
Minnesota Odor Rulemaking Study

Minnesota Pollution Control Agency
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Executive summary

The 2023 Minnesota legislative session required that the Minnesota Pollution Control Agency (MPCA) develop odor rules for MN Statute 116.064 subdivision 7 ([Section 116.064 MN Statutes](#)). In December 2023, MPCA asked Management Analysis and Development (MAD) to collect information about odor rules from states, cities, and provinces and identify typical odor rule practices so that MPCA is positioned to undertake rulemaking when capacity allows. MAD read twenty-four odor regulations that exist in the United States and Canada.

MAD worked with MPCA to generate interview questions to learn more from state and local agencies who regulate odor. MAD then conducted eleven interviews with nine regulating agencies and two consulting firms. The goal of these interviews was to learn more about what each agency does to regulate odor. The interview (see Appendix C: Interview questions template) asked about terminology, methodology, implementation, penalties and enforcement, lessons learned, and additional questions identified by MPCA that were specific to each entity interviewed.

Following the interviews, MAD created a summary of common practices and recommendations provided by the agencies interviewed, found in the Common practices and recommendations from interviewees section of this report. The most consistently recommended practice was to have an objective, number-based standard (often a 7:1 dilution threshold) and use that standard to address quality-of-life issues. Nearly all interviewees noted that odor is highly subjective and much of the subjectivity can be removed through practices such as objective rules, consistent standards, and training of inspectors.

This report also includes a list of public comments MPCA received through a request for input about odor regulation rules. MAD summarized the public comments made by three organizations and provided additional context and links to sources below each comment summary.

Acronyms and definitions

Acronym/Term	What it means
MAD	Management Analysis and Development
MPCA	Minnesota Pollution Control Agency
CAFO	Concentrated animal feeding operations
Dilution threshold	Dilution threshold: a ratio used to determine the strength of an odor based on how many volumes of air an odor is still detectable at. For example, a D/T of 7:1 would mean one volume of odorous air still being detectable after being diluted with seven equal parts odor-free ambient air.
Source	Any person, machinery, or facility emitting odor into the ambient air
NOV	Notice of violation
FIDOL	Frequency, intensity, duration, offensiveness, location
Ambient air	The portion of the atmosphere that is external to buildings, structures, facilities, or installations to which the public has access.
Nasal Ranger	A device used in measuring and quantifying odor strength in the ambient air. It is considered the national standard of determining a dilution threshold concentration objectively by many agencies MAD spoke with.

Methodology

MAD began the initial review of odor rules and regulations in February 2024 and continued through May 2024. MAD started with a [list of regulations created by St. Croix Sensory](#) and continued to identify additional regulations through conversations with MPCA, locating rules cited by other regulations, and interviews with other state and municipal agencies. MAD and MPCA drafted and finalized interview questions in March. MAD reached out to twenty-four state, municipal, or provincial agencies and consulting firms to interview. Of this group, fourteen replied to the initial inquiry. Three agencies declined an interview but provided information about their regulations and eleven were interviewed. The full list of agencies and consulting firms interviewed can be found in Appendix A: List of interviewees and contact information.

The questions created for the interviews were based on a combination of MAD's initial findings about odor regulations and what MPCA was specifically looking for to be better informed for their rulemaking process. Following discussion between MAD and MPCA, the questions were grouped into categories:

- **Terminology:** Definitions behind what an agency saw as an odor nuisance as well as framing their regulations as a quality of life versus public health issue.
- **Methodology and implementation:** What the process was to draft these rules, what an odor investigation entails, what universe this rule applies to, and the staff and capacity required to implement this rule.
- **Penalties and enforcement:** What happens if this rule is violated, what penalties may exist, and background behind any odor compliance plans.
- **Lessons learned:** Reflection of what is working well with this rule from the perspective of industry, the public, and the regulating agency, anything that would be done or written differently in retrospect, any suggestions for a state undertaking this rulemaking process, and any models or case studies to recommend investigating.
- **Specific questions for this entity:** Any clarifying follow-up questions specific to the agency being interviewed.

The interview questions can be found in Appendix C: Interview Questions Template. The interview questions for RK & Associates and St. Croix Sensory Labs were drafted from this template and modified more heavily based on specific questions that were relevant to each organization, as they were not regulating agencies.

This report highlights what other states, municipalities, and provinces have done in writing, implementing, and enforcing odor regulation in their respective regions. MAD read twenty-four odor regulations that currently exist in the United States and Canada. The regulations can be found in Appendix B: List of regulations and sources reviewed. Along with reading and reviewing odor regulations, MAD conducted eleven interviews to learn more about odor regulations. Nine interviews were conducted with state and municipal regulating agencies to better understand their approach to odor. MAD also interviewed two consulting firms: St. Croix Sensory Inc., a sensory evaluation laboratory, and RK & Associates, a consulting firm that offers services in odor science. The following sections contain the results of these eleven interviews and review of the twenty-four regulations.

