is unnecessary: years of litigation that reached the Texas Supreme Court and ended in an order for a new trial (Section 5.2). A rule should require a compliance test after each phase opens, periodic retests at the loudest normal condition, and retests after complaints and expansions. Stafford County, Virginia tests annually for 10 years at summer peak cooling (Stafford County Board of Supervisors 2025).

7. Write an enforceable procedure. A limit is only as strong as the measurement behind it, as the failed Hood County, Texas prosecution showed (Section 5.7). The rule should name the instrument class (Class 1 under IEC 61672-1:2013), calibration before and after, the weather limits, the measurement

standard, and how to separate the facility from background sound (International Electrotechnical Commission 2013). Separation is the hard part, as the year of testing at Great Oak in Prince William County showed (Section 4.7). Short shutdown tests, measurements near the source scaled to the home, and band-level analysis at the tone frequency all help (David A. Nelson, Nelson Acoustics, for Prince William County DCOAG 2025a; Nelson Acoustics for Prince William County 2025).

8. Coordinate the zoning ordinance with the general noise ordinance. Zoning standards bind new data centers through site plan and special use review. A general police-power ordinance reaches every source, including existing ones (213 Mich App 287 (1995)). If the two use different metrics or limits, a facility can pass zoning review and violate the general ordinance on its first night, or the reverse. Use one metric, one measurement method, and one set of definitions in both. In Michigan, the two follow different adoption processes: the planning commission drafts zoning text for the township board to adopt, while the board alone adopts the general ordinance (Section 7.2).

The method matters more than the number

A rule that states its metric, weighting, averaging period, and location will do more for neighbors than a lower number without them. So will a rule that requires independent studies before and after construction and names its measurement procedure. Courts have upheld measured limits read against a stated or reasonable method (192 Mich App 273 (1991); Tuscola Wind III v. Almer Charter Twp. (E.D. Mich. Mar. 2018)). They have struck vague words used alone (*Trap Rock* 1982; *Jim Crockett* 1983; 314 Mich App 528 (2016)). Every tier below includes all eight principles. The tiers differ in how strict the numbers are and how much monitoring they require.

9.2 Three tiers

Exhibit 27 compares the three tiers element by element. The first row says, in one line, where each tier fits. Most values come from a health benchmark, a federal or state rule, or an adopted local code, and the text after the exhibit names those sources. The exhibit note lists the values that are our own judgment. Four figures in the text are our own arithmetic from cited values. They are the Baseline tier's day-night level, the vibration conversion in the Most protective tier, the band levels in the Most protective callout, and the cost of a 20-foot barrier.

All three tiers share a few definitions. Day runs from 7 a.m. to 10 p.m. and night from 10 p.m. to 7 a.m. The day-night level (Ldn) and Pittsfield Charter Township, Michigan use the same split (Federal Transit Administration 2018; Pittsfield Charter Township 2026). Limits apply to the sound the facility contributes, not to total sound. They apply at a **nonparticipating property**: any parcel the operator does not own or lease, unless its owner has signed a recorded agreement that expressly waives the sound limits. An easement or agreement for another purpose, such as a utility line, access, or drainage, does not count. All dBA and dBC limits are Leq values measured 5 feet (1.5 meters) above grade.

The tiers are built so that each is at least as protective as the one before it in every element. In the one place where a borrowed value would have broken that rule, the Recommended value is used instead (Section 9.2.3, octave-band table).

Exhibit 27. Three tiers of data center noise and vibration provisions

Element	Baseline	Recommended	Most protective
Where it fits	Loud settings, such as by a highway or in an industrial park.	Most places with homes within about a mile.	Quiet rural places with close homes; may rule out some sites.
Night limit (10 p.m.–7 a.m.)	50 dBA.	45 dBA.	40 dBA.
Day limit (7 a.m.–10 p.m.)	55 dBA.	50 dBA.	45 dBA.
C-weighted limit	70 dBC day, 65 night. A gap (dBC minus dBA) over 10 dB requires band analysis.	65 dBC day, 60 night. Gap no more than 20 dB.	60 dBC day, 55 night. Gap no more than 20 dB.
Octave-band limits	16–8,000 Hz reported in tests; no limit.	65 dB at 16, 31.5, and 63 Hz, at all hours.	Full table, 16–8,000 Hz, never above 65 dB (Exhibit 29).
Tonal penalty	5 dB, named test.	5 dB, named test, presumed in models unless disproven; a tone-free design avoids it.	10 dB, with the same test.
Background cap	None; background reported.	Night: lower of the limit or L90 + 10 dBA.	All hours: lower of the limit or ANS-weighted L90 + 5 dBA.
Floor	No cap or tonal penalty sets an effective limit below 35 dBA, in any tier.		
Measurement location	Nonparticipating parcels zoned or used for homes, inside or outside the township.	Any nonparticipating parcel, any zoning, inside or outside the township.	Also an indoor low-frequency test on complaint, with consent.
Averaging period	1-hour Leq.	15-minute Leq.	10-minute Leq.
Modeling margin	None.	Model meets each limit by 3 dB.	As Recommended.
Generator testing	Weekdays 8–6; meet day limits; 100 hours per generator a year (all tiers).	Weekdays 9–5; one per building; 60-minute tests plus one 2-hour annual load test; 24 hours' notice.	Weekdays 10–4; one on site; one 30-minute test a month plus one 2-hour annual load test (72 hours' notice). Outages: 55 dBA.
Vibration	None perceptible at the property line. Construction: 0.2 in/s PPV at homes.	0.01 in/s PPV. Construction: survey structures within 500 ft; monitor PPV.	Also 0.10 mm/s RMS; continuous monitoring through year one.
Background sound survey	7 days with a weekend at 2 or more locations; one-third-octave data.	At least 3 locations.	Two 7-day surveys, one in November–March.
Predictive model	ISO 9613-2:2024, full load, 63–8,000 Hz, dBA and dBC; tonal assessment.	Also 16 and 31.5 Hz method, four cases, input files.	Also hard-ground run and 30 dBA contour.
Independent review	Optional, at the applicant's cost.	Required; township picks, applicant funds escrow.	Reviewer also witnesses tests and audits data.
Post-construction test	Within 90 days of each phase.	Within 60 days; yearly for 5 years at summer peak.	Yearly for life, summer and winter night.
Continuous monitoring	None.	One or more stations for 2 years; monthly reports.	Permanent stations each direction; public data.
Complaint response	Answer in 2 business days; investigate in 14 days.	Answer in 24 hours; test in 7 days at operator cost; plan in 30 days.	24-hour line; test in 72 hours; plan in 30 days.
Penalties and security	Civil infraction, escalating fines; 30-day cure.	30-day cure, then suspension; guarantee for mitigation.	30-day cure; also curtailment orders; revocation 90 days after suspension.
Expansion	New model before adding outdoor equipment.	New model and test for each phase.	One budget for the site and adjacent parcels under common control.

Source: The sources for each value are named in Sections 9.2.1 to 9.2.3.

Note: All dBA and dBC limits are Leq values for the facility's contribution at 5 feet above grade. PPV is peak particle velocity; RMS is root mean square. To find background, take the L90 for each hour of the survey, then use the median (middle) value, separately for day hours and night hours (Appendix B, Section 4(c)). With the 3 dB modeling margin and the tonal penalty, a design must model below the limit shown; see the Achievability paragraphs. Our judgment, where no source sets the number: the 35 dBA floor; the 10-minute averaging period; the 2- and 3-location survey counts; the 2-year monitoring period; the complaint-response times; the cure periods; the 24- and 72-hour notice periods; the 500-foot survey radius; the winter test; and the hard-ground sensitivity run.

What to notice. Three rows separate the tiers most: the night limit, the low-frequency limits, and how much independent review and monitoring the township requires. The floor row is shared. It keeps every effective limit at a level that can be measured reliably at a rural site (Section 9.2.3).

Why the dBC limits sit 15 dB above the dBA limits. In every tier the dBC limit is 15 dB above the dBA limit for the same period. Adopted pairs run 5 to 25 dB apart, most often 10 or 15 (Exhibit 22). Linn County, Iowa and Oglethorpe County, Georgia use 10. Pittsfield Charter Township and Wixom, Michigan use 15, and Clark Township, Michigan's single 65 dBC cap sits 20 to 25 dB above its dBA limits.

The engineering record explains the choice. C-weighted levels run 8 to 15 dB above A-weighted levels in the studies and resident data. A dBC limit set much below the dBA limit plus 15 would therefore be the limit an ordinary facility hits first (Section 4.11). At 15 dB, the dBC limit catches a facility with unusual low-frequency content without becoming the real limit for every facility. The 20 dB cap on the gap does the rest. It applies at every level, so a facility running well under its dBA limit still may not carry an outsized hum.

9.2.1 BASELINE

The Baseline tier is the floor a township should not go below. It suits a site with a loud existing background, such as land next to a highway or an industrial park, where the measured night L90 is already in the mid-40s or higher.

Where the numbers come from.

- **55 dBA by day.** This matches WHO's 1999 threshold for serious annoyance in outdoor living areas and EPA's 1974 outdoor level of 55 dB Ldn (Berglund et al. 1999; U.S. Environmental Protection Agency 1974).
- **50 dBA at night.** This is the night value in the general state rules of Washington, New Jersey, Colorado, and Minnesota (Section 6.2). Connecticut's night value, 51 dBA, is close.
- **5 dB tonal penalty.** This is the ANSI S12.9 Part 4 adjustment, which the Michigan Public Service Commission adopted for energy facilities over utility objection (Acoustical Society of America 2005; MPSC Case U-21547, Oct. 10, 2024 order).
- **70/65 dBC.** These sit between Wixom's 70 dBC day limit and Prince William County, Virginia's 73/68 dBC limits for steady tonal sound (City of Wixom 2026; Prince William County Board of County Supervisors 2025b).
- **10 dB screen.** A dBC minus dBA gap over 10 dB is WHO's and ANSI's trigger for a closer look at low frequencies (Berglund et al. 1999; Acoustical Society of America 2005). Most facilities will trip this screen, because C-weighted levels run 8 to 15 dB above A-weighted levels in the studies (Section 4.11). It requires analysis, not mitigation.
- **Procedures.** The 7-day survey follows Aurora, Illinois's week-long study (City of Aurora 2026b). The 100-hour generator cap is the federal cap on testing emergency engines (U.S. EPA (via Cornell LII) 2026). The 0.2 in/s construction limit is FTA's damage criterion for typical houses (Federal Transit Administration 2018).

Adopted precedent. Many adopted rules already meet or beat this tier (Exhibit 23). Lower Saucon Township, Pennsylvania uses 55 dBA by day and 50 dBA at night (Lower Saucon Township Council 2026). Linn County, Iowa pairs 55 dBA with 65 dBC as hourly averages (Linn County Board of Supervisors 2026). Stafford County and Henry County, Virginia require post-construction tests within 90 days (Stafford County Board of Supervisors 2025; Henry County Board of Supervisors 2026).

Achievability. Every applicant study in Exhibit 12 predicts 54 dBA or less at homes, and most predict 50 dBA or less. Most designs also stay under 65 dBC; Raylan, Kentucky, at up to 67 dBC, would need work at night (Section 4.11). A well-designed facility should meet this tier without unusual cost.

What it will not do. This tier will not prevent complaints. Virginia's legislative auditors found that resident complaints arose at 40 to 59 dB, "typically below the 55 or 60 decibel limit" that the large Northern Virginia counties allow (Joint Legislative Audit and Review Commission, Virginia 2024). A facility running at 55 dBA by day and 50 at night would produce an Ldn of about 57.6 dB (our calculation). That is above FERC's 55 dBA Ldn limit for gas compressor stations (FERC 2026b). In a quiet rural township, Baseline is a weak rule.

Legal risk. This tier carries the least legal risk. Its numbers sit at or above most state siting limits, so a claim that they are arbitrary or confiscatory would be hard to make (*Penn Central* 1978; *Euclid* 1926). The main risk is drafting: a Baseline rule that omits its metric or location invites the same disputes as a vague rule (Section 5.6).

9.2.2 RECOMMENDED

The Recommended tier is our default for a township with homes within about a mile of the site. It sets 50 dBA by day and 45 dBA at night, 65/60 dBC, a 20 dB cap on the dBC minus dBA gap, and 65 dB limits in the three lowest octave bands. It adds independent review, five years of annual testing, and two years of continuous monitoring.

Where the numbers come from.

- **45 dBA at night.** This equals WHO's 1999 value outside a bedroom. WHO set it so people can sleep with windows open, assuming a 15 dB reduction through the window, which keeps the bedroom near WHO's 30 dB indoor value (Berglund et al. 1999). WHO's value is an 8-hour night average, so a 15-minute limit at 45 is stricter than WHO's value at the same number. It also equals WHO's 2018 night value for road traffic noise, applied here by analogy, since WHO set no industrial value (World Health Organization Regional Office for Europe 2018).
- **50 dBA by day.** This is WHO's 1999 level for moderate annoyance (Berglund et al. 1999).
- **20 dB cap on the dBC minus dBA gap.** This comes from Hessler's peer-reviewed finding that a gap of 20 dB or more marked nearly every problem site he studied (Hessler 2004). Hessler proposed the cap for very quiet sites with A-weighted limits below about 40 dB, so applying it with a 45 dBA limit is our extension (Section 2.3). Pittsfield adopted the same cap (Pittsfield Charter Township 2026).
- **65 dB in the 16, 31.5, and 63 Hz bands.** This is the level below which ANSI S12.9 Part 4 says low-

frequency annoyance "is generally minimal" (Acoustical Society of America 2005). It is also New York's siting limit for wind facilities in the same bands (New York Office of Renewable Energy Siting and Electric Transmission 2024).

- **Background cap of L90 plus 10 dBA at night.** This tracks the Massachusetts DEP noise policy, a guideline rather than an enforceable standard (Section 6.2), and the voluntary standard the T5 consultant recommended in Chantilly, Virginia (Massachusetts Department of Environmental Protection 2026; WorkingBuildings / Cerami for T5 (posted by FFXnow) 2026).
- **3 dB modeling margin.** This is the accuracy of plus or minus 3 dB usually quoted for ISO 9613-2 (Piercy 1993).
- **Procedures.** The 15-minute Leq appears in Augusta-Richmond County, Georgia (Augusta-Richmond County Planning and Development 2026). Annual testing for five years is required in Chandler, Arizona and Saginaw Charter Township, Michigan (City of Chandler 2022; Saginaw Charter Township 2026). The 9 a.m. to 5 p.m. test window and the one-at-a-time rule follow CyrusOne's posted schedule in Aurora, Illinois (CyrusOne 2025). The 2-hour annual test matches Fairfax County, Virginia's daily testing allowance (Fairfax County 2015).