Common practices and recommendations from interviewees

Throughout the course of the interviews, interviewees provided a series of common practices as well as recommendations for MPCA to consider in writing odor regulation. Below is a summary of these practices and recommendations, split into the following sections:

- Focus of regulation and reporting an odor complaint
- Thresholds and other standards
- Rule implementation and odor management plans
- Detection methods, tools, staffing, training
- Practices that work well for industry, the public, and regulating agencies

In addition to these sections, another section on unique rules follows that describes rules MAD found that use a separate standard than a volume-based, dilution threshold approach that all states interviewed use.

Focus of regulation and reporting an odor complaint

Odor regulation generally has a focus on the quality of life and enjoyment of property, though several rules also consider public health. Quality of life tends to be more common in odor regulations and a few interviewees have described it as a more legally defensible standard than one based on public health. A few interviewees mentioned that the two are often not separable or seen as discrete areas when thinking about the effects odor can have on people.

Regulating agencies receive odor complaints via a combination of phone, email, online form, or physical mail.

- Most agencies have set up a hotline (such as a 311, using a service like Answer Plus, or a direct line set up about a specific facility) that operate specifically to receive complaints.
- Other agencies have an online form that can track specific information about an odor, such as the time of day it was detected, characteristics, duration, and concentration.
- Information about the individual making the report can also be gathered, such as personal contact information for follow-up and location to see if they are near a specific facility or known odor emitter.

Thresholds and other standards

The most common standard used by interviewees in determining whether an odor is in violation of any odor management regulation is a dilution threshold. The most common dilution threshold used is 7:1, though several agencies' rules rely on different dilution thresholds. See Appendix B: List of regulations and sources reviewed for a full list of the dilution thresholds identified in each agency that uses them as a standard. While a few

interviewees said that a 7:1 threshold requires too strong an odor in order to violate the standard (one of those agencies specifically has feedlots as an exemption to their rule), most agencies MAD spoke with are satisfied with this standard as (1) anything lower may be too stringent in its rules and (2) violations in general are low and agencies will typically work proactively with odor-emitting facilities before reaching that limit. An ordinance in a more densely populated area that provides an additional standard that is measured differently, such as receiving a certain number of complaints from individuals within a period of time, may complement a dilution threshold by offering a more flexible framework of what is considered an objectionable odor.

Rule implementation and odor management plans

MAD asked agencies how their rules were initially drafted. All agencies MAD interviewed stated their rules were in place well before the individual being interviewed was working there. Most interviewees' rules were drafted during the 1970s. The most commonly cited technique recalled for how the odor regulations were created was looking at what other states, cities, or provinces were doing. The primary focus was on what was seen as working well and could be feasibly enforced.

Six out of nine agencies interviewed cited odor management plans as an effective enforcement tool to use in odor standard violations. The process for creating an odor management plan varied. In nearly every case described by interviewees, the regulatory agency will notify the facility found to be in violation of the standard that they need to draft a plan to address the odor within a specified amount of time (typically one to three weeks), and that they need to send it to the agency for approval. The agency would then review the plan, and if it was deemed sufficient by the agency, the plan would be signed and put into effect. The reason the odor-emitting facility is asked to draft the plan instead of the regulatory agency is that the facility has the expertise and technology to best address odors. Facilities have access to the subject matter experts from their industries, who are in a better position to identify and plan for solutions. Two agencies interviewed that use different plans have either never seen an odor violation that required an odor management plan on a state level or enacted a verbal agreement rather than create a formal, documented plan to address a violation. All agencies interviewed emphasized success in taking proactive steps to work with facilities before an odor complaint would violate their standard and require a plan to be put in place.

Detection methods, tools, staffing, training

All regulatory agencies interviewed will conduct an odor investigation upon receiving a complaint. An odor investigation typically involves an inspector visiting the site of the odor emission and taking multiple measurements of the odor. Methods for how this process is timed vary, but a typical method for measurement involves taking one measurement, then taking another measurement in the same location at least fifteen minutes later within a one-hour period. The timing of the inspection varied across agencies, and all agencies interviewed did not know how other agencies timed their inspections. Most regulations require multiple inspectors to visit a site, but this is not feasible for all interviewees because several agencies interviewed have only a handful of inspectors available to conduct inspections throughout an entire state. Local municipalities often staff more inspectors who can better address local issues.

The most common tool used in detecting odor is the Nasal Ranger, which is a nationally recognized instrument according to all agencies interviewed that use it. The Nasal Ranger measures the dilution threshold of a specific odor. Nearly all interviewees who use the Nasal Ranger cited the benefit of having a numeric measurement of odor that takes some subjectivity out of measurement during an inspection. Two agencies have reported difficulty in using the Nasal Ranger to provide an objective measurement of odors because of variations in individual sensitivity to odors as well as the topography of their state, specifically around mountains and valleys. Training and certification courses such as those offered by St. Croix Sensory may help reduce the subjectivity behind determining the concentration of odors when using a Nasal Ranger. No agencies reported taking this training course, and one agency expressed interest in taking it to reduce subjectivity in their measurements.