Adopted precedent. Pittsfield Charter Township, Michigan adopted 50 dBA by day and 40 dBA at night, 65/55 dBC, and the 20 dB gap cap in October 2026, stricter than this tier at night (Pittsfield Charter Township 2026). Wixom, Michigan adopted 55/45 dBA and 70/60 dBC with peer review, and Oglethorpe County, Georgia adopted 45 dBA and 55 dBC at night with escrow-funded review (City of Wixom 2026; Oglethorpe County 2026). New York, Wisconsin, and North Dakota use 45 dBA at homes in their siting rules (New York Office of Renewable Energy Siting and Electric Transmission 2024; Wisconsin Legislature 2026a; North Dakota Legislative Branch 2026). One element is looser than an adopted rule: this tier allows 100 generator test hours per generator each year, while Pittsfield allows 100 hours a year for the whole site (Pittsfield Charter Township 2026).

Achievability. The limit on paper is 45 dBA at night, but the design target is lower. The 3 dB modeling margin means a design must model at about 42 dBA at night. If the model shows a prominent tone, the 5 dB penalty applies as well, and the design must model at about 37 dBA. Section 4.11 shows that models reach about 45 dBA at homes with ordinary measures, and that 40 dBA is at the edge.

Few studies meet the 42 dBA target. Of the studies in Exhibit 12, only Coal City, Illinois (a maximum of 41 dBA at night) models at or below 42 (WorkingBuildings / Cerami for Aligned Data Centers (posted by Village of Coal City) 2026). Chantilly Premier, Virginia (40 to 42 dBA) does too, but its study reports daytime levels only (Ramboll for Kimley-Horn (posted by Fairfax County Sully District) 2023). T5 (45 dBA) and Smithfield, Pennsylvania (38 to 47 dBA) would not pass as modeled (WorkingBuildings / Cerami for T5 (posted by FFXnow) 2026; Ostergaard Acoustical Associates for Legend Properties (filed with Smithfield Township) 2026). The same margin puts the night dBC design target at 57 dBC, which T5 meets exactly and Raylan misses by 10 (ERM for Justified DataPower (Kentucky PSC filing) 2026).

So the Recommended tier is demanding for an air-cooled campus near homes. It will push designs toward more distance, tone control at the source, and fewer outdoor fans. The tier is built to reward

tone control. A design that removes prominent tones, shown by a one-third-octave tonal assessment in the model and confirmed in the compliance test, avoids the penalty and models against 42 dBA, not 37. Transformer and inverter sound is "typically tonal" in the Michigan Public Service Commission's view, so this is real design work, not a formality (Section 7.3).

A township that finds 42 dBA too hard for its sites can reduce the margin, since the model ordinance brackets it. The trade is that a smaller margin leaves more of the risk of a wrong model with the neighbors and the post-construction test.

Legal risk. The risk is modest. The numbers sit inside the range that six states use at homes at night, which answers a claim that they are arbitrary (Section 6.3). The 15-minute averaging period and the dBC limit are measurable with ordinary Class 1 meters. The main risk is a site where existing sound already exceeds the limit. At Minooka, Illinois, measured background at one property line was already 46 dBA, above a 44 dBA night limit (Shen Milsom & Wilke for Equinix (posted by Village of Minooka) 2025). The model ordinance handles this by limiting the facility's own contribution and stating how to separate it from background (Appendix B).

9.2.3 MOST PROTECTIVE

The Most protective tier is for quiet rural places where night background sound is in the low 30s and homes are close. It sets 45 dBA by day and 40 dBA at night, 60/55 dBC, a full octave-band table, a 10 dB tonal penalty, and a background cap of L90 plus 5 dBA. It adds permanent public monitoring and a sound budget for the whole campus.

Where the numbers come from.

- **40 dBA at night.** This is WHO's 2009 night guideline, the lowest outdoor level at which WHO saw adverse effects, and WHO's 2018 value for aircraft noise (World Health Organization Regional Office for Europe 2009; World Health Organization Regional Office for Europe 2018).
- **Background cap of L90 plus 5 dBA.** This is our proposal, and it works as a ceiling. Ohio and New Hampshire use the same 5 dBA increment the other way, as a floor: a facility may produce the greater of 40 dBA or background plus 5 (L50 in Ohio; L90 in New Hampshire) (Ohio Power Siting Board 2024; New Hampshire Site Evaluation Committee 2026). That design raises the limit where background is loud. Ours lowers it where background is quiet. As a ceiling, it follows Henrietta Township, Michigan (background plus 5 dBA) and Coweta County, Georgia (plus 5 dBA at night) (Henrietta Township 2026; Coweta County 2025). It is looser than Wixom (plus 1 dB) and Morton County, North Dakota (plus 3 dB) (City of Wixom 2026; Morton County 2026). EPA's 1974 analysis expected widespread complaints once an intruding noise exceeded the existing level by about 5 dB (U.S. Environmental Protection Agency 1974).
- **Octave-band table.** From 31.5 to 8,000 Hz, the table in Exhibit 29 uses the Illinois Pollution Control Board's limits for sound from commercial-class sources received on residential land (Illinois Joint Committee on Administrative Rules 2018). We chose the commercial column, not the industrial one, on the model of Groton, Connecticut, which classes data centers as commercial emitters (Town of Groton Planning and Zoning Commission 2026). We made one change. By day, Illinois allows 72

and 71 dB at 31.5 and 63 Hz, which is looser than the Recommended tier's 65. We cap both at 65 dB, the ANSI level below which low-frequency annoyance is generally minimal (Acoustical Society of America 2005). The daytime row then runs 65 dB from 16 to 125 Hz and falls steadily above that. At 16 Hz, which Illinois does not cover, the same 65 dB applies day and night. At night the Illinois values (63 and 61 dB at 31.5 and 63 Hz) are already below 65 and stand.

- **10 dB tonal penalty.** This is Wixom's (City of Wixom 2026).
- **0.10 mm/s RMS vibration.** This is Pittsfield's limit. It equals about 72 VdB, FTA's criterion for homes exposed to frequent events (our conversion) (Pittsfield Charter Township 2026; Federal Transit Administration 2018).
- **Generators.** The 10 a.m. to 4 p.m. window is Henrico County, Virginia's (Henrico County, Virginia Planning 2026). The 30-minute monthly test is CyrusOne's posted Aurora schedule (CyrusOne 2025). The 55 dBA outage limit is Lower Saucon Township's (Lower Saucon Township Council 2026).

> **For specialists: how the band limits fit together.** Why keep a band table when the tier already has a dBC limit? Because they catch different problems. A dBC reading counts almost all of the sound in the 31.5 and 63 Hz bands: C-weighting trims only about 3 dB and 1 dB there (International Electrotechnical Commission 2013). So at night the 55 dBC limit by itself holds the 63 Hz band to about 56 dB and the 31.5 Hz band to about 58 dB, lower than the table allows.
> The table adds protection in two places. At 16 Hz, C-weighting trims about 8.5 dB, so a deep rumble could pass the dBC limit but fail the 65 dB band cap. In the higher bands (125 Hz and up at night, 2,000 Hz and up by day), the table catches a single loud whine that the overall dBA reading would blend away. A township that drops the dBC limit should keep the table.

The 35 dBA floor and the tonal penalty. The 35 dBA floor is our judgment. Below about 35 dBA, wind on the microphone and the meter's own electronic noise make rural readings unreliable (Section 2.7). Without a floor, the penalties could push a limit below that level. A 10 dB tonal penalty on a 40 dBA limit would require 30 dBA, and on a 35 dBA background cap it would require 25. So the model ordinance lets no penalty or cap set an effective limit below 35 dBA, in any tier. In this tier, a facility with a prominent tone therefore faces 35 dBA at night, and with the 3 dB margin it must model at about 32. In practice, the design must have no prominent tone.

Adopted precedent. This tier is less common, but each element has been adopted somewhere.

- **Night and day limits.** Clark Township, Michigan adopted 45 dBA by day and 40 dBA at night, or ambient L90 plus 5 dBA if lower, with a 65 dBC cap (Clark Township 2026a). Pittsfield Charter Township and Berkley, Michigan set 40 dBA at night, and Pittsfield sets 55 dBC at night next to homes (Pittsfield Charter Township 2026; City of Berkley 2026).
- **Limits relative to background.** At least five are in force. Chandler, Arizona allows no increase (City of Chandler 2022). Wixom, Michigan allows plus 1 dB and Morton County, North Dakota plus 3 dB at a home (City of Wixom 2026; Morton County 2026). Henrietta Township, Michigan and Coweta County, Georgia allow plus 5 dBA (Henrietta Township 2026; Coweta County 2025).
- **Low-frequency limits.** Octave-band zoning limits have been upheld in Michigan since *City of*

Rochester v. Superior Plastics in 1991 (192 Mich App 273 (1991)). New York City sets octave-band limits inside homes (City of New York 2026).

- **Generators and monitoring.** Lower Saucon Township, Pennsylvania applies 55 dBA during power outages (Lower Saucon Township Council 2026). Berkley requires continuous vibration monitors, and Pittsfield requires a public dashboard (City of Berkley 2026; Pittsfield Charter Township 2026).

Achievability. This tier is at or beyond the edge of what the engineering record shows. With the 3 dB margin, a design must model at about 37 dBA at night, or about 32 with a tone. No applicant study we reviewed predicts even 40 dBA at every home at night (Section 4.11). A large air-cooled campus would probably need a setback on the order of a mile plus the full set of source treatments. Distance alone is not enough: Raylan, Kentucky, 3,200 to 5,700 feet from homes with remote siting as its main measure, still models 45 to 49 dBA (ERM for Justified DataPower (Kentucky PSC filing) 2026).

Battery storage practitioners describe night limits of "30–40 dBA at the nearest home" as common, so such levels are not unknown for energy equipment (Solar Power World (Kelly Pickerel) 2025). A township choosing this tier should expect some sites to be unbuildable for a large air-cooled campus, and should say so in its findings.

Legal risk. The risk is higher, for three reasons.

- **Exclusion.** A limit that no available design can meet anywhere in the township can look like an exclusion of the use. In Michigan, MCL 125.3207 bars zoning that has "the effect of totally prohibiting" a use where there is demonstrated need, unless no appropriate location exists in the township (MCL 125.3207). A township choosing this tier should show in its findings where a compliant data center could locate.
- **An as-applied challenge.** A challenge under *Nectow* becomes plausible if a limit bears no relation to conditions at a site, for example where measured background already exceeds 40 dBA (*Nectow* 1928).
- **Measurement.** Very low limits are hard to measure, which is why the 35 dBA floor exists.

The defense against all three is a record: measured background, a stated health basis, and findings that explain why this place needs this tier. With that record, the tier rests on the same police power that has supported noise rules since *Hadacheck* (*Hadacheck* 1915). Takings claims remain weak, because a noise limit rarely removes all economic use of land (*Lucas* 1992).

In our view, the Recommended tier suits a township with homes within about a mile

The Recommended tier's 45 dBA night limit matches WHO's value for sleep with a window open (Berglund et al. 1999). Three states use 45 dBA at night for wind or solar (New York Office of Renewable Energy Siting and Electric Transmission 2024; Wisconsin Legislature 2026a; North Dakota Legislative Branch 2026). With its 3 dB modeling margin, the tier asks a design to model at about 42 dBA, and at 37 if it leaves a prominent tone. Few modeled designs reach that (Section 9.2.2), so the tier is demanding, and a tone-free design is the main way to meet it.

The Most protective tier is defensible for quiet rural places, but it sits beyond what designs have shown.

A township choosing it should build a record of measured background and show where a compliant facility could go. Baseline is a floor, not a goal: complaints arise at levels it allows (Joint Legislative Audit and Review Commission, Virginia 2024).

9.3 Costs and trade-offs

Stricter rules cost money, land, and staff time. A township should weigh those costs openly. The public record contains few verified cost figures, so some of this discussion is qualitative.

Costs to the operator. Quiet equipment, silencers, barriers, and distance all cost something. Highway noise barriers cost about $48.76 per square foot from 2020 to 2022, which puts a 20-foot wall at about $975 per linear foot (Federal Highway Administration 2023). Low-sound cooling tower fans cost about 3% of cooling capacity, so the owner must buy more tower (Baltimore Aircoil Company (copy hosted by equipment reseller) 2026). Silencers add fan energy (Building Design + Construction (Alex Odom, Acentech) 2026). Larger setbacks take land. No operator has published a total noise mitigation cost for a facility (Section 4.10).

The cost of not deciding early. Retrofits cost more than design. Operators told Virginia's auditors that "reducing noise after a building is operational can be difficult and expensive" (Joint Legislative Audit and Review Commission, Virginia 2024). The Tanner Way retrofit took about 11 months and left low-frequency tones in place (Section 4.11). A $7 million sound wall at a turbine site in Southaven, Mississippi was reported to do "little to muffle the noise" (Scientific American (Austyn Gaffney) 2026). A clear limit, adopted before the design is fixed, lets the operator buy the right equipment once.

Costs to the township. Enforcement needs meters, training, and staff. Prince William County, Virginia delayed its new ordinance's effective date by six months to hire staff and buy meters (Section 8). The tiers shift most of this cost to the applicant: studies, review escrow, compliance tests, and monitoring. The township still needs an attorney, an inspector who can read a monitoring report, and a reviewer it trusts. Continuous monitor prices are quoted on request (Svantek 2026).

Trade-offs within the design. Some goals pull against each other. Rules that favor closed-loop or dry cooling to save water push designs toward dry coolers, which need more fan area (Henrico County, Virginia Planning 2026; U.S. Department of Energy, FEMP 2024). A night fan-speed limit saves energy and sound at once, because cooler night air lowers the load (Ramboll for Kimley-Horn (posted by Fairfax County Sully District) 2023). Low limits in the 31.5 and 63 Hz bands can produce "false positives" from traffic and other sources, as Prince William County's consultant warned (David A. Nelson, Nelson Acoustics, for Prince William County DCOAG 2025a). A township should pair low-band limits with a procedure for separating the facility from those sources.

Waivers. Most state siting laws let a neighbor sign away the limit, and Linn County, Iowa allows a recorded waiver by adjacent owners (Wisconsin Legislature 2026a; Linn County Board of Supervisors 2026). A waiver lets a willing neighbor accept more sound, often for payment. It also shifts protection

from a public standard to a private deal that later buyers inherit (Section 8). The model ordinance treats a parcel as participating only if its owner signed a recorded agreement that expressly waives the sound limits. It leaves the choice to allow waivers at all to the township.

9.4 Objections and answers

A planning commission that proposes these provisions will hear objections. Some have real force. Each answer below concedes where the objection is right.

"This has never been done." The claim is not accurate. Michigan local governments have adopted data center zoning with numeric sound limits (Section 7.5). So have at least 30 local governments elsewhere, and the tools themselves are decades old (Section 8.1). The fair concession is narrower. These rules are proven in adoption, not yet in court (Section 7.7). Prince William County, Virginia's 2025 ordinance has only a short record, and its board has since voted to revive a stricter version (Section 8) (Prince William Times 2026).

"The limits are unachievable." For the Baseline tier, the record says otherwise. For the Recommended tier, the objection has partial force. Models reach about 45 dBA with ordinary measures, but the tier's margin asks for about 42, and a tone-free design; few studies meet that as modeled (Section 9.2.2). The Most protective tier is beyond what designs have shown, and none of this evidence has been checked after construction (Section 4.11). That is why the tiers exist, why the margin is a bracketed choice, and why the compliance test matters.