One agency interviewed uses a tool called EnviroSuite. This tool can be placed near odor-generating facilities and monitors concentrations of odorous chemical compounds in the air, such as hydrogen sulfide. This tool can also alert the agency when the concentration of a compound exceeds a limit that would be deemed odorous. This agency uses EnviroSuite instead of relying on a Nasal Ranger since inspectors would lose time in arriving to a site and may not find an accurate reading of the odors that were reported. The benefits of using this tool include the ability to track what odorous compounds are in the air (and their concentration) as well as not requiring an inspector to go to the source of the odor since it would all be tracked by the monitors. One major drawback to this tool is that it only measures a concentration of chemical compounds, not odor, so not all odors will be captured by the device.

Practices that work well for industry, the public, and regulating agencies

During the interviews with each agency, MAD asked what they felt worked well for industry, the public, and the agency themselves. Below is a summary of interviewee responses to these questions.

Practices that work well for industry

- Providing an objective, number-based framework for facilities to adhere to makes them cognizant of what they have to do to comply and be good neighbors.
- It is helpful to have an objective standard that is not “no odor.” It is also helpful to have a standard that does not apply unless there is a citizen complaint. Certain industries inherently produce odor, and it may be impossible to fully prevent any odor emission from a facility.
- It is effective to reach out to any odor-emitting source to try to work with them to reduce any odor emission prior to finding a definitive violation of a standard outlined in law. Most agencies expressed appreciation of facilities that were proactive in cooperating with them to address odor issues before a formal violation was found.

Practices that work well for the public

- Establishing a rule that provides a way for the community to complain lets them know they can call with any concerns related to odor.
- The regulatory agencies MAD interviewed said responding to any citizen complaint with an investigation tends to be well received by the public, even if it does not lead to a violation.

Practices that work well for a regulating agency

- Reaching out to counties or city commissioners when drafting the rules can help create relevant standard(s) for state agencies, as several issues may be best handled locally.
- A dilution threshold works well as a consistent standard. Ordinances from cities or counties can complement this state rule by providing more specific regulation if an issue in the area does not violate the standard established by the state but is still prompting consistent complaints.
- Most agencies interviewed noted that it is important for any effective regulating agency to have dedicated, trained staff and documentation of standard operating procedures for consistent odor investigations.
- One agency recommended providing technical and financial assistance to local agencies and counties because they will know specific industries and communities and their respective concerns. Local agencies were described as important allies in compliance and enforcement on a statewide level.

Unique rules

Most odor management regulations use a dilution threshold to determine whether any odor being emitted is in violation. However, two other regulations rely on other, more unique, standards in their rules. These approaches can be seen as alternative standards by the two states using these approaches or may complement a statewide, volume-based standard built on a local-level dilution threshold for counties or cities that continue to experience odor issues.

Texas uses a different approach from a dilution threshold standard to measure odor. It is the only state MAD found that uses what they call odor-based values as described by the acronym FIDOL: frequency (how often an odor is experienced), intensity (how strong the odor is), duration (the duration that the odor is experienced), offensiveness (how unpleasant the odor is to most people), and location. At a high level, the process behind deriving an odor-based value using this method includes (1) identifying data describing odor character, (2) determining if the chemical is from a class of chemicals known as malodorous, and (3) searching for available odor threshold data. Following this data gathering, a value is determined based on professional judgement. See Appendix B: List of regulations and sources reviewed for a white paper that describes the FIDOL approach in greater detail. Aspects of the FIDOL method are included in the definitions of an objectionable odor or odor nuisance in rules in other states and municipalities.

Similar to Texas, Oregon (see Appendix B: List of regulations and sources reviewed) has inspection staff refer to an odor intake form to evaluate the odor frequency, duration, intensity, and offensiveness reported by complainants. The standard that would prompt an odor investigation would require ten individuals from separate addresses over a sixty-day period to file a complaint about an odor.

Public comments

In July 2023, MPCA gave notice requesting comments on any relevant issues related to the planned new rules governing air quality, referred to as the Odor Management Rule. [This link will go to the website requesting comments from the public and industry.](#) This initial request for comments specifically outlines the following seven points that MPCA has been directed to issue rules on:

1. Establish that “no person may cause or allow emission into the ambient air of any substance or combination of substances in quantities that produce an objectionable odor beyond the property line of the facility that is the source of the odor.”
2. Identify the types of facilities that are exempt from the odor management requirements.
3. Establish an odor standard or standards for air pollution that may qualify as an objectionable odor under Minnesota Statutes, section 116.064.
4. Define the process for determining if an odor is objectionable.
5. Define the process for investigating and addressing odor complaints.
6. Provide guidance for what must be included when developing odor management plans.
7. Determine procedures and criteria for determining the success or failure of an odor management plan.

Three organizations provided comments in response: the Minnesota Chamber of Commerce, the Minnesota Asphalt Pavement Association, and Sanimax. Below is a summary of each of these comments followed by related findings from interviews and a review of regulations that address each comment provided.

Minnesota Chamber of Commerce

The Minnesota Chamber of Commerce (Chamber) is a business organization, representing over 6,300 businesses of various types and sizes across the state. Their mission is to lead the business community statewide to advance pro-business, responsible Minnesota public policy to create jobs and grow the economy.

The Chamber wrote comments on each of the seven points above. Each bullet point below represents a summary of the comments made by the Chamber for each of the seven points outlined above by MPCA. Each sub-bullet contains related findings from interviews and review of regulations that address each comment made.

- The Chamber believes a rule will be most effective if (1) it creates an objective and science-based approach that can be practically implemented, and (2) is based on a review of approaches and lessons learned from odor management rules implemented by other states and localities (1).
 - Most agencies interviewed identified that a science-based approach should be used to keep odor regulation as objective as possible on what is a very subjective topic. A review of lessons learned from other agencies that have regulated odor that speak to keeping rules objective can be found in the Practices that work well for industry, the public, and regulating agencies section.
- The Chamber requests that MPCA describe the process for determining whether any entities fall under exemptions. They also believe there are likely additional source or event types that should be exempt from the rule, such as emergency or disaster incidents that create short-term and/or isolated odors (2).

- Some odor regulations mention exempt facilities. Colorado has exemptions that currently exist for agriculture. Missouri also has exemptions for agriculture operations as well as charcoal facilities.
- Any odor standard should be clear on any numeric thresholds as well as the approach to applying those thresholds in real situations. Terms used in the legislation require definitions or how they will be applied in the context of the rule, for example, “unreasonably expected to be” and “objectionable.” MPCA should also specify how an odor management rule will interact with other state and federal rules or compliance requirements. The Chamber also requests MPCA describe how standards will be applied, such as an action level that triggers an investigation or a red line that must not be exceeded (3).
 - Numeric thresholds have been used in nearly every state regulation reviewed (specifically a dilution threshold) and a list of terms and definitions are shown at the start of nearly every regulation reviewed. There are currently no federal odor ambient air standards.
- Procedures should address requirements in the legislation prescribing aspects of an investigation. For example, if there is a requirement in the law for an investigation if there are ten or more odor complaints within 48 hours, clarity is requested on the process: should these complaints come from ten different people? May the complaints be anonymous? Can they be submitted to the same agency? Similarly, the Chamber requests clarity behind what it means to consult a “random sample of persons” to determine whether an odor is objectionable based on a collected odor sample. Finally, the Chamber suggests MPCA utilize a set of criteria over one or two factors in determining an objectionable odor. One suggestion is to use FIDOL to characterize an odor: frequency, intensity, duration, offensiveness, and location. A composite set of criteria coupled with a clear procedure will enable entities to take proactive action when there may be objectionable odors (4, 5).
 - Numeric thresholds have been used in nearly every state regulation reviewed (specifically a dilution threshold) and a list of terms and definitions are shown at the start of nearly every regulation reviewed. There are currently no federal odor ambient air standards.
- The Chamber said an odor management rule must go further than what is currently outlined in the enabling legislation for what should be included in an odor management plan. The Chamber requests MPCA provide specific guidance on required plan elements and MPCA’s procedures for reviewing and approving odor management plans. They mentioned that addressing odors is an iterative process and that it is important that the rule anticipates improvements over time and is thus clear on the compliance status of entities that are following their odor management plan, meeting permit and regulatory requirements, and seeking improvements. MPCA should also include guidance on analyzing cost effectiveness and potential allowances for situations where technology does not exist to control specific odors or control may be cost prohibitive (6, 7).
 - Each interview with statewide agencies has identified how their standards are applied and what would trigger an investigation. Specific methodology behind how an investigation is conducted for states with odor regulations can be found in their regulation. As of this writing, Texas was the only state found to use FIDOL to characterize an odor specifically in their odor management rules, though methodology identified in regulations elsewhere uses a set of criteria similar to FIDOL in defining what is considered an objectionable odor or odor nuisance.
 - More information behind what has reportedly been most effective in creating an odor management rule can be found in the Common practices and recommendations from interviewees section.

Minnesota Asphalt Pavement Association

The Minnesota Asphalt Pavement Association (MAPA) is a group that represents the voice of the asphalt industry by acting as a liaison to state and local agencies, providing technical assistance to members to provide a quality product, and keeping membership informed of new technologies and training. The following three bullets represent a summary of their comments. The paragraph that follows contains relevant findings from interviews and a review of regulations that address each comment provided.

- MAPA seeks clarification on whether exemptions for refineries contained within Minnesota Session Law—2023, Chapter 60, H.F. Number 2310 apply to asphalt production plants.
- Asphalt mix plants are classified under NAICS 324, which includes refineries and are heavily regulated by the MPCA and USEPA. It is MAPA’s belief that asphalt plants should be considered exempt from the rule. MAPA also cites that in 2002, the EPA officially delisted asphalt plants as a major source of air pollution, with asphalt being composed of only 5 percent petroleum products, otherwise mostly being made of stone, sand, and gravel.
- MAPA mentions strides taken by the asphalt industry in controlling and reducing odors, as well as the use of odor-capture systems available for tanks and natural odor neutralizing agents that can be used. It is also mentioned in this comment that in the absence of odor regulations, asphalt plants are subject to general air quality regulations that help control odors, including emissions control requirements, operating permits, and regular inspections.

In interviewing agencies and reading regulations, no asphalt plants were identified as specific exemptions. An interview with the Nevada Division of Environmental Protection mentioned asphalt plants were a facility commonly regulated under their odor rules for the state and may be a useful reference.