"dBC is unenforceable." Most Class 1 and Class 2 meters read dBC, and an inspector reads it the same way as dBA. Wixom, Pittsfield, Oglethorpe County, and Linn County have adopted dBC limits, among others (Exhibit 23). The objection is right that dBC readings pick up wind and distant traffic more than dBA readings do (Acoustical Society of America 2016; David A. Nelson, Nelson Acoustics, for Prince William County DCOAG 2025a). Measurements therefore need calm air, a stated wind limit, and a way to separate the facility from other sources. The model ordinance requires all three.

"The health evidence is weak." Part of this is true. Applying WHO's night values to a data center is reasoning by analogy (World Health Organization Regional Office for Europe 2018). The heart disease effect per person is small, and infrasound health claims lack support (Section 3.12). A township should not cite infrasound or heart disease as the basis for its limits. The case for protective night limits rests on sleep disturbance and annoyance, which show consistent exposure–response relationships (Basner and McGuire 2018; Guski et al. 2017). Michigan's Citizens Research Council found several common concerns about data centers overstated, yet concluded that "the most concerning negative impact of data centers is noise pollution" (Citizens Research Council of Michigan 2026).

"It will scare off investment." A strict rule can rule out some sites, and an operator may choose another township. Some states have moved to protect the industry; West Virginia has barred local noise ordinances for certified data centers since 2025 (West Virginia Legislature 2025). But a clear number gives an operator a design target before it buys equipment, when quiet design is cheapest

(Joint Legislative Audit and Review Commission, Virginia 2024; Building Design + Construction (Alex Odom, Acentech) 2026). A vague rule does not spare the operator from nuisance suits, because compliance "is generally not a complete defense" (WilmerHale 2026).

"Our existing noise ordinance and nuisance law are enough." The record says they are not. Complaints arise at levels that meet common 55 to 60 dBA limits (Joint Legislative Audit and Review Commission, Virginia 2024). Nuisance suits are slow and after the fact, and courts often award money rather than stop the noise (Section 5.2). Many old general ordinances use "disturbing" standards that courts have struck when used alone (314 Mich App 528 (2016); *Tanner* 2009).

9.5 For Michigan townships

Michigan townships hold every tool these tiers need, and Section 7.7 explains who adopts each part, why PA 233 does not reach data centers, and how to repair the Michigan Townships Association sample. MCL 125.3207 bars zoning that totally excludes a use where there is demonstrated need, so a Most protective township should map where a compliant facility could go (MCL 125.3207). MCL 125.3505 authorizes performance guarantees for "the estimated cost of improvements," so the attorney should confirm separate authority before requiring an escrow for acoustic review or testing (MCL 125.3505).

9.6 How to choose

A township can choose a tier in four steps. First, measure. A township-wide or site-area background survey at night tells the commission which tier the place needs; Genoa Charter Township, Michigan extended its moratorium to gather such data before setting final numbers (Section 7.5). Second, map the distances from likely sites to homes, and compare them with the achievability evidence in Section 4.11. Third, choose the tier, and record the reasons in the ordinance findings: the measured background, the health basis, and the adopted precedents. Fourth, adopt the procedures in full. A strict number without testing, monitoring, and enforcement is weaker than a moderate number with them.

Tiers can also be mixed. A township might adopt Recommended limits with Most protective monitoring, or Baseline limits in an industrial park and Recommended limits elsewhere. If a township mixes tiers, it should still pick one averaging period, one measurement location, and one set of definitions for every limit, so that one meter reading can answer every question. Appendix B gives text that does this.

SECTION 10

Conclusion

What the evidence settles, what it leaves open, and what to do next.

10 Conclusion

This report set out to test a claim that local governments often hear: that strict data center noise rules have never been done and cannot be met. This section sums up what the evidence settles, says plainly what it leaves open, and lists the steps a local government can take now.

10.1 What we learned

The evidence answers the two objections differently. Section 1.2 lists the findings in full; this subsection draws them together.

The first objection, that strict data center noise rules "have never been done," is not accurate. Numeric rules are in force in dozens of local governments, including nine in Michigan, and their tools have been in zoning codes for decades (Sections 7.5 and 8.1). Local governments hold the power to write them. A few states cap or bar local rules for some facilities, so each government should check its own state's law (Sections 5 and 6.5).

The second objection, that strict rules cannot be met, has partial force. Sound studies filed by applicants predict about 45 dBA at nearby homes for several designs. A 45 dBA limit with a 3 dB modeling margin needs a design that models at about 42 dBA, and only one study with night results reached that. A night limit of 40 dBA is harder still (Sections 4.11 and 9.2.2). That is why Section 9 offers three tiers rather than one number, and why a design free of prominent tones is the main route to the Recommended tier.

Three points matter most for drafting:

- **Night and quiet places drive the health case.** Sleep disturbance and annoyance are worse at night, for tonal and low-frequency sound, and in quiet places (Basner and McGuire 2018; Guski et al. 2017). A data center in a rural township runs all night, often makes a low-pitched tonal sound, and sits in a quiet place (Section 3).
- **A-weighted limits alone are not enough.** A complete rule adds a dBC or octave-band limit and a tonal penalty with a named test (Sections 2.3 and 4.7).
- **The method matters more than the number.** The most common drafting errors are a missing weighting, a missing time basis, and a clause that names a tool but sets no number (Section 8.4).

10.2 What remains uncertain

Several important questions remain open. A local government should state them in its record rather than leave them for an opponent to raise.

No proof after construction. Every achievability figure in Exhibit 12 is a prediction. We found no published post-construction measurement in the United States confirming that a large data center met

a 40 dBA night limit or matched any of the modeled results. The closest case is abroad: a 2025 report for a Microsoft data center near Sydney, Australia, calculated about 30 and 32 dBA at two receiver locations from measurements near the equipment (Section 4.11). The one measured retrofit series, at Tanner Way in Prince William County, Virginia, reached 48 to 55 dBA by residents' readings, short of the 45 dBA they sought. The operator's own best-case estimate was 49.9 dBA (Section 4.11).

No industrial health value. WHO's 2018 guidelines do not cover industrial noise (World Health Organization Regional Office for Europe 2018). Applying WHO's night values to a data center is a reasonable analogy, but it is a policy choice, not a medical finding. We found no medical study of people living near a data center or cryptocurrency mine (Section 3).

Lawsuits unresolved. The nuisance suits filed against data centers and cryptocurrency mines in 2026 are allegations. None had a ruling on the merits in our sources (Section 5.8). We also found no court decision on any data center noise limit, and no enforcement history for any Michigan data center noise provision. The one Michigan citation of a data center we found, in Dowagiac, came under a general noise ordinance and was challenged (Sections 7.5 and 8.6).

Sample limits. The local survey is a sample. Several code hosts blocked automated reading, and coverage of the West was thin (Section 8.6). More rules exist than we found, so our counts are a floor. Some state findings rest on searches that could not cover every official source, and Appendix A gives a confidence rating for each state.

Moving targets. Rules are changing quickly. Prince William County voted to revive a stricter version of its 2025 rule, and Linn County, Iowa paused new rezonings to test whether its rules are strong enough (Section 8.1). State bills in 2027 may add local tools or take them away (Section 6.7).

Economic effects. We found no study measuring whether noise rules change where data centers locate, and no operator has published a total noise mitigation cost for a facility (Sections 9.3 and 9.4). Neither side of that debate can cite numbers.

These gaps narrow the case for the strictest limits. They do not undo the case for clear, measured, enforceable ones.

10.3 What a local government should do next

A local government that wants a data center noise rule can take six steps. Each draws on the sections named.

1. **Confirm the power and check for preemption.** Find the statute that grants zoning or police power to this type of local government, and check whether any state law caps or bars the rule (Sections 6.5 and 6.6). In Michigan, confirm that PA 233 does not reach the data center portion of a campus (Section 7.3).
2. **Measure the background at night.** A night survey of existing sound tells the commission which tier the place needs. Measure it by a stated method, before any site is chosen if possible (Section 9.6).

3. **Choose a tier and write down the reasons.** Compare the distances from likely sites to homes with the achievability evidence, and choose Baseline, Recommended, or Most protective. Record the measured background, the health basis, and the adopted precedents in the ordinance findings (Section 9.2).
4. **Write the method into the text.** State the metric, weighting, averaging period, measurement location, instrument class, and weather limits. Add a dBC or octave-band limit and a tonal penalty with a named test, and set generator testing windows (Section 9.1).
5. **Make the applicant pay for proof.** Require a background sound survey, a predictive model with its input files, and independent review funded by the applicant. Then require compliance tests after each phase opens, periodic retests, and monitoring (Section 9.1).
6. **Align the zoning and general noise ordinances.** Use one metric, one measurement method, and one set of definitions in both. In Michigan, the planning commission drafts zoning text and the township board adopts it; the board alone amends the general ordinance (Section 7.2).

Appendix B gives model text for each of these steps, with the tier values in brackets. A local attorney should review the draft ordinance before adoption, and a qualified acoustical consultant should review the technical standards.

10.4 Closing

A data center noise rule is not new ground. Local governments in many states have written numeric limits, and courts have long accepted measured noise limits with stated methods. The open questions are real: whether the strictest limits will hold up in operation, and how courts will treat them. They are reasons to write a careful rule, with measured background, stated methods, and testing after construction. They are not reasons to write none.

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A Fifty-State Reference

This appendix gives one row per state for a reader who needs the detail behind Section 6. Each row answers five questions. Does the state have a general noise law with numbers? Does a state siting law set a sound limit for energy facilities? Has the state enacted, or considered, a data center or cryptocurrency mining law that mentions noise? Does the state limit local noise rules or say how much power local governments hold? And how confident are we in the row?

How to read the table. The cells use two phrases for gaps. "None found" means our searches found nothing; it is not proof that no law exists. "Unverified" means we saw the item only in a title, a summary, or a secondary source, or did not read the part that matters. Bill entries give status as of the cited source, checked through November 24, 2026. Bills not marked as enacted did not become law by the dates checked, or their outcome is unknown. A local authority label such as "Dillon's rule" is given as fact only where we read the supporting text.

Confidence ratings. Each rating reflects the underlying state research record (Appendix D). **High** means we read the primary text of the main rules. **Medium** means we read the core rule, though some provisions rest on secondary copies or leave gaps. **Low** means the row rests on negative findings, secondary sources, or an official code that could not be searched in full. Mixed ratings ("medium-high," "low-medium") fall between. Eleven states rate high, ten medium-high, twelve medium, twelve low-medium, and five low.

Exhibit 28. Fifty-state reference: state noise law, siting limits, data center law, and local authority

State	General noise law	Siting sound limits	Data center law and bills	Local authority and preemption	Confidence
Alabama	None found.	None found.	None with noise terms found.	Right-to-farm law bars local nuisance findings against qualifying farms (Alabama Legislature 2026). Counties receive noise power by local act; Dillon's rule applies to counties only (Richardson et al. 2003; Encyclopedia of Alabama 2026).	Low

Continued on next page

Fifty-state reference, continued

State	General noise law	Siting sound limits	Data center law and bills	Local authority and preemption	Confidence
Alaska	None found; a 1990s survey reported an unenforced rule (unverified).	None found.	SB 250 (2026) on data centers has no noise terms (ALEA Institute 2026).	Sport shooting and private airport noise chapter exists (Alaska Legislature 2026); its preemptive scope is unverified.	Low
Arizona	None found.	Line siting committee must weigh "noise emission levels"; no number (Arizona Legislature 2026b).	No enacted law; 2026 bills pending or unknown.	State sets 64 dBA Leq(h) for outdoor shooting ranges and preempts local standards (Arizona Legislature 2026a). Charter cities act "subject to" state law (Arizona Legislature 2026c). Counties operate under Dillon's rule (National Association of Counties 2022).	Low-medium
Arkansas	None found.	None for wind or solar.	Act 851 (2023) and Acts 173 and 174 (2024) regulate cryptocurrency mining noise, require noise-reduction techniques, and set penalties up to $5,000 a day (Arkansas General Assembly 2023; Arkansas General Assembly 2024a; Arkansas General Assembly 2024b).	Local decibel limits on home mining barred beyond general limits; mining may not be treated differently from data centers (Arkansas General Assembly 2023).	Medium
California	Noise Control Act of 1973; no statewide number found (California Legislature 2025). General plans must include a noise element (California Legislature 2026c).	None found.	AB 1577 (Ch. 434, 2026) requires an average and maximum dBA estimate at the loudest property-line point for data centers of 10 MW or more (California Legislature 2026a).	Cities and counties hold police power "not in conflict with general laws" (California Legislature 2026b). No preemption found.	Medium-high

Continued on next page

Fifty-state reference, continued

State	General noise law	Siting sound limits	Data center law and bills	Local authority and preemption	Confidence
Colorado	C.R.S. 25-12-103: residential 55/50 dBA, 25 feet or more from the property line; prima facie nuisance (Colorado General Assembly 2024).	None for wind or solar.	SB26-102 (introduced) addressed backup generator noise; no number (Colorado General Assembly 2026b).	Local standards must be no less restrictive; local transmission line limits capped at the state process (Colorado General Assembly 2024). SB26-098 (exemptions from the state noise statute) postponed (Colorado General Assembly 2026a).	High
Connecticut	ch. 442 and RCSA 22a-69: industrial to residential 61/51 dBA; tonal and infrasound limits (Connecticut General Assembly 2026; Connecticut Department of Energy and Environmental Protection 1978).	None found.	None with noise terms found.	Local ordinances must be at least as stringent as the state plan; state approval repealed in 2022; shooting range exemption (Connecticut General Assembly 2026).	Medium-high
Delaware	Noise Control Act (ch. 71) (Delaware General Assembly 2026) plus 7 Del. Admin. Code 1149 (stationary sources only): 65/55 dBA at residential land; 10 dBA over background is a disturbance; 5 dBA tonal penalty; 100 dB infrasound cap; vibration limit of 0.15 in/s in a Class A zone (Delaware Department of Natural Resources and Environmental Control 2026).	None found.	SB 312 and SB 353 (2026): no noise terms found; status unknown.	State environment department and police enforce (Delaware General Assembly 2026). Home rule chapter exists; scope unverified.	Medium
Florida	None found.	None found; Power Plant Siting Act unverified.	Ch. 2026-65 (SB 484) has no noise terms; HB 1007 laid on table; HB 1517 died (Florida Senate 2026).	Municipal home rule by statute (Florida Legislature 2026).	Medium

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Fifty-state reference, continued