Sanimax

Sanimax is a provider of agriculture and animal nutrition products that renders by-products from the agri-food industry such as meat, cooking oil, and grease into useful materials. The bullet points below represent a summary of the comments made. The paragraph that follows contains relevant findings from interviews and a review of regulations that address each comment provided.

- Sanimax requests that MPCA look for practical rules based on the difficulty it experienced in enforcing the original odor rule that was previously established before being repealed in 1995. Sanimax requests looking at other jurisdictions that have practical odor regulations that could serve as guidance, with one example being the FIDOL method used by the Texas Commission on Environmental Quality. Sanimax also requests that MPCA ensures that whatever rules are ultimately promulgated should be the same across the state and enforced in the same manner.
 - The Common practices and recommendations from interviewees section lists suggestions to use for writing practical odor rules.
- Similar to the Chamber, Sanimax commented on the seven points identified by MPCA’s Request for Comment:
 - Sanimax requests that MPCA consider updating the language of the rule from the boundary beyond the property line for the regulation of objectionable odors to being beyond the facility because the reference point to a geographic boundary “beyond the property line” is vague

without a property survey in hand. Additionally, the strict prohibition (“no person may”) on objectionable odors is unrealistic as certain businesses deal in inherently odorous inputs and are unlikely to eliminate all odors, even when using the best available odor mitigation technology and best practices to mitigate odors (1).

- The Colorado interview mentions difficulty in measuring odor at or beyond property lines and may be a useful resource for this issue.
- Sanimax notes that most if not all of the exempted facilities produce and contribute to odors in the seven-county metropolitan area and that non-exempted facilities such as Sanimax should not bear responsibility for such odors because it did not receive a legislative exemption (2).
- Sanimax requests that MPCA should consider using the FIDOL method to determine objectionable odors because “objectionable” cannot be a single value. If the agency chooses to use a numerical standard, it should rely on people, and not on exclusively analytical tools such as the Nasal Ranger to assess the results. Further, the people making the assessments should have adequate training and sensitivity training (3).
 - As mentioned in the comments provided by the Chamber, Texas is the only state found to use FIDOL to characterize an odor specifically in their odor management rules, though methodology identified in state regulations elsewhere uses a set of criteria similar to FIDOL in defining what is considered an objectionable odor or odor nuisance. More information can be found in the Common practices and recommendations from interviewees section regarding how to characterize objectionable odor and setting a standard.
- Sanimax requests that MPCA consider the FIDOL factors and use of trained investigators to determine if an odor is objectionable because the investigators are significantly better equipped to assess the FIDOL factors and to determine if an odor is objectionable than analytical equipment, which is largely limited to identifying chemical compounds (4).
 - Training and certification offered by organizations such as St. Croix Sensory Labs and RK & Associates may provide a more accurate measurement of odors than a tool alone, such as a Nasal Ranger.
- Regarding the process for investigating and addressing odor complaints, Sanimax requests that the rules provide requirements associated with “verifiable odor complaints” to establish that a complaint is genuine and assist in identifying the source. For example, being able to differentiate between ten complaints from one individual or ten complaints from one community, such as an apartment complex. Second, Sanimax requests that the rule should establish a procedure for identifying the source of the odor due to the nature of odors and effects of the ambient environment. The rule should require complaints to include information necessary to complete a follow-up investigation, including the date, time, location, description of the odor, and any physical effects experienced. Finally, Sanimax believes MPCA should establish qualitative criteria for selecting a “random sample of persons” to ensure reliable results when assessing odors. Sanimax also requests that MPCA clarify the language in subdivision 4(b), which seems to suggest a Tedlar bag of ambient air would be collected and then tested. Sanimax cautions against testing air in this process because it is not likely to produce useful results when in the field (5).

- Steps can be taken in creating an online form that will require an odor complaint to include personal information (e.g., date, time, location, description of odor) as well as details on the odor itself to deem it a “verifiable odor complaint.”
- Sanimax requests that the language of the rule includes operational changes as a means of reducing odor in the odor management plan. Sanimax also mentions that it can be very useful for MPCA to visit facilities that are developing odor management plans because a site visit can provide MPCA and the facility with valuable information about site operations and provide insight into what is happening at the facility to potentially cause an objectionable odor (6).
 - Information behind practices identified for an odor investigation can be found in the Common practices and recommendations from interviewees section, as well as practices for an odor management plan.
- Sanimax requests that MPCA consider multiple measures for demonstrating the success of the odor management plan, including when the management plan reduces the number of complaints below the standard that triggers a facility inspection; when the local government decides, through its own processes, not to forward complaints; when nonagency action might resolve the issue; or when a facility utilizes best management practices (7).
 - Due to the complexity of what may generate odors across industries, all agencies interviewed described odor management plans as being primarily drawn up by a facility that was reviewed and signed into action by the agency. Local laws can also complement state regulations to address odor. See the rules for Denver and Colorado in Appendix B: List of regulations and sources reviewed.

Appendix A: List of interviewees and contact information

Interviewee	Type of entity	Link to website
North Dakota	State	Air Quality—North Dakota Department of Environmental Quality (nd.gov)
Des Moines	Municipality	Neighborhood Inspections (dsm.city)
Colorado	State	Air Pollution Control Department of Public Health & Environment (colorado.gov)
Denver	Municipality	Air Quality—City and County of Denver (denvergov.org)
Louisville	Municipality	Odors LouisvilleKY.gov
RK & Associates	Environmental and engineering consulting group	ABOUT US—RK & Associates Inc (rka-inc.com)
Missouri	State	Air Pollution Control Program Missouri Department of Natural Resources (mo.gov)
Kentucky	State	Air—Kentucky Energy and Environment Cabinet
Nevada	State	Air NDEP (nv.gov)
Minneapolis	Municipality	Health—City of Minneapolis (minneapolismn.gov)
St. Croix Sensory Labs	Sensory evaluation laboratory	Homepage—St. Croix Sensory, Inc. (fivesenses.com)

Appendix B: List of regulations and sources reviewed

Region applied to	Regulation name	Link to document	Health-based versus quality of life focus	Odor standard
Connecticut	Section 22a-174-23 - Control of Odors	Section 22a-174-23— Control of odors, Conn. Agencies Regs. § 22a-174-23 Casetext Search + Citator	Both	Dilution threshold of 7:1
Colorado	Regulation 2 Odor Emission 5 CCR 1001-4	Air Quality Control Commission regulations Department of Public Health & Environment (colorado.gov)	Quality of life	Dilution threshold of 7:1
Delaware	Title 7 Natural Resources and Environmental Control 1100 Air Quality Management Section	1119 Control of Odorous Air Contaminants (delaware.gov)	n/a	No person shall cause or allow the emission of an odorous air contaminant such as to cause a condition of air pollution
Illinois	Part 245 Odors	PART 245 ODORS : Sections Listing (ilga.gov)	Quality of life	Dilution threshold of 8:1 on residential, recreational, institutional, retail sales, hotel, or educational premises; 24:1 on industrial premises; 16:1 on other premises

Region applied to	Regulation name	Link to document	Health-based versus quality of life focus	Odor standard
Kentucky	Regulation 010: Ambient air quality standards	Title 401 Chapter 53 Regulation 010 • Kentucky Administrative Regulations • Legislative Research Commission	Both	Dilution threshold of 7:1
Massachusetts	Section 143: Trade or employment attended with noisome and injurious odors: assignment of places	General Law—Part I, Title XVI, Chapter 111, Section 143 (malegislature.gov)	Public health	No person having control of any dust or odor generating operations shall permit emissions therefrom which cause or contribute to a condition of air pollution
Missouri	Missouri Code of Regulations Section 10 Restriction of Emission of Odors	Section 10 CSR 10-6.165—Restriction of Emission of Odors, Mo. Code Regs. tit. 10 § 10-6.165 Casetext Search + Citator	Quality of life	Dilution threshold of 7:1
Michigan	Michigan Administrative Code Section R 336.1901—Air contaminant or water vapor	Section R. 336.1901—Air contaminant or water vapor; prohibition, Mich. Admin. Code R. 336.1901 Casetext Search + Citator	Both	Odor intensity odor scale with anything at level 3 or above (out of a scale from 0 to 5) as being an unreasonable interference with enjoyment of life and property
Nevada	Nevada Administrative Code Section 22087 Odors	NAC: CHAPTER 445B—AIR CONTROLS (state.nv.us)	Both	Dilution threshold of 7:1

Region applied to	Regulation name	Link to document	Health-based versus quality of life focus	Odor standard
North Dakota	North Dakota Administrative Code Chapter 16 Restriction of Odorous Air Contaminants	North Dakota Administrative Code—Title 33.1 Article 15 Chapter 16 (ndlegis.gov)	Both	Dilution threshold of 7:1
Oregon	Department of Environmental Quality Nuisance Odor Report	DEQ Nuisance Odor report (oregon.gov)	n/a	Odor intake form measuring frequency, duration, intensity, and offensiveness
West Virginia	45 CSR 4: To prevent and control the discharge of air pollutants into the open air which causes or contributes to an objectionable odor or odors	Q:\AIR_QUALITY\RULES\45-04.wpd (wv.gov)	n/a	No person shall cause, suffer, allow, or permit the discharge of air pollutants which cause or contribute to an objectionable odor at any location occupied by the public
Texas	Approaches to Derive Odor-Based Values	Development Support Document (texas.gov)	n/a	FIDOL scale to derive odor-based values
Denver, Colorado	Denver Code of Ordinances Section 4-10. —Nuisance.	Chapter 4—AIR POLLUTION CONTROL Code of Ordinances Denver, CO Municode Library	Both	Reg II of Colorado; receiving five or more complaints within a thirty-day period