State	General noise law	Siting sound limits	Data center law and bills	Local authority and preemption	Confidence
Georgia	None found.	None found.	HB 1059 (2026) moratorium bill cites cooling and generator noise; no data center law passed (Georgia General Assembly 2026a).	Right-to-farm and shooting range shields (Georgia General Assembly 2026b). County home rule under the constitution (State of Georgia 2026); Dillon's rule for cities, per a 2003 fifty-state review (Richardson et al. 2003).	Low-medium
Hawaii	HRS ch. 342F; rules must use dBC and dBA (Hawaii State Legislature 2026). HAR 11-46: residential 55/45 dBA (Hawaii Department of Health 2025).	None facility-specific.	Working group resolutions (2026); adoption unknown.	County preemption not checked.	Low-medium
Idaho	None found.	None found.	2026 data center bills have no noise terms.	State and local decibel rules do not apply to protected shooting ranges (Idaho Legislature 2026a). Local police power "not in conflict" with general law (Idaho Legislature 2026b). Dillon's rule state, per a 2003 fifty-state review (Richardson et al. 2003).	Low-medium
Illinois	Environmental Protection Act Title VI; 35 Ill. Adm. Code 901 octave-band limits, 31.5–8,000 Hz (Illinois Joint Committee on Administrative Rules 2018).	Counties may not set wind or solar sound limits stricter than state rules (Illinois General Assembly 2026a).	HB 5818 and SB 4206 (local data center noise), SB 3030 (mining), HB 4319; none enacted (Illinois General Assembly 2026b).	Home rule for large counties and cities (Illinois General Assembly 1970).	High

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Fifty-state reference, continued

State	General noise law	Siting sound limits	Data center law and bills	Local authority and preemption	Confidence
Indiana	None found.	50 dBA hourly average, modeled at the dwelling, for wind and solar; default in ready communities (Indiana General Assembly 2022a; Indiana General Assembly 2022b).	SB 79 and HB 1245 (2026): text unverified.	Statutory home rule (Indiana General Assembly 2026). Ready communities may relax state defaults.	Medium-high
Iowa	None found.	None enacted.	2026 data center bills have no noise terms.	SF 2447 would have capped local wind limits at 47 dBA; stalled (Iowa General Assembly 2026). Home rule label unverified.	Medium
Kansas	None found.	None found; wind rules are county zoning.	SB 526 and SB 400 (2026) have no noise terms.	Shooting range shield from state decibel rules and noise suits (Kansas Office of Revisor of Statutes 2026). City home rule in the constitution; county home rule by statute (Kansas Revisor of Statutes 2026).	Low-medium
Kentucky	None found.	Siting board weighs noise; applicant certifies compliance with local noise rules (Kentucky General Assembly 2026c; Kentucky General Assembly 2026b).	HB 937 (2026) would require noise modeling; enactment unknown (Kentucky General Assembly 2026a).	Broad statutory city powers (Kentucky General Assembly 2026d); county scope unverified.	Low-medium
Louisiana	None found.	Solar of 75 acres or more: 10 dBA over pre-operation background at the property line, for construction after January 1, 2026 (Louisiana Legislature 2025).	No data center noise law found.	Parishes with solar ordinances may opt out by resolution (Louisiana Legislature 2025).	Medium-high

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Fifty-state reference, continued

State	General noise law	Siting sound limits	Data center law and bills	Local authority and preemption	Confidence
Maine	Limits through the Site Law: 75 dBA at the property line; 60/50 dBA at protected locations; 55/45 in quiet areas (Maine Department of Environmental Protection 2026).	No separate limit; the Site Law rule applies to energy projects (counted in Section 6 as a general rule) (Maine Department of Environmental Protection 2026).	LD 307 (data center council) has no noise terms; the governor vetoed it, and the veto was sustained April 29, 2026 (Maine Legislature 2026b).	Local standard within 5 dBA of the state limits replaces the rule (Maine Department of Environmental Protection 2026). Statutory home rule (Maine Legislature 2026a).	Medium-high
Maryland	COMAR 26.02.03.02: residential 65/55 dBA; tonal penalty; perceptible vibration barred (Maryland Division of State Documents 2026).	None separate.	HB 1534 (45 dBA/55 dBC) and HB 1411 heard March 10, 2026; no passage (Maryland General Assembly 2026b; Maryland General Assembly 2026a).	Charter and code home rule counties; label unverified.	High
Massachusetts	310 CMR 7.10 bars "unnecessary" noise; 1990 policy uses 10 dBA over the L90 ambient (Massachusetts Department of Environmental Protection 2026).	No separate limit; the policy applies in energy siting (counted as a general rule). A 2026 proposal would presume 40 dBA acceptable (Massachusetts Department of Environmental Protection 2026).	No data center sound limit found.	Local boards of health may enforce (Massachusetts Department of Environmental Protection 2026).	Medium
Michigan	None found.	55 dBA average hourly, modeled at the nearest dwelling wall, for state-sited solar, wind, and storage (Michigan Legislature 2023d).	HB 6139 and HB 6391 (2026) would require acoustic studies; introduced (Michigan Legislature 2026a).	"Compatible" ordinances may be no more restrictive than state standards (Michigan Legislature 2023a). See Section 7.	Medium-high
Minnesota	Minn. R. 7030.0040: L50/L10 of 60/65 dBA day and 50/55 night for homes; applies to all sources (Minnesota Office of the Revisor of Statutes 2003).	Wind noise rule 7854.0500 repealed in 2024 (Minnesota Office of the Revisor of Statutes 2025).	HF 4888 and SF 4298 (2026) would add a moratorium and noise report; no passage found (Minnesota Legislature 2026).	Local authority not verified.	High

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Fifty-state reference, continued

State	General noise law	Siting sound limits	Data center law and bills	Local authority and preemption	Confidence
Mississippi	None found.	None enacted.	No data center noise bill found.	SB 2528 (40 dBA wind limit) died in committee (Mississippi Legislature 2026). Dillon's rule state, per a 2003 fifty-state review, with a municipal home rule statute (Richardson et al. 2003; Mississippi Legislature 2025).	Low-medium
Missouri	None found.	None found.	HB 3390 and SB 1750 (2026) introduced; no law passed (Missouri Senate 2026).	Firearm range immunity (Missouri Revisor of Statutes 2026a); right-to-farm (Missouri Revisor of Statutes 2026b). Charter city powers. Dillon's rule state, per a 2003 fifty-state review (Richardson et al. 2003).	Low-medium
Montana	None found.	None found.	No data center noise law found.	Local rules may not treat mining differently from data centers; home mining open to existing noise ordinances (Montana Legislature 2025b). Right to compute statute (Montana Legislature 2025a).	Medium
Nebraska	None found.	None enacted.	LB 1010 (2026) large-load law; no noise terms found (Nebraska Legislature 2026).	LB 503 would have capped county renewable limits at 50 dBA (Nebraska Legislature 2025). Dillon's rule state (Richardson et al. 2003; Nebraska Legislative Research Office 2020).	Low

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Fifty-state reference, continued

State	General noise law	Siting sound limits	Data center law and bills	Local authority and preemption	Confidence
Nevada	County power to regulate excessive noise as a nuisance; no state number (Nevada Legislature 2026a).	None found.	No data center noise law found.	Express county noise power (Nevada Legislature 2026a). Counties have statutory power over matters of local concern since 2015, though Dillon's rule "remains a vital component of Nevada law" (Nevada Legislature 2026b).	Low-medium
New Hampshire	None found.	Wind: greater of 45 dBA or L90+5 by day, 40 dBA or L90+5 at night; compressor stations Ldn 55 dBA (New Hampshire Site Evaluation Committee 2026).	SB 439 as introduced ("5 percent" over ambient; struck by Senate amendment) died on the House table (New Hampshire General Court 2026).	HB 639 (Ch. 286, 2026) was enacted without the House's cap on local decibel limits for home mining (New Hampshire General Court 2025).	Medium-high
New Jersey	N.J.A.C. 7:29: 65/50 dBA at residential line; octave bands from 31.5 Hz; active program (New Jersey Department of Environmental Protection 2000).	None separate.	A 5373, A 5420, S 4402 (2026) introduced (New Jersey Legislature 2026a; New Jersey Legislature 2026b).	Local ordinances must be more stringent and, in the 2000 text, state approved (New Jersey Department of Environmental Protection 2000).	High
New Mexico	No general limit; the Environmental Improvement Board's duties include "noise control," but we found no adopted rule (New Mexico Legislature 2025).	None found.	No data center noise law found.	Municipal home rule; Dillon's rule rejected under N.M. Const. art. X, § 6(D) (Richardson et al. 2003).	Low

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Fifty-state reference, continued

State	General noise law	Siting sound limits	Data center law and bills	Local authority and preemption	Confidence
New York	No binding statewide limit found; state agency noise policy is guidance.	Wind and solar: 45 dBA Leq (8-hour) at nonparticipating homes; 65 dB Leq (1-hour) at 16, 31.5, and 63 Hz for wind; 40 dBA Leq (1-hour) for collector substations (New York Office of Renewable Energy Siting and Electric Transmission 2024).	Data center bills found by title; no noise provision confirmed.	A 9087/S 8119 would cap local sound limits on distributed solar (New York State Assembly 2025).	Medium
North Carolina	None found.	Wind permits require a noise impact study; no number (North Carolina General Assembly 2026a).	S 730 sound-profile assessment passed House; no later action (North Carolina General Assembly 2026b; North Carolina General Assembly 2026c).	Local zoning under ch. 160D; no noise preemption found.	Medium-high
North Dakota	None found.	Wind: 45 dBA within 100 feet of a home is an avoidance criterion; waivable (North Dakota Legislative Branch 2026).	None found; bill coverage poor.	County zoning; label unverified.	Medium
Ohio	None found.	Wind and solar: greater of 40 dBA or background L50+5 at nonparticipating sensitive receptors within one mile of the project boundary (Ohio Power Siting Board 2024).	HB 646 would create a study commission.	State siting board certification for covered facilities.	Medium-high
Oklahoma	None found.	None enacted.	HB 2992 (2026) ratepayer law; no noise terms.	SB 1514 (35 dBA at a dwelling for wind) in committee (Oklahoma Legislature 2026). Dillon's rule state, per a 2003 fifty-state review (Richardson et al. 2003).	Medium

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Fifty-state reference, continued

State	General noise law	Siting sound limits	Data center law and bills	Local authority and preemption	Confidence
Oregon	OAR 340-035-0035 remains; state program ended in 1991 (Oregon Secretary of State 2026; Oregon Department of Environmental Quality 2026).	No separate limit; the state siting council applies the general rule to wind and, since 2024, solar (counted as a general rule) (Oregon Secretary of State 2026).	None found.	Cities and counties may adopt noise ordinances (Oregon Legislature 2026).	High
Pennsylvania	None found.	None found.	HB 2151 passed House; HB 2515, HB 2821 pending (Pennsylvania General Assembly 2026a; Pennsylvania General Assembly 2026b; Pennsylvania General Assembly 2026c).	Municipal zoning; no preemption enacted.	Medium
Rhode Island	Vehicle limits, plus a plainly audible rule for amplified sound under a state policy against "unreasonable, excessive and annoying noise levels from all sources" (Rhode Island General Assembly 2026a; Rhode Island General Assembly 2026b; Rhode Island General Assembly 2026c).	None found.	None found.	Local ordinances; Dillon's rule state (Richardson et al. 2003).	Medium
South Carolina	None found.	None found.	S. 867 and S. 902 (2026) pending (South Carolina General Assembly 2026b; South Carolina General Assembly 2026c).	S. 163, Act 208, signed May 19, 2026: in industrial zones, bars mining-specific local decibel limits (South Carolina General Assembly 2026a).	Medium

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Fifty-state reference, continued

State	General noise law	Siting sound limits	Data center law and bills	Local authority and preemption	Confidence
South Dakota	None found.	None found in sampled statutes (South Dakota Legislature 2026b).	SB 127 (45 dB) killed in Senate committee February 18, 2026 (South Dakota Legislature 2026a; South Dakota Public Broadcasting 2026).	Local conditional use permits central to state review (South Dakota Legislature 2026b). Dillon's rule state, per a 2003 fifty-state review (Richardson et al. 2003).	Low-medium
Tennessee	None found.	None found.	HB 946/SB 962 sound-profile assessment deferred to 2027 (Tennessee General Assembly 2026).	Dillon's rule for non-home-rule governments; home rule cities excepted (Richardson et al. 2003). Disorderly conduct covers "unreasonable noise" (Tennessee General Assembly 2025).	Low-medium
Texas	Disorderly conduct: noise over 85 dB presumed unreasonable after notice (Texas Legislature 2026b).	None found.	SB 338 prefiled for 2027 (Texas Legislature 2026a).	Shooting ranges excluded (Texas Legislature 2026b).	Medium-high
Utah	None found.	None found.	HB 76 (2026) on water enacted; no noise law found.	Dillon's rule rejected (*State v. Hutchinson*, 1980) (Richardson et al. 2003).	Low
Vermont	None found.	Wind over 150 kW: 42 dBA day, 39 dBA night, 100 feet from the residence (Vermont Public Utility Commission 2017).	H. 727 veto sustained May 29, 2026 (Vermont General Assembly 2026).	Label unverified.	High
Virginia	None found.	None found.	Va. Code 15.2-2209.5 (2026): sound-profile assessment within 500 feet for 100 MW facilities (Virginia General Assembly 2026b).	Shooting range shield (Virginia General Assembly 2026c); civil-penalty schedule excludes industrial-property business noise (Virginia General Assembly 2026d).	High

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Fifty-state reference, continued

State	General noise law	Siting sound limits	Data center law and bills	Local authority and preemption	Confidence
Washington	WAC 173-60: industrial to residential 60 dBA day, 50 dBA night (Washington Department of Ecology 2026).	No separate limit; the state siting council adopts the general rule by reference (counted as a general rule) (Washington Energy Facility Site Evaluation Council 2025).	No data center noise law found.	HB 1960 would treat strict energy sound limits as moratoria (Washington State Legislature 2025).	High
West Virginia	None found.	None found.	HB 2014 (approved April 30, 2025) exempts certified data centers from local noise rules; a 2026 amendment (HB 5168) is unverified (West Virginia Legislature 2025).	Overrides municipal home rule for covered projects (West Virginia Legislature 2025).	High
Wisconsin	None found.	Wind: 50 dBA day, 45 dBA night at the residence wall (Wisconsin Legislature 2026a).	No data center law found; moratorium bills died.	Local wind rules may be no stricter than state rules (Wisconsin Legislature 2026b).	High
Wyoming	None found.	Siting act covers large wind; no noise term (Wyoming Legislature 2026b).	None found.	Dillon's rule state (Richardson et al. 2003). Breach of the peace covers "unreasonably loud noise" (Wyoming Legislature 2026a).	Low-medium

Sources. Each row rests on a state research file that lists what we searched, what we read in primary text, what we corrected, and what remains unverified. Each source record gives a URL, an access date, and a short quote where possible. Appendix D describes the method.

B Model Ordinance

This appendix gives model text for a data center noise and vibration ordinance. It carries out the eight principles and three tiers in Section 9. A planning commission, board, or attorney can copy it, choose a tier for each bracketed number, and adapt it to local law.

How to use this text.

1. **Choose a tier for each bracket.** Brackets show the three tiers from Exhibit 27 as **[B: ... / R: ... / MP: ...]**, for Baseline, Recommended, and Most protective. Pick one value and delete the others. For example, a township choosing the Recommended tier turns "during nighttime, [B: 50 / R: 45 / MP: 40] dBA" into "during nighttime, 45 dBA." Tiers may be mixed, but every limit must use the same averaging period, location, and procedure.
2. **Fill the other blanks.** Items such as **[Township]**, **[Zoning Administrator]**, and dollar amounts depend on local law and practice.
3. **Fit it to the state enabling law.** Decide whether each part belongs in the zoning ordinance, the general police-power ordinance, or both. In Michigan, the planning commission drafts zoning text and the township board adopts it; the board alone adopts the general ordinance (Section 7.2). Check state preemption first (Section 6.5).
4. **Confirm standards and editions.** Standards are revised. Confirm the current edition of each named standard before adoption, and decide whether the ordinance names a fixed edition or "the current edition."
5. **Have the local attorney review it.** This text is a starting point for drafting. It is not legal advice and has not been reviewed for any particular jurisdiction.

The text uses "Township" throughout. Substitute "City," "Village," or "County" as needed. Drafting notes, set in italics, explain choices and are not part of the ordinance.

Section 1. Purpose and findings

(a) **Purpose.** This ordinance protects the public health, safety, and welfare of Township residents from noise and vibration produced by data centers and their accessory equipment. It sets measurable limits, requires studies before and after construction, and provides a procedure for enforcement.

(b) **Findings.** The **[Township Board]** finds that:

(1) Data centers operate cooling, electrical, and standby power equipment that runs day and night and can produce steady, tonal, and low-frequency sound audible at nearby homes.

(2) Sleep disturbance and annoyance from environmental noise are well documented, and both are greater at night, for tonal and low-frequency sound, and in quiet places.

(3) A-weighted sound limits alone do not adequately control low-frequency and tonal sound.

(4) The measured nighttime background sound in the Township is **[insert measured range and**

source].

(5) Design choices made before construction, such as siting, equipment selection, and enclosures, control noise more effectively and at lower cost than repairs after construction.

(6) Measured limits with a stated method give operators a clear design target and give the Township an enforceable standard.

(7) **[Most protective tier, Michigan:]** A data center that meets this ordinance can be located at **[describe the districts or areas where a compliant facility could locate]**.

Drafting note. Findings (1) through (3) and (5) rest on Sections 3 and 4. Finding (4) should cite the Township's own survey. Finding (7) answers MCL 125.3207, which bars zoning that has "the effect of totally prohibiting" a use where there is demonstrated need (MCL 125.3207). A tier choice is easier to defend when the findings explain it.

Section 2. Definitions

In this ordinance, the following words have these meanings.

(a) **A-weighted sound level (dBA)** means the sound level measured with the A frequency weighting defined in IEC 61672-1.

(b) **Accessory equipment** means any equipment on the site that serves the data center, including chillers, cooling towers, dry coolers, fans, air handlers, pumps, transformers, substations, battery storage, generators, load banks, and on-site power generation.

(c) **Background sound** means the A-weighted L90 of all sound at a place when the facility is not operating, measured under ANSI/ASA S12.100 and Section 8. For a data center in operation on the effective date, background sound is found under Section 4(c)(3). **[MP: Background sound is the ANS-weighted L90: the A-weighted level with the octave bands above 1,000 Hz removed, so that insects and rustling leaves do not count.]**

(d) **C-weighted sound level (dBC)** means the sound level measured with the C frequency weighting defined in IEC 61672-1. It counts low-frequency sound more fully than dBA.

(e) **Data center** means a facility whose primary use is to house computer servers and related equipment that store, process, or transmit data, together with its accessory equipment. The term includes cryptocurrency mining facilities. **[Optional threshold: The term applies only to facilities with a design electrical demand of [ ] megawatts or more.]**

(f) **Daytime** means 7 a.m. to 10 p.m. **Nighttime** means 10 p.m. to 7 a.m.

(g) **Emergency operation** has the meaning in Section 7(a).

(h) **Equivalent continuous sound level (Leq)** means the steady sound level that contains the same sound energy as the actual varying sound over a stated period. "Leq(15 min)" means an Leq over 15 minutes.

(i) **Facility sound** means the sound produced by the data center and its accessory equipment, separate from all other sound.

(j) **L10, L50, and L90** mean the levels exceeded 10, 50, and 90 percent of the time during a mea-

surement period. The L90 is the quiet level that the sound stays above for 90 percent of the period.

(k) **Load bank** means a device that places an artificial electrical load on a generator for testing, including its cooling fans.

(l) **Nonparticipating property** means any parcel except (1) a parcel owned or leased by the operator, or (2) a parcel covered by a waiver agreement. A waiver agreement is a written agreement between the owner and the operator, recorded with the **[register of deeds]**, that expressly waives the sound limits of this ordinance for that parcel. An easement or agreement for any other purpose, such as a utility line, access, or drainage, is not a waiver agreement. **[Optional: The Township does not recognize waiver agreements; delete clause (2) and the two sentences after it.]**

(m) **Octave band** means a band of frequencies whose upper limit is twice its lower limit, named by its center frequency (16, 31.5, 63, 125, 250, 500, 1,000, 2,000, 4,000, or 8,000 Hz). A **one-third-octave band** is one third of an octave band. An **octave-band level** is the unweighted Leq in an octave band, in decibels (dB).

(n) **Operator** means the owner, lessee, and any person who operates the data center, each of whom is responsible for compliance.

(o) **Peak particle velocity (PPV)** means the maximum instantaneous speed of a vibrating surface, in inches per second.

(p) **Phase** means a building, or a group of outdoor equipment, that the approved site plan shows being placed into operation at one time.

(q) **Prominent tone** means a tone identified under Section 5(c).

(r) **Qualified acoustical consultant** means a person who is board certified by the Institute of Noise Control Engineering, or a licensed professional engineer with at least **[five]** years of experience in environmental acoustics. The person may have no financial interest in the project other than the fee for the work.

(s) **Receptor point** means any point on or beyond the property line of a nonparticipating property, 5 feet (1.5 meters) above grade. A receptor point may be inside or outside the Township. **[B: Receptor points are limited to nonparticipating property zoned or used for residences.]**

(t) **Residual sound** means the sound at a place at the time of a measurement when the facility is not operating, or when the equipment being tested is shut down.

(u) **Reviewer** means the qualified acoustical consultant the Township retains under Section 10. If the Township does not retain a reviewer, references to the reviewer mean the Township.

(v) **RMS particle velocity** means the root-mean-square speed of a vibrating surface over a 1-second period, in millimeters per second. A value of 0.10 mm/s is about 0.004 inch per second.

(w) **Site** means the parcel or parcels on which the data center and its accessory equipment are located.

(x) **Sound level meter** means an instrument that meets the Class 1 requirements of IEC 61672-1:2013 (ANSI/ASA S1.4-2014 Part 1), with one-third-octave band capability.

(y) **Studies and tests.** The **background sound survey** is the survey required by Section 8. The **predictive study** is the study required by Section 9. A **compliance test** is a test under Section 11.

(z) **Vibration** means oscillating motion of the ground or a structure.

Drafting note. The night period matches the day-night level (Ldn) and Pittsfield Charter Township, Michigan (Federal Transit Administration 2018; Pittsfield Charter Township 2026). The receptor definition reaches any nonparticipating parcel whatever its zoning, which avoids the gap in Capitol Properties *(283 Mich App 422 (2009)). Wixom, Michigan measures "at or beyond the nearest receiving property line," including in neighboring communities (City of Wixom 2026). The definition of nonparticipating property turns on an express waiver of the sound limits, so a neighbor who grants an ordinary utility or access easement keeps full protection.*

Section 3. Applicability

(a) This ordinance applies to every new data center, to every expansion or modification under Section 15, and to every data center operating under an approval granted after the effective date.

(b) **[General ordinance version only:]** The following also apply to data centers in operation on the effective date: Sections 1 and 2; Section 4, except subsection (g); Section 5, except the predictive-study sentences of subsection (d); Section 6(a) and (b); Section 7; Section 9(f); Section 11, except subsection (e); Sections 13 and 14; Section 16, except subsection (e); Section 17; and **[R and MP: Sections 10 and 12]**. An existing data center shall complete a compliance test under Section 11 within **[180]** days of the effective date. Background sound for an existing data center is found under Section 4(c)(3).

(c) This ordinance applies in addition to the Township's general noise ordinance. Where they differ, the stricter provision applies.

(d) Construction activity is governed by Section 6(c) and by the Township's general construction noise rules.

(e) **[Michigan:]** This ordinance does not apply to an energy facility to the extent that 2023 PA 233 governs it.

Drafting note. In Michigan, zoning standards generally do not reach lawful existing uses, but a general ordinance can (MCL 125.3208; 213 Mich App 287 (1995)). Subsection (b) belongs only in the general ordinance version. An existing data center never had a background sound survey, so subsection (b) relies on shutdown tests instead.

Section 4. Sound limits

(a) **A-weighted limits.** Facility sound at any receptor point shall not exceed:

(1) during daytime, **[B: 55 / R: 50 / MP: 45]** dBA; and

(2) during nighttime, **[B: 50 / R: 45 / MP: 40]** dBA.

(b) **Averaging period.** Each sound limit in Sections 4, 5, and 7 is an Leq over **[B: 1 hour / R: 15 minutes / MP: 10 minutes]**. Each period begins on the hour or at a whole multiple of its length after the hour. For example, 15-minute periods begin at :00, :15, :30, and :45. Each period in which facility sound exceeds a limit is a separate exceedance.

(c) **Background cap. [B: Delete this subsection.]**

(1) **[R: During nighttime / MP: At all times]**, facility sound at a receptor point shall also not exceed the background sound at that point plus **[R: 10 / MP: 5]** dBA. Where this cap is lower than the limit in subsection (a), the cap applies.

(2) Background sound at a receptor point is the median of the hourly L90 values for the same period (daytime or nighttime) over the whole background sound survey. It is taken at the survey location nearest the receptor point in the same direction from the site, as stated in the survey report under Section 8(g).

(3) For a data center in operation on the effective date, background sound is the median L90 measured during 1-hour shutdown tests under Section 9(f)(6) on at least **[three]** different days or nights. Instead, the reviewer may approve a 7-day measurement under Section 8 at a comparable location away from the facility.

(d) **Floor.** No cap under subsection (c) shall be set below 35 dBA. Facility sound that carries a tonal penalty under Section 5(d) complies with this section if its level, before the penalty, does not exceed 35 dBA.

(e) **Low-frequency and tonal limits.** Facility sound shall also meet Section 5.

(f) **Facility sound, not total sound.** The limits apply to facility sound. Where other sound is present, facility sound is found under Section 9(f).

(g) **Modeling margin.** A facility shall not be approved unless the predictive study shows that facility sound will meet each limit by at least **[B: 0 / R: 3 / MP: 3]** dB at every receptor point.

Drafting note. The numbers and their sources are in Section 9.2. The 3 dB margin reflects the plus or minus 3 dB accuracy usually quoted for ISO 9613-2 (Piercy 1993). With that margin, a Recommended design must model at about 42 dBA at night, or 37 dBA if the tonal penalty applies (Section 9.2.2). A township may lower the margin, at the cost of leaving more of the risk of a wrong model with the neighbors. The 35 dBA floor in subsection (d) keeps every effective limit at a level that can be measured reliably at a rural site.

Section 5. Low-frequency and tonal provisions

(a) **C-weighted limits.** Facility sound at any receptor point shall not exceed **[B: 70 / R: 65 / MP: 60]** dBC during daytime or **[B: 65 / R: 60 / MP: 55]** dBC during nighttime. **[R and MP:]** The C-weighted level of facility sound shall not exceed its A-weighted level by more than 20 dB. **[B:]** If the C-weighted level exceeds the A-weighted level by more than 10 dB, the predictive study or compliance test shall identify the octave bands and sources responsible and the mitigation considered.

(b) **Octave bands.**

(1) Every compliance test shall report facility sound in each octave band from 16 to 8,000 Hz. Every predictive study shall report the octave bands it models under Section 9(b).

(2) **[R and MP:]** In addition, facility sound at any receptor point shall not exceed an octave-band level of 65 dB in any of the 16, 31.5, or 63 Hz octave bands.

(3) **[MP:]** In addition to paragraph (2), facility sound at any receptor point shall not exceed the

octave-band levels in Exhibit 29.

(c) **Prominent tones.** A prominent tone is present when the Leq in a one-third-octave band exceeds the Leq in both adjacent bands by at least a set margin. The margin is 15 dB for bands from 25 to 125 Hz, 8 dB from 160 to 400 Hz, and 5 dB from 500 to 10,000 Hz. The test follows ANSI/ASA S12.9 Part 4, Annex C, or ISO 1996-2, Annex K. **[R and MP: For tones from 50 Hz upward, the applicant may instead show under ISO/TS 20065 that the tone is not audible at the receptor point.]**

(d) **Tonal penalty.** When facility sound contains a prominent tone at a receptor point, **[B: 5 / R: 5 / MP: 10]** dB shall be added to its measured or modeled A-weighted level before it is compared with Section 4. The qualified acoustical consultant preparing the study or test shall make this adjustment. The floor in Section 4(d) applies. **[R and MP: That consultant shall apply the penalty in the predictive study unless the study's tonal assessment, based on one-third-octave source data, shows no prominent tone at any receptor point. Where the study does not apply the penalty, the initial compliance test shall include a tonal assessment at each receptor point.]**

(e) **Indoor low-frequency test. [MP:]** On a complaint about low-frequency sound, and with the occupant's written consent, the Township may require a one-third-octave measurement inside the complainant's home, with windows closed, under ANSI/ASA S12.9 Part 7. The results shall be reported to the Township and the occupant and used to design any corrective action.

Exhibit 29. Most protective tier: octave-band limits for facility sound at receptor points (unweighted Leq, dB)

Octave band center (Hz)	16	31.5	63	125	250	500	1,000	2,000	4,000	8,000
Daytime	65	65[a]	65[a]	65	57	51	45	39	34	32
Nighttime	65	63	61	55	47	40	35	30	25	25

Source: 31.5–8,000 Hz: Illinois Pollution Control Board limits for sound from Class B (commercial) sources received on Class A (residential) land, 35 Ill. Adm. Code 901.102 (Illinois Joint Committee on Administrative Rules 2018). 16 Hz, and the daytime cap at 31.5 and 63 Hz: ANSI S12.9 Part 4 level below which low-frequency annoyance is generally minimal (Acoustical Society of America 2005).

Note: (a) Illinois allows 72 dB at 31.5 Hz and 71 dB at 63 Hz by day. These are capped at 65 dB, the Recommended tier's band limit, so the Most protective tier is never looser than the Recommended tier. Illinois measures at any point within the receiving land at least 25 feet from the noise source; this table applies at receptor points. Illinois daytime is 7 a.m. to 10 p.m., the same as Section 2(f).