Region applied to	Regulation name	Link to document	Health-based versus quality of life focus	Odor standard
Denton, Texas	Denton, Texas—Code of Ordinances Section 17.21. —Odors	Denton, Texas.pdf (nonoise.org)	Both	Unlawful for any person to create or cause any unreasonably noxious, unpleasant, or strong odor which causes material distress, discomfort or injury to persons of ordinary sensibilities
Des Moines, Iowa	Des Moines, Iowa—Code of Ordinances Article V. —Odor Control	ARTICLE V. —ODOR CONTROL Code of Ordinances Des Moines, IA Municode Library	Quality of life	No person shall erect, continue, or use any building or other place that occasions odor pollution
Hillside, Illinois	Section 42-15. —Odor nuisance.	Chapter 42—HEALTH AND SANITATION Code of Ordinances Hillside, IL Municode Library	Both	Unlawful for any owner or operator of premises within the village to cause or allow odor to emit beyond the boundaries of the real property which 1) creates odors which are offensive, 2) endangers the health and welfare of persons, 3) creates a detrimental effect on the use and enjoyment of property, and 4) interferes with the enjoyment of life, health, safety, peace, comfort, or property of other persons
Louisville, Kentucky	Regulation 1.13 Control of Objectionable Odors in the Ambient Air	Regulation 1.13—Control of Objectionable Odors in the Ambient Air, Version 7 Louisville Metro Air Pollution Control District 2023 (louisvilleky.gov)	Both	No person shall emit or cause to be emitted into the ambient air such quantities of air contaminants or other material that creates an objectionable odor beyond the person's property line

Region applied to	Regulation name	Link to document	Health-based versus quality of life focus	Odor standard
San Francisco Bay Area, California	Regulation 7: Odorous Substances	Reg 7 Odorous Substances (baaqmd.gov)	Quality of Life	Dilution rate based on elevation (Table I) or concentration of chemical compounds (Table II)
San Luis Obispo, California	Chapter 8.22 Offensive Odors	Ch. 8.22 Offensive Odors San Luis Obispo Municipal Code	Quality of life	Receiving three or more verified complaints from individuals representing separate households within a one-month time span
Shreveport, Louisiana	Section 58-2. – Emission of odor nuisances or odorous air contaminants	Chapter 58—NUISANCES Code of Ordinances Shreveport, LA Municode Library	Quality of life	Dilution threshold of 7:1
Sioux City, Iowa	Chapter 4.78. Odor Control	Document Viewer Municipal Code (encodeplus.com)	Quality of life	No person shall erect, allow, operate, or continue to use any building or facility that creates an environment which the resultant emissions are deemed a public nuisance
Ontario	Regulation 419/05: Air Pollution – Local Air Quality	O. Reg. 419/05: AIR POLLUTION - LOCAL AIR QUALITY (ontario.ca)	Both	A person shall not discharge or cause or permit the discharge of a contaminant listed in Schedule 2 into the air if the discharge results in the concentration of the contaminant at a point of impingement exceeding the half hour standard set out for the contaminant in Schedule 2
Quebec	Processing of environmental reports	Processing of environmental reports (gouv.qc.ca)	n/a	n/a

Appendix C: Interview questions template

Interview questions

Questions would be removed, added, or modified based on previous review of each agency's regulation.

Questions about terminology

- What constitutes an odor nuisance?
- Was there a focus on quality of life, public health, or both (or neither) when writing these rules?

Questions about methodology/implementation

- What constitutes an odor complaint?
- What initiates an odor investigation?
- What type of facilities do you typically receive complaints about, are any exempt?
 - What kinds of facilities are exempt, and why? Is the process of exempting described somewhere?
- How often are you unable to determine the origination of the odor, and then what?
- Were there any articles/sources that defined criteria behind methodology?
 - Number of complaints received before investigating
 - Odor detection threshold (for example odor detectable when diluted with seven volumes of odor-free air)
 - Timing for making measurements (will vary by agency but for example, 2–3 samples taken in a one-hour period with each sample taken 15 minutes apart)
 - Tools or methods used in measuring odorous air (for example, olfactometer, panel, scentometer)
 - If they use a panel of residents, how do they select them?
- Do you generally rely on these rules you have in law or anything else when regulating/enforcing odor nuisance emissions?
- What was the process like behind drafting these rules?
 - How/why did you choose the methodology (*i.e.* scentometer, olfactometer) you did, and do you regret it?
- What universe does the rule apply to (*i.e.* permitted facilities; any business; residents; specific zoning areas, *etc.*)
- How many odor complaint investigations are conducted each year? How many complaints do you get each year?
- How many staff do you have dedicated to doing odor investigations?

Questions about penalties

- (If not specified) What happens if the rules are violated?
- (If enforcement exists) Does the amount fined feel effective in preventing odor emissions?
 - Was there a process behind coming to number you did for the fine?
 - What other violations have a similar penalty?

- (If a compliance plan is mentioned) Does this compliance plan seem effective in preventing odor emissions?
 - Do they require plans as part of penalties or earlier as part of planning or permitting?
 - How do they 'approve' a plan?
 - What are the criteria for a plan being deemed 'successful'?
 - What guidance or list of plan requirements do they provide to the facility?
 - What are the most common actions facilities take, and how well do they work?
- How many investigations result in enforcement?
 - How many of those cases involve a monetary penalty?

Questions about lessons learned

- What is working really well?
 - From the perspective of industry
 - From the perspective of the public/community
 - From the perspective of the regulating agency
- What would you do differently in retrospect?
- What suggestions do you have for a state undertaking this rulemaking?
- Do you have any examples or case studies of odor inspections/enforcement related to your programs that worked particularly well?
- Is there an odor program you've heard good things about or would recommend as a model?
- Are any of the guidance documents, forms, etc. online where we can take a look at them?
- Can we contact you again with follow-up questions as we write the rule and develop our implementation plans?