Drafting note. The tone test margins are the ANSI S12.9 Part 4 and ISO 1996-2 values that Stafford County, Virginia adopted (Acoustical Society of America 2005; Arup 2026; Stafford County Board of Supervisors 2025). ISO/TS 20065 is not validated below 50 Hz (International Organization for Standardization 2022). The 20 dB gap cap follows Hessler (2004) and Pittsfield (Pittsfield Charter Township 2026). A design that removes prominent tones avoids the penalty, which is the main route to the Recommended and Most protective tiers. Do not adopt an octave-band clause without numbers (Michigan Townships Association 2026; 314 Mich App 528 (2016)).

Section 6. Vibration

(a) **Operating limit.** Vibration from the facility, measured at or beyond the property line of any nonparticipating property **[R and MP: under ANSI/ASA S2.71 or ISO 2631-2]**, **[B: shall not be perceptible to a person without instruments / R: shall not exceed a peak particle velocity of 0.01 inch per second in any direction / MP: shall not exceed a peak particle velocity of 0.01 inch per**

second, nor an RMS particle velocity of 0.10 millimeter per second, in any direction].

(b) **Equipment isolation.** The operator shall mount generators, chillers, pumps, fans, and transformers on vibration isolators designed to meet subsection (a).

(c) **Construction.** During construction:

(1) vibration at any residential structure shall not exceed a peak particle velocity of 0.2 inch per second, or 0.12 inch per second at a structure that a condition survey identifies as fragile or historic;

(2) **[R and MP:]** before pile driving, blasting, or other high-vibration work, the operator shall offer a photographic condition survey to the owner of every structure within **[500]** feet. During that work, the operator shall monitor peak particle velocity at the nearest structures and stop work when a limit is reached;

(3) **[MP:]** the operator shall monitor vibration continuously at the property lines nearest homes during construction and the first year of operation; and

(4) high-vibration work shall occur only from **[8 a.m. to 6 p.m.]** on weekdays.

Drafting note. The 0.2 and 0.12 in/s construction values are FTA damage criteria (Federal Transit Administration 2018). People barely perceive continuous vibration at about 0.01 in/s PPV (California Department of Transportation 2020). Saginaw Charter Township uses 0.01 in/s PPV, and Pittsfield uses 0.10 mm/s RMS under ANSI S2.71 (Saginaw Charter Township 2026; Pittsfield Charter Township 2026). Operating vibration is rarely felt off site; the limits mainly guard against poor isolation (Ostergaard Acoustical Associates for Legend Properties (filed with Smithfield Township) 2026).

Section 7. Emergency and backup generators

(a) **Emergency operation** means operation of a generator during an interruption of utility power to the site, or during an emergency declared by the electric utility or regional grid operator. Operation for economic reasons, demand response, peak shaving, or routine power supply is not emergency operation.

(b) **Continuous on-site generation.** Any turbine, engine, or other generator that supplies power other than in emergency operation or testing is accessory equipment subject to Sections 4 through 6 at all times.

(c) **Testing.** Generator testing, maintenance runs, and load bank operation:

(1) shall occur only on weekdays, not on federal or state holidays, between **[B: 8 a.m. and 6 p.m. / R: 9 a.m. and 5 p.m. / MP: 10 a.m. and 4 p.m.]**;

(2) shall meet the daytime limits of Sections 4 and 5, including the sound of any load bank;

(3) **[R:]** shall run only one generator per building at a time, for no more than 60 minutes per test; **[MP:]** shall run only one generator on the site at a time, with no more than one routine test per generator per month, each of no more than 30 minutes;

(4) **[R and MP:]** may also include, for each generator, one annual full-load test of no more than **[2]** hours, which may use a load bank and is otherwise subject to this subsection;

(5) shall not exceed 100 hours per generator per calendar year **[Optional: and [100] hours per**

year for all generators on the site combined]; and

(6) **[R:]** shall be posted on a public website at least 24 hours in advance. **[MP:]** shall be posted on a public website at least 24 hours in advance for routine tests and at least 72 hours in advance for each annual full-load test.

(d) **Emergency operation limit. [B and R:]** Emergency operation is exempt from Sections 4 and 5. **[MP:]** During emergency operation, facility sound at any receptor point shall not exceed 55 dBA.

(e) **Records.** The operator shall log the date, start and end time, generator, load, and reason for every generator operation, and shall give the log to the Township **[monthly / on request]**. The operator shall report each emergency operation lasting more than one hour to the Township within 5 business days.

Drafting note. The 100-hour limit matches the federal cap on maintenance and testing of emergency engines (U.S. EPA (via Cornell LII) 2026). Pittsfield Charter Township, Michigan caps testing at 100 hours a year for the whole site, which the optional clause in (c)(5) adopts (Pittsfield Charter Township 2026). The 30-minute monthly test follows CyrusOne's posted schedule in Aurora, Illinois, and the 10 a.m. to 4 p.m. window follows Henrico County, Virginia (CyrusOne 2025; Henrico County, Virginia Planning 2026). The 2-hour annual test matches Fairfax County, Virginia's daily testing allowance (Fairfax County 2015). Lower Saucon Township, Pennsylvania applies 55 dBA during outages (Lower Saucon Township Council 2026). Load banks can be louder than the generator they serve (Ramboll for Kimley-Horn (posted by Fairfax County Sully District) 2023).

Section 8. Pre-application background sound survey

(a) **When.** Before applying, the applicant shall complete a background sound survey. The Township shall approve the survey plan, including locations and dates, before it begins.

(b) **Who.** A qualified acoustical consultant shall conduct the survey. **[R and MP: The reviewer may observe it.]**

(c) **Locations.** Measurements shall be made at **[B: two / R: three / MP: three]** or more locations representing the nearest nonparticipating properties in each direction with homes.

(d) **Duration.** Unattended monitoring shall run for at least 7 consecutive days, including every night and at least one weekend. **[MP: Two such surveys shall be made, in different seasons, one of them between November and March.]**

(e) **Data.** The survey shall store the A-weighted and C-weighted Leq for each 1-second period, and one-third-octave band Leq from 12.5 to 10,000 Hz for each 1-minute period. From the stored data, it shall report the Leq, L10, L50, and L90 in dBA and dBC for each 10-minute and each 1-hour period **[MP: and the ANS-weighted L90 for each hour]**. It shall log wind speed and direction at microphone height, temperature, and precipitation, and shall record audio samples sufficient to identify sources.

(f) **Methods.** The survey shall use sound level meters as defined in Section 2, calibrated before and after each deployment. It shall follow the applicable parts of ANSI/ASA S12.9, ANSI/ASA S12.18, and ANSI/ASA S12.100. Periods with wind above the limits of Section 9(f)(3), precipitation, or

unrelated events shall be excluded and listed.

(g) **Report.** The report shall give, for each location, the median of the hourly L90 values for daytime and for nighttime, which is the background sound used in Section 4(c). It shall also give the lowest hourly nighttime L90 and the spectrum. The Township shall make the report public.

Drafting note. Chandler, Arizona requires a third-party baseline study before an application, and Aurora, Illinois requires a week-long study (City of Chandler 2022; City of Aurora 2026b). ANSI/ASA S12.100 keeps insect and leaf sound from inflating a rural background (Acoustical Society of America 2014). Storing 1-second and 1-minute data lets the same record produce the 10-minute, 15-minute, and 1-hour values that each tier uses. The median of hourly values is less sensitive to one unusual night than an average or a minimum.

Section 9. Predictive acoustic study and measurement procedure

(a) **Study required.** The application shall include a predictive study prepared and sealed or signed by a qualified acoustical consultant. A data center shall not be approved unless the study shows compliance with Sections 4 through 7.

(b) **Model.** The study shall use ISO 9613-2:2024, or a method the reviewer finds equivalent, with:

(1) octave-band sound power data for each source from 63 to 8,000 Hz, and at 16 and 31.5 Hz where manufacturer data exist, taken from manufacturer test data for the specific models proposed;

(2) all equipment running at full load, with fans at the highest speed allowed by the operating plan;

(3) meteorological conditions favorable to sound propagation toward every receptor point;

(4) a stated ground factor and a stated treatment of buildings, barriers, terrain, and reflections; and

(5) **[R and MP:]** a stated method for the 16 and 31.5 Hz octave bands, which ISO 9613-2 does not cover, such as geometric spreading with no ground or air absorption credit. Where manufacturer data at those bands do not exist, the study shall state the source values it assumes and their basis.

(c) **Operating cases. [R and MP:]** The study shall model at least: normal nighttime operation; peak cooling on the hottest expected day; one generator test with its load bank; and emergency operation of all generators.

(d) **Results.** The study shall report, at each receptor point and as contour maps, the predicted dBA, dBC, and octave-band levels. It shall include a tonal assessment under Section 5(c), using one-third-octave source data where available. It shall state the expected accuracy of the predictions. **[MP: It shall include a sensitivity run with hard ground (ground factor 0) and a contour map out to 30 dBA.]** It shall list each mitigation measure the applicant commits to, with the sound level each must achieve.

(e) **Files. [R and MP:]** The applicant shall give the Township the model input and output files, source data, and all assumptions.

(f) **Measurement procedure.** Every measurement under this ordinance shall meet these conditions:

(1) a sound level meter as defined in Section 2, with a windscreen, calibrated in the field before

and after each measurement, and laboratory-calibrated within the past **[12]** months;

(2) microphone 5 feet (1.5 meters) above grade at the receptor point, at least **[10 feet]** from any reflecting surface other than the ground;

(3) no precipitation, and average wind speed at the microphone no more than 5 meters per second (about 11 mph), or no more than 2 meters per second (about 5 mph) for dBC and octave-band measurements below 125 Hz;

(4) a record of the facility's operating state during the measurement, certified by the operator, including load, the number of chillers, fans, and generators running, fan speeds, and outdoor temperature;

(5) facility sound is found by comparing the measured level with the residual sound (the level with the facility, or the equipment being tested, shut down). If the measured level is 10 dB or more above the residual sound, the measured level is facility sound. If it is 3 to 10 dB above, facility sound is the measured level minus the residual sound on an energy basis: $L_{\text{facility}} = 10 \log_{10}\left(10^{L_m/10} - 10^{L_r/10}\right)$, where L_m is the measured level and L_r the residual sound. If it is less than 3 dB above, subtraction is not reliable. Facility sound shall then be found by a shutdown test, by measurements near the source scaled to the receptor point, or by band analysis at the tone frequencies; and

(6) the operator shall cooperate with shutdown tests of up to **[30]** minutes on reasonable notice, or up to 1 hour when needed to measure background sound under Section 4(c)(3).

Drafting note. ISO 9613-2 covers 63 to 8,000 Hz and predicts conditions that favor propagation, such as clear, calm nights (International Organization for Standardization 2024). FERC requires model input files from compressor applicants (FERC 2026b). The 3 dB subtraction rule follows the ANSI practice cited by Prince William County's consultant (Nelson Acoustics for Prince William County 2025). The wind limits come from California Department of Transportation (2013) and Acoustical Society of America (2016).

Section 10. Independent review paid by the applicant

(a) **Reviewer. [B: The Township may / R and MP: The Township shall]** retain a qualified acoustical consultant of its choice to review the background sound survey, the predictive study, and every compliance test. **[R and MP: The reviewer shall also review the monitoring station locations and reports under Section 12.]** The reviewer shall have no relationship with the applicant.

(b) **Escrow.** Before review begins, the applicant shall deposit **[$ amount]** in an escrow account held by the Township to pay the reviewer. The applicant shall replenish the account when it falls below **[$ amount]**. Unused funds shall be returned after the final compliance test is accepted.

(c) **Scope.** The reviewer may require additional data, model runs, or measurements. **[MP: The reviewer shall witness each compliance test and shall audit monitoring data under Section 12 at least once a year.]**

(d) **Report.** The reviewer's report shall be public and shall be part of the record of the approval.

Drafting note. Oglethorpe County, Georgia funds county review through escrow; Wixom, Michigan

requires independent peer review (Oglethorpe County 2026; City of Wixom 2026). The attorney should confirm the Township's authority to require a review escrow under state law. In Michigan, the performance guarantee statute covers the cost of improvements, not review, so it does not by itself authorize this escrow (Section 16(e)).

Section 11. Post-construction compliance testing

(a) **Initial test.** Within **[B: 90 / R: 60 / MP: 60]** days after each phase begins operation, the operator shall have a qualified acoustical consultant measure facility sound at the receptor points used in the predictive study, under Section 9(f). The test shall include daytime and nighttime measurements and one generator test.

(b) **Periodic tests. [R:]** The operator shall repeat the test every year for 5 years after the last phase begins operation, between June 1 and August 31 during weekday peak cooling. **[MP:]** The operator shall repeat the test every year for the life of the use, with one summer peak-cooling test and one winter nighttime test each year.

(c) **Report.** Each test report shall compare the results with the limits and with the predictions of the study, and shall state the operating conditions. The operator shall file it with the Township within 30 days. The Township shall make it public.

(d) **Failure.** If a test shows an exceedance, the operator shall file a corrective action plan within 30 days and complete it within the period in Section 16(b). A new test shall follow completion.

(e) **Certificate. [R and MP:]** A final certificate of occupancy for a phase shall not issue until its initial test shows compliance.

Drafting note. Stafford County, Virginia tests within 90 days and then yearly for 10 years at summer peak cooling. Henry County, Virginia tests yearly for the life of the use, and White County, Indiana within 60 days of each phase (Stafford County Board of Supervisors 2025; Henry County Board of Supervisors 2026; White County Area Plan Commission 2026).

Section 12. Continuous monitoring and reporting

[B: Delete this section.]

(a) **Stations.** The operator shall install and maintain **[R: at least one permanent sound monitoring station / MP: at least one permanent sound monitoring station in each direction with homes]**, at locations the Township approves, for **[R: the first 2 years of operation of each phase / MP: the life of the use]**.

(b) **Equipment.** Each station shall use a sound level meter as defined in Section 2. It shall log the A-weighted Leq for each 1-second period; the Leq in dBA and dBC and one-third-octave band levels for each 1-minute period; and the L90 for each hour. It shall record audio when levels exceed a threshold the Township sets, and shall log wind speed and precipitation.

(c) **Operating log.** The operator shall keep a log of equipment operating state that can be matched to the monitoring data.

(d) **Reports.** The operator shall file a monthly report summarizing the data, noting every period above a limit, and explaining its cause. **[MP: The operator shall post the data on a public website within 24 hours.]**

(e) **Use of data.** Monitoring data may be used as evidence of a violation, subject to Section 9(f).

Drafting note. One-minute values combine exactly into the 10-minute, 15-minute, and 1-hour periods of Section 4(b). Pittsfield Charter Township, Michigan requires a public dashboard; Berkley, Michigan requires continuous vibration monitors (Pittsfield Charter Township 2026; City of Berkley 2026). Monitor prices are quoted on request (Section 4.13).

Section 13. Complaint response

(a) **Contact.** The operator shall maintain a **[B and R: telephone and email contact / MP: 24-hour telephone line]** for noise and vibration complaints, posted at the site entrance and on a public website.

(b) **Response.** The operator shall acknowledge each complaint within **[B: 2 business days / R and MP: 24 hours]**, and shall log every complaint and its resolution. The operator shall file the log with the Township **[monthly]**.

(c) **Testing. [B: The operator shall investigate within 14 days.] [R and MP: Within [R: 7 days / MP: 72 hours] of a complaint that gives the date, time, location, and character of the sound, a qualified acoustical consultant shall measure facility sound at the complainant's property, at the operator's cost. The test shall use the conditions most likely to produce the complained-of sound.]**

(d) **Corrective plan. [R and MP:]** If a test under subsection (c) shows an exceedance, Section 11(d) applies.

(e) **Retest trigger.** If the Township receives **[10]** or more complaints from **[3]** or more households within 6 months, the operator shall conduct a full compliance test under Section 11.

(f) **Complaints are not proof.** A complaint alone does not establish a violation. A violation is established only by measurement under this ordinance.

Drafting note. Augusta-Richmond County, Georgia retests after 10 complaints in 6 months (Augusta-Richmond County Planning and Development 2026). Subsection (f) follows Crockett*, which struck a rule treating complaints as evidence of a violation (*Jim Crockett *1983).*

Section 14. Records and access

(a) The operator shall keep all studies, test reports, monitoring data, and logs required by this ordinance for at least **[5]** years and shall make them available to the Township on request.

(b) The Township's inspectors and reviewer may enter the site at reasonable times, on reasonable notice, to observe equipment and operating conditions for measurements under this ordinance.

(c) A measurement at a receptor point on private land requires the owner's consent. Without consent, the measurement may be made at the nearest accessible point on public land or at the property

line of the site, and adjusted to the receptor point by a method the reviewer approves.

Section 15. Expansion and modification

(a) **When this applies.** This section applies to any new building or phase, any added outdoor equipment, any replacement of outdoor equipment with equipment of higher sound power, and any change to the generator testing program.

(b) **Study.** Before the change, the operator shall file an updated predictive study under Section 9 showing that the whole facility, including the change, will meet this ordinance. **[R and MP: The change is subject to Sections 10 and 11.]**

(c) **Campus sound budget. [MP:]** The limits in Sections 4 through 6 apply to the combined sound of all data centers and accessory equipment on the site and on any adjacent parcel under common ownership or control. A later phase may not rely on sound headroom that an earlier phase needs to comply.

Drafting note. Two facilities that each meet a limit can together exceed it by 3 dB at a home between them (Federal Transit Administration 2018). Prince William County staff said the county could not use cumulative noise to reject a project (Prince William County, Virginia 2025). A campus budget closes that gap for one operator.

Section 16. Enforcement and penalties

(a) **Violations.** A violation of this ordinance, or of a condition of approval under it, is a **[municipal civil infraction]**. Each day a violation continues is a separate violation. **[Michigan zoning version: A violation is also a nuisance per se.]**

(b) **Notice and cure.** The **[Zoning Administrator]** shall give written notice of a violation found by measurement. The operator shall stop or correct the violation within **[30]** days. For a corrective action plan that requires new equipment, the Township may approve a longer period in writing, not to exceed **[180]** days.

(c) **Fines.** Fines shall be **[$ first]** for a first violation, **[$ second]** for a second violation within 12 months, and **[$ third]** for each later violation within 12 months. Fines do not accrue during a cure period under subsection (b) while the operator meets the schedule of its corrective action plan.

(d) **Suspension and revocation. [R and MP:]** If a violation is not cured within the cure period, the Township may suspend the **[special land use / conditional use / special exception]** approval for the noncompliant phase after notice and hearing. **[MP: The Township may instead order the operator to reduce the load of, or stop, named equipment until compliance is shown. It may revoke the approval for a violation not cured within [90] days after suspension.]**

(e) **Financial guarantee. [R and MP:]** Before a building permit issues, the operator shall provide a performance bond, letter of credit, or cash deposit. Its amount shall equal the estimated cost of the mitigation measures listed in the predictive study. The Township may draw on it to complete mitigation measures the operator fails to complete.

(f) **Costs.** When a test confirms a violation, the operator shall pay the Township’s costs of the

investigation and of the reviewer.

(g) **Other remedies.** These remedies are in addition to any other remedy at law or in equity, including an action to abate a nuisance.

Drafting note. Michigan townships may designate violations as municipal civil infractions, and a zoning violation is a nuisance per se (MCL 41.183; MCL 42.21; MCL 125.3407). Morton County, North Dakota suspends approval automatically and revokes it after 60 uncured days; Frederick County, Maryland allows 180 days to fix a measured problem (Morton County 2026; Frederick County Council 2025a). In Michigan, MCL 125.3505 authorizes a guarantee covering "the estimated cost of improvements" to "insure faithful completion of the improvements." It is deposited when the permit issues, and cash is rebated as work is completed (MCL 125.3505). Barriers, enclosures, and silencers fit that grant. Testing and monitoring costs fit it less clearly, so subsection (e) covers mitigation only. The attorney should confirm the authority for any review or testing escrow under Section 10, and for conditions of approval under MCL 125.3504 (MCL 125.3504). Fine amounts depend on state law.

Section 17. Severability

If any section, subsection, sentence, or number in this ordinance is held invalid, the holding shall not affect the rest of the ordinance. The **[Township Board]** declares that it would have adopted each remaining part without the invalid part.

Section 18. Effective date

This ordinance takes effect **[on the date provided by state law after publication / on (date)]**. It applies to any application not finally approved before that date. **[General ordinance version: Section 3(b) applies to existing data centers on (date).]**

Drafting note. In Michigan, a zoning amendment takes effect seven days after notice of adoption is published, unless a later date is set (MCL 125.3401). In a general law township, a general ordinance with a penalty takes effect 30 days after first publication (MCL 41.184). In a charter township, it takes effect on publication unless a later date is stated (MCL 42.22). Whether a pending application is subject to the new rules depends on state vested-rights law.

C Glossary

This glossary gives plain definitions of the technical and legal terms used in this report, including every term the body text marks as defined. Section 2 explains the acoustic and vibration terms in more depth, with sources. Legal terms are defined in their general sense; their exact meaning depends on each state's law, discussed in Sections 5 to 7.

Term	Definition
A-weighting (dBA)	A meter filter that reduces low and very high frequencies so the reading roughly matches human hearing at ordinary levels. It is the standard measure for environmental noise.
Acceleration (vibration)	How fast the speed of a vibrating surface changes. It is one of three ways to describe vibration.
Adjusted sound level (rating level)	A measured level with penalties added for annoying features such as tones, impulses, or night hours. ANSI says "adjusted"; ISO says "rating."
Allegation	A claim in a complaint or lawsuit that no one has yet tested. This report keeps allegations apart from measurements and models.
Ambient sound	All sound present at a place, including the facility being studied. Many ordinances use "ambient" to mean what this report calls background sound, so an ordinance should define the term if it uses it.
ANS-weighting	A-weighting with all sound above the 1,000 Hz octave band removed. It measures quiet backgrounds without the insect, bird, and leaf sound that does little to mask a hum.
As-applied challenge	A lawsuit claiming a law is invalid only as applied to the challenger's particular facts.
Association	A pattern in which two things rise and fall together. An association alone does not show that one causes the other.
Attenuation	The drop in sound level between a source and a listener.
Background sound	All sound at a place except the source being studied. In this report it means the L_{90} of sound without the facility; many ordinances call this "ambient."
Blade-pass frequency	The tone a fan makes: its rotation speed in revolutions per minute, times the number of blades, divided by 60.
Blanket certificate	The Federal Energy Regulatory Commission's advance approval for a class of small, routine projects. Section 5.5 describes its post-construction noise survey.
Broadband sound	Sound spread across many frequencies, with no single dominant pitch.

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Term	Definition
C minus A (dBC − dBA)	The gap between a sound's C-weighted and A-weighted levels. A large gap signals strong low-frequency content; it is used as a screen (often at 10 dB) or, in some ordinances and in this report's Recommended and Most protective tiers, as a cap (at 20 dB).
C-weighting (dBC)	A meter filter much flatter than A-weighting at low frequencies. It captures more bass and rumble.
Causation	A relationship in which one thing produces another. Health studies try to separate causation from mere association.
Class 1 and Class 2 meters	The two accuracy grades of sound level meter under IEC 61672-1. Class 1 is more precise; older American documents say Type 1 and Type 2.
Class action	A lawsuit in which a few named people sue on behalf of everyone similarly affected.
Coming to the nuisance	A defense in a nuisance case when homes are built near an existing industrial or agricultural use.
Common law	Law made by judges through court decisions rather than by statute. Nuisance law is common law.
Community noise equivalent level (CNEL)	A 24-hour average like L_{dn}, with an added 4.77 dB penalty from 7 to 10 p.m. It is used in California.
Community tolerance level	A single number that summarizes how much more or less annoyed one community is than others at the same sound level.
Compatible renewable energy ordinance (CREO)	Under Michigan's PA 233 of 2023, a local ordinance whose requirements are no more restrictive than the state's siting standards in MCL 460.1226(8). Whether a township has one decides which approval path a developer may use.
Conditional use	A land use allowed in a zoning district only after review and approval under stated standards, often with conditions attached. Michigan calls this a special land use.
Confidence interval	The range of values a study's data are consistent with. If the range for a relative risk includes 1.00, the study cannot rule out no effect.
Consent judgment	A court judgment entered on the agreement of the parties to settle a lawsuit. In land use disputes, it can fix the terms under which a project may proceed.
Content-based rule	A rule that treats speech differently depending on what it says or who says it. Courts review such rules strictly.
Cortical arousal	A brief shift toward lighter sleep, seen in brain-wave recordings, that the sleeper may not remember.
Crest factor	Peak vibration divided by its RMS value. It is about 4 to 5 for trains and 8 or more for impulsive vibration.
Critical band	A narrow frequency band around a tone. Noise inside it masks the tone; noise outside it does little.

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Term	Definition
Data center	A building, or a campus of buildings, full of computer servers, with outdoor cooling equipment, transformers, and backup generators.
Data hall	A room of server racks inside a data center.
Day-evening-night level (L_{den})	The European Union's 24-hour average. It adds 5 dB to evening sound and 10 dB to night sound.
Day-night average sound level (L_{dn}, DNL)	A 24-hour average with 10 dB added to sound between 10 p.m. and 7 a.m.
Decibel (dB)	A logarithmic unit for sound level, referenced to 20 micropascals for sound pressure. Each 10 dB step is ten times the energy.
Decibel addition	Combining levels by adding their energies, not their numbers. Two equal sources give 3 dB more than one.
Dillon's rule	A rule of interpretation under which a local government has only the powers its state expressly grants, plus those necessarily implied or essential to its purpose. It is the opposite starting point from home rule.
Displacement (vibration)	How far a vibrating surface moves from rest.
Energy facility siting law	A state law that governs where and how power plants, wind farms, solar farms, or storage can be built. Some set sound limits.
EPA Levels Document	The U.S. Environmental Protection Agency's March 1974 report on noise levels that protect health and welfare. It identified 55 dB L_{dn} outdoors and 45 dB L_{dn} indoors for homes. EPA said these were not standards.
Equal-loudness contours	Curves showing which levels at different frequencies sound equally loud. They are the basis for frequency weightings.
Equivalent sound level (L_{eq}; equivalent continuous sound level)	A steady level with the same total energy as a varying sound over a stated time, such as one hour.
Exceedance level (L_x, including L_{10} and L_{50})	The level exceeded x percent of the time. L_{10} reflects louder moments; L_{50} is the level exceeded half the time; L_{90} reflects the quiet floor.
Exposure–response relationship	A curve showing how the share of people with an outcome, such as high annoyance or sleep disturbance, changes as the sound level rises.
Facial challenge	A lawsuit claiming a law is invalid in every application.
Fast and slow time weighting	Meter settings that smooth readings over about 0.125 second (fast) or 1 second (slow).
Frequency	The number of pressure cycles per second, measured in hertz. It is heard as pitch.
Frequency weighting	A filter in a sound level meter that treats different frequencies differently, usually to mimic hearing. A, C, and Z are the common weightings.
G-weighting	A frequency weighting designed for infrasound, much as A-weighting is designed for ordinary sound. Levels are written dB(G).

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Term	Definition
GAAMPs	Generally accepted agricultural and management practices, set by Michigan's Commission of Agriculture and Rural Development under the Right to Farm Act. A farm that follows them is shielded from nuisance claims.
General noise rule	A statewide table of sound limits that applies to most sources, adopted by statute or by a state agency.
Ground-borne noise	A low rumble heard inside a building when ground vibration makes walls and floors radiate sound.
Ground-borne vibration	Vibration that travels through the ground into buildings and can be felt.
Ground effect	Extra loss of sound as it travels over the ground. Soft ground such as grass absorbs more than pavement.
Hertz (Hz)	Cycles per second; the unit of frequency.
High energy use facility	Virginia's 2026 statutory term for a facility expected to need 100 megawatts or more of power, such as a large data center.
Highly annoyed	A survey category for people who rate a sound's annoyance above 72 on a 0 to 100 scale.
Home rule	Authority of a local government to act on local matters without specific permission from the state, as granted by a state constitution or statute.
Impulsive sound	A brief burst of sound, usually under one second, well above the surrounding sound. Highly impulsive sources include gunfire, hammering, and pile driving.
Infrasound	Sound below 20 Hz, the conventional lower limit of hearing. It can be heard or felt at high enough levels. The band from 10 to 20 Hz is both infrasound and low-frequency sound.
Injunction	A court order to stop or change an activity.
Inverse square law	For a point source, sound energy per unit area falls with the square of distance. The level drops about 6 dB per doubling of distance.
Ischemic heart disease	Disease from narrowed arteries that reduce blood flow to the heart.
L_{90}	The level exceeded 90% of the time. It is a common measure of the quiet background between events.
Line source	A source that is long compared with the distance to the listener, such as a busy road. Its averaged level drops about 3 dB per doubling of distance.
L_{max}	The highest level during a period or event, read with a stated fast or slow setting.
L_{night}	The European Union's nighttime average, used to assess sleep disturbance.
Load bank	A large electric heater that gives a generator something to power during a test. It can be louder than the generator it serves.

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Term	Definition
Low-frequency sound (low-frequency noise, LFN)	Sound from about 10 to 200 Hz, the range this report uses, often heard as a hum or rumble. Some sources start the range at 20 Hz. It passes through walls easily.
Masking	The effect of one sound making another harder to hear.
Measurement	A reading taken with an instrument, by a consultant, agency staff, or a resident.
Meta-analysis	A study that pools the numbers from several studies into one estimate.
Metric	A rule for summarizing a period of changing sound as one number, such as L_{eq}, L_{max}, or L_{90}.
Michigan Zoning Enabling Act	Michigan's zoning statute, 2006 PA 110, MCL 125.3101 to 125.3702. It is the source of local (including township) zoning power in Michigan.
Model (modeling)	A computer prediction of sound levels made before construction. Several state laws allow modeling in place of measurement.
Moratorium	A temporary pause on approving a land use. It sets no sound limit; it buys time to write one.
Municipal civil infraction	In Michigan, a non-criminal violation of a local ordinance that carries a civil fine.
Natural quiet	The soundscape of a place without human-made sound.
Noise	Unwanted sound. Physically, noise and sound are the same thing.
Noise Control Act of 1972	The main federal noise statute, 42 U.S.C. §§ 4901–4918. It created EPA's noise program, which lost its funding in the early 1980s.
Nonconforming use	A use that was lawful before a zoning change and may continue even though it does not meet the new rules.
Nonparticipating property	A parcel the facility operator does not own or lease, and whose owner has not signed a recorded agreement that expressly waives the sound limits. In the model ordinance, an easement or agreement for another purpose, such as a utility line, access, or drainage, is not such a waiver, so it does not make a parcel participating. State siting laws define the term in their own ways, and often apply stricter sound limits or setbacks to these parcels.
Normal person test	The rule that a nuisance is judged by how a person of ordinary sensitivity in the community would experience it, not by an unusually sensitive plaintiff.
Nuisance	An unreasonable interference with the use and enjoyment of land (private nuisance) or with a right common to the public (public nuisance). Courts can order a nuisance stopped or award damages.
Nuisance per se	Conduct that is a nuisance by law, without proof that it is unreasonable in fact. In Michigan, a zoning violation is a nuisance per se.
Octave band	A frequency band whose top is twice its bottom, named by its center frequency, such as 63 Hz or 500 Hz.
Octave-band limit	A separate sound limit for each octave band, from low rumble to high hiss. It controls the shape of a sound, not just its total.

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Term	Definition
Odds ratio	A close cousin of relative risk. An odds ratio of 2 means the odds of the outcome double.
On the merits	Describes a court ruling that decides whether the claims are true, rather than a procedural point.
One-third-octave band	One of three bands that together make an octave. Neighboring band centers differ by a factor of about 1.26.
Onset rate	How fast a sound rises at the start of an event. Very fast onsets startle people and get a penalty under ANSI S12.9 Part 4.
Peak particle velocity (PPV)	The highest instantaneous speed of a vibrating surface, in inches or millimeters per second. High values (0.1 to 0.2 in/s) are used to judge building damage; low values (about 0.01 in/s) mark the level at which people begin to feel continuous vibration.
Performance standard	A zoning rule that limits a use's measurable effects, such as noise, vibration, light, or odor, rather than listing which uses are allowed.
Point source	A source small compared with the distance to the listener, such as one fan or generator. Its level drops about 6 dB per doubling of distance.
Police power	The general power of government to make laws protecting public health, safety, and welfare. States hold it, and local governments use the share their state delegates.
Polysomnography	A sleep study that records brain waves, eye movements, and muscle activity.
Preemption	The displacement of a lower level of government's law by a higher level's law on the same subject. A state siting law, for example, may preempt local sound limits for certain facilities.
Preponderance of the evidence	The usual standard of proof in a civil case: more likely than not.
Prima facie evidence	Evidence that is enough to prove a point unless the other side rebuts it.
Private nuisance	An interference with a person's use and enjoyment of their own land that does not involve physically entering it.
Proffer	Virginia's term for conditions an applicant offers as part of a rezoning.
Prominence ratio (PR)	A tone test comparing the critical band that holds the tone with its two neighbors. Above 1,000 Hz, a tone is prominent at 9 dB or more; lower frequencies need more.
Property line (property line measurement)	The boundary of the site that makes the sound. A property line measurement is taken there, as distinct from a receptor point where people hear the sound.
Public nuisance	An unreasonable interference with a right common to the general public, such as public health or the use of a public road. A public official usually brings the case.
Pure tone	Sound at a single frequency, such as a whistle.
Quiet Communities Act of 1978	The federal law that expanded EPA's noise program, including grants to state and local noise programs.

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Term	Definition
Rational basis review	The most lenient test a court applies to a law. The court upholds the law if it is rationally related to a legitimate government purpose.
Receptor (receiver)	A place where people hear the sound, such as a home, school, or hospital. Some rules measure at receptors instead of, or as well as, at the property line.
Refraction	Bending of sound by wind or by temperature that changes with height. It can carry sound farther than expected.
Regulatory taking	A regulation that goes so far in restricting property that it counts as a taking, which requires just compensation.
Relative risk (RR)	How much more common an outcome is in one group than another. An RR of 1.08 per 10 dB means the outcome is 8% more common for each 10 dB increase.
Residual sound	ANSI S12.100's term for background sound: the sound left at a place when the source being studied is absent.
Root mean square (RMS)	A way to average a signal that swings above and below zero: square each value, average the squares, then take the square root.
Setback	A minimum distance required between a structure or piece of equipment and a property line, road, or dwelling.
Sound	Small, rapid pressure changes in the air that the ear detects.
Sound exposure level (SEL)	The total energy of one event, compressed into one second. It lets short loud events be compared with long quiet ones.
Sound level meter	An instrument that measures sound pressure level with standard weightings and time settings. IEC 61672-1 specifies its performance.
Sound power (sound power level)	The total acoustic power a source emits, in watts, or the same quantity expressed in decibels. It is a property of the source, does not depend on distance or surroundings, and is the input to noise models.
Sound pressure level (SPL)	The sound pressure at a place, in decibels relative to 20 micropascals. It depends on distance and surroundings.
Soundscape	The full mix of sounds in a place.
Special land use	Michigan's term for a use allowed in a zoning district only after review and approval under standards in the zoning ordinance, often with conditions. Other states call this a conditional use or special exception.
Spectrum	The mix of frequencies in a sound, often shown as levels in octave or one-third-octave bands.
Standard of review	How closely a court examines a law or decision. Most zoning rules get a deferential standard.
Strength of evidence	How much confidence a body of research supports. WHO graded its 2018 evidence as high, moderate, low, or very low quality.
Summary judgment	A ruling before trial that one side wins on the undisputed facts.
Systematic review	A study that gathers all research on a question by a stated method.

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Term	Definition
Taxonomy	A classification scheme. This report uses one to compare noise and vibration provisions across jurisdictions.
Temperature inversion	A layer of air that warms with height instead of cooling. It bends sound back toward the ground and is common on clear, calm nights.
Tonal penalty	An amount added to a measured or modeled level when a sound has a distinct pitch, because tones are more annoying.
Tonal sound (tone)	Sound with a clear pitch, such as a whine or hum, that stands out from the surrounding sound. Assessment standards usually add a penalty.
Tone-to-noise ratio (TNR)	A tone test comparing the tone's level with the noise in its critical band. Above 1,000 Hz, a tone is prominent at 8 dB or more; lower frequencies need more.
Variance	Permission to depart from a specific zoning requirement, usually granted by a zoning board of appeals when strict compliance would cause practical difficulty or hardship.
Velocity (vibration)	The speed of a vibrating surface. It is the basis of both PPV and VdB.
Vested right	A right to proceed with a project under the rules in force before a change. Whether a project has one depends on state law.
Vibration	Back-and-forth motion of the ground or a structure.
Vibration velocity level (VdB)	Vibration speed on a decibel scale, referenced in the United States to one millionth of an inch per second. People begin to feel about 65 VdB.
Void for vagueness	A constitutional defect in a law that does not give an ordinary person fair notice of what it prohibits, or that gives officials no explicit standards for applying it.
Wavelength	The distance between pressure peaks in a sound wave. It is about 1 foot at 1,000 Hz and about 20 to 22 feet at 50 Hz.
WHO 1999 Guidelines for Community Noise	World Health Organization guidelines that remain in force for sources WHO did not revisit in 2018. They give bedroom values of 30 dB L_{Aeq} and 45 dB L_{Amax}.
WHO 2009 Night Noise Guidelines	World Health Organization guidelines for Europe that set 40 dB L_{night} outside as the night guideline, with 55 dB as an interim target.
WHO 2018 Environmental Noise Guidelines	The World Health Organization's most recent noise guidelines, written for its European Region and based on eight systematic reviews.
Wind-induced noise	False sound readings caused by wind blowing on the microphone. It is worst at low frequencies.
Windscreen	A foam cover that reduces wind noise at the microphone. It does not remove it.
W_m weighting	The ISO 2631-2 frequency weighting used to judge how people perceive building vibration from 1 to 80 Hz.
Z-weighting (dBZ)	A flat, unweighted response that treats all frequencies alike.
Zoning	The division of a community into districts with different rules for land use.

D Methods and Sources

This appendix explains how we gathered and checked the evidence in this report, and where that evidence is thin. Readers who want to rely on a specific number should use this appendix to judge how much weight it can bear.

D.1 Research questions and scope

The report set out to answer nine questions:

1. What are noise and vibration, and how are they measured? (Section 2)
2. What do medical and environmental research show? (Section 3)
3. What sound do data centers make, and how much can design remove? (Section 4)
4. What do federal and general United States law allow? (Section 5)
5. What does each of the fifty states do? (Section 6 and Appendix A)
6. What does Michigan law provide, in detail? (Section 7)
7. What have local governments adopted? (Section 8)
8. How can those local rules be classified? (Section 8)
9. What could a local government adopt? (Section 9 and Appendix B)

Data centers were the primary subject. We also collected rules for battery storage, substations, solar, wind, cryptocurrency mining, and gas compressor stations, because they use similar equipment and because states have already written sound limits for several of them. The research cutoff is November 24, 2026. Later legislative action, court decisions, and ordinance amendments are not reflected.

D.2 How the research was organized

The work covered seven subjects, organized into eight research tracks: definitions and measurement; health and environment; law; engineering and mitigation; local codes and their classification; Michigan; and the fifty states, surveyed in two halves. AI research assistants gathered the sources and wrote first drafts, following a written plan under the author's direction. For each subject they kept research notes in which every factual statement points to a source record. A source record gives the title, publisher, date, web address, date accessed, and, where possible, a short exact quotation. Sections were drafted from those notes, then reviewed twice for accuracy and plain language.

D.3 Sources and how they were found

We preferred primary sources:

Exhibit 31. Research records behind this report

Record set	Count
Source records with web address and access date (all areas)	890
State files (one per state)	50
Court decisions summarized with full citation	50
Local code provisions coded (outside the Michigan inventory)	79
Michigan local ordinances, drafts, and models	39
Equipment sound levels from studies and data sheets	90
Mitigation measures with typical reductions	44

Source: Project research files, November 24, 2026.

- statute and rule text from official state legislature and agency sites;
- federal text from the Electronic Code of Federal Regulations and the United States Code;
- court opinions;
- adopted ordinance text from county and municipal sites and code publishers;
- agency manuals, such as the Federal Transit Administration's noise and vibration manual;
- standards-body catalog pages; and
- peer-reviewed research with DOIs.

Sources were first found through web search and read directly. We then re-read every source address with our own retrieval software, which tries a plain download first and switches to a real web browser when a site requires one. We kept a copy and a fingerprint of each page, and checked each record's quotation word for word against the retrieved text. Of 890 source records, 815 matched exactly. Another 47 were confirmed by reading a scanned document with text recognition, by using the publisher's data service or an archived copy, or in an earlier pass. Of the remaining 28, 26 are records with no stored quotation or address, or claims we dropped, and none is cited in the report. Two are cited with a warning in the text: Warrenton, Virginia's zoning article, which no longer loads (Section 8), and West Virginia's 2026 House Bill 5168, whose official text we could not re-read (Section 6). Searches made to fill the last gaps used a commercial search service. For 2025 and 2026 state bills, we searched the full text of the KL3M US State Bills Dataset, a public collection, for words such as *noise*, *decibel*, *sound*, and *data center*. We used version 1.1.7, with activity through November 22, 2026 (ALEA Institute 2026). We then checked each bill's status on the official legislature site where we could.

Several standards are sold rather than published free. Where we could not read a standard's text, we cite its official catalog page and describe it from reliable secondary sources, and the text says so. One example is ANSI/ASA S12.9 Part 4: the penalty values in this report come from the 2005 edition, a copy of which is held publicly by the Minnesota Legislative Reference Library. We did not review the 2021 edition.

D.4 How claims were checked

Each source was tagged as read in full, read in part, or known only from a search summary. Claims resting only on search summaries were either confirmed or dropped before drafting. Both halves of the state survey then went through a second, separate check against primary text, which corrected errors and revised each state's confidence rating. These checks corrected several earlier findings, including figures that circulated in early 2026 summaries of data center rules. The main corrections are these:

- York County, Virginia, does not use a 75/65 dB limit. Its rule is the greater of 55 dBA or the measured nighttime background level.
- Chesterfield County, Virginia, has no numeric data center noise limit.
- Prince William County, Virginia's 73/68 dBC limits apply only to steady tonal sound received at homes.
- Widely repeated figures of $100 to $300 per foot for noise walls and $500,000 to $5 million per facility for mitigation are not supported by any source we found (Section 4).
- Ohio's siting noise limit is in Ohio Administrative Code 4906-4-09, and North Dakota does have a 45 dBA wind siting limit.
- Claims that liquid cooling eliminates fan noise heard by neighbors are not supported. We found no measurement showing that it lowers sound at nearby homes (Section 4).
- Delaware does have a statewide numeric noise rule (7 Del. Admin. Code 1149), which our first count missed (Section 6).
- A final re-read of every flagged source found that New Hampshire's HB 639 was signed without its cap on local decibel limits for home mining, and that the Senate had struck the noise rule from SB 439 (Section 6).

We use one convention for gaps. "We found no" means a documented search turned up nothing; it is not proof that nothing exists. Values we computed ourselves from cited inputs are marked as our calculations.

Each state file carries a confidence rating (Appendix A). **High** means we read the primary text of the main rules. **Medium** means we read the core rule, though some provisions rest on secondary copies or leave gaps. **Low** means the row rests on negative findings, secondary sources, or an official code that could not be searched in full. Mixed ratings ("medium-high," "low-medium") fall between.

D.5 Limits

- **Local coverage is a sample, not a census.** We coded rules for about 59 local governments outside Michigan, most from adopted text, and 39 Michigan ordinances, drafts, and models. Several code-hosting sites blocked automated reading. A late search pass in November 2026 reached more places, but some communities were still not reviewed (Section 8.6). Counts and ranges in Section 8 describe this sample.
- **Absence is not proof.** When we say a state has no general noise statute, we mean none was found

after a documented search, not that one cannot exist.

- **Predictions are not measurements.** Most achievability evidence comes from applicants' predictive studies, not from measurements after construction. The one published verification report we found is from Australia (Section 4.11).
- **Lawsuits are allegations.** The 2026 data center and cryptocurrency mining lawsuits are described from complaints and news reports. None had a ruling on the merits in our sources.
- **Fast-moving law.** Bills, ordinances, and appeals described here may change after the cutoff date. Check current status before relying on any of them.
- **Not legal or engineering advice.** A local government should have its own attorney review any ordinance, and a qualified acoustical consultant review any technical standard, before adoption.
- **Standards editions.** Some standards are sold rather than freely available. Where we could not read the current edition, the text names the edition we relied on.

D.6 Where the records are kept

The research notes, source records, and coded data tables behind this report are archived in the project repository.