Specific questions for each specific entity were included in the space below.

Appendix D: Interview Summaries

This section contains summaries of interviews conducted with the agencies and firms MAD spoke with to learn more about odor rulemaking and signed off on having the notes shared in the report.

States

North Dakota

The [Division of Air Quality](#) (DoAQ) in the North Dakota Department of Environmental Quality is responsible for odor investigation and enforcement in the state. The North Dakota state administrative code [Chapter 33.1-15-16](#) (Restriction of Odorous Air Contaminants) guides odor management. MAD interviewed a representative of the DoAQ.

Methodology and implementation

- North Dakota is concerned with both public health and quality of life in respect to odor management.
- Odor complaints are accepted in any form, including email, letter, or phone call.
- Typically, a first-time complaint for a facility will result in DoAQ contacting the facility to inform them of the complaint. If additional follow-up is needed and/or additional complaints are received for the same facility, DoAQ will investigate further. Should the information provided to the DoAQ be deemed excessive in nature, immediate action may be taken.
- No facilities are exempt from the odor rules.
- It is rare that the source of an odors would be unidentifiable during an investigation. If the source of the odor is not identified, DoAQ would keep monitoring until the odor and the source were identified.
- The specific rule created for odor (Chapter 33.1-15-16) can be used only to determine whether a facility is not in compliance with the state rules. A civil judge would determine whether an odor nuisance has been created that infringes upon local rules, laws, or ordinances.
- The legislature treated odor management as primarily a local zoning issue when drafting the rule because odor is subjective and there is no federal standard.
- About twenty complaints are submitted in per year. Only a portion of those complaints require detailed investigation by DoAQ.
- No staff are dedicated to odor within DoAQ. The role of odor investigation and compliance is handled by staff of various programs of DoAQ, including Oil & Gas, Permitting, and Compliance.

Enforcement and penalties

- Odor violations are rare in North Dakota. When a violation occurs, the facility or source is issued a letter. The facility must reply to DoAQ in writing and provide an odor management plan to correct the issue.
- If an odor management plan is necessary, the facility is given fifteen days to implement the plan. DoAQ verifies whether the odor management plan is in place. If it is not in place, the facility or source may be issued a notice of violation and a fine may follow.

- A calculation matrix is used to calculate the fine, which can be up to \$10,000 per day per violation.
- Investigations rarely result in enforcement because facilities and sources seldom exceed the odor standards.
- North Dakota is an agriculture-friendly state and uses a dilution threshold of 7:1 that represents an agriculture-friendly perspective.

Lessons learned

- From the perspective of industry, this rule provides a framework for facilities to adhere to and makes them cognizant of what they have to do to be good neighbors.
- From the perspective of the public, this rule lets the community know they can call with any concerns related to odor.
- It is considered a well-written rule for what North Dakota needs to monitor regarding odor.
- This interviewee suggested that Minnesota reach out to Minnesota county or city commissioners because there are issues that may be best handled locally.

Kentucky

The [Division for Air Quality](#) (DfAQ) in the Kentucky Department for Environmental Protection is responsible for odor investigation and enforcement in the state. The Kentucky state law [401 KAR 53:010](#) (Ambient Air Quality Standards) guides odor management. MAD interviewed a representative of DfAQ.

Methodology and implementation

- Kentucky does not use a nuisance standard when assessing what is considered an odor nuisance. The standard does not apply without a complaint that would start an evaluation or investigation.
- Kentucky is concerned with quality of life in respect to odor management.
- Odor complaints are accepted in any form, including phone, email, online, or mail. If the complaint is combined with burning or dust, DfAQ addresses those concerns first with rules applicable to those pollutants and then address odor if the other control measures do not resolve the odor. The DfAQ tries to look at situations holistically.
- The policy of DfAQ is to respond to all reasonable citizen odor complaints with an investigation.
- There are no facilities that are exempt from this rule. The only area not subject to this rule is Jefferson County because they have an approved local air control program and local odor ordinance they enforce.
- The standard is generally applicable and applies to all “ambient air,” referring to the portion of the atmosphere outside of buildings to which the general public has access.
- The most common facilities DfAQ receives complaints about include landfills, wastewater treatment systems, and concentrated animal feeding operations (CAFOs).
- It is not common for DfAQ to be unable to determine the origination of an odor. When it does happen, wind direction is considered, and observations are made upwind and downwind of locations based on the suspected odor source. If no source can be identified and the odor is not ongoing, the investigation is closed pending future complaints.

- The state rule has been in effect since 1979. The most likely source of the methodology used comes from the US Public Health Service guidance from the 1950s that developed the scentometer and dilution threshold criteria.
- Kentucky uses a dilution threshold of 7:1 as the threshold for a violation. The tools used to determine this threshold is either the Barneby-Chaney style (US Public Health Designation: Scentometer Model 1959-A) or Nasal Ranger brand scentometers.
- On average, DfAQ receives four hundred complaints a year and conducts about three hundred investigations. There are wide swings in the number of complaints received if there is an active odor problem from a facility or community action to address a specific issue.
- The air inspection staff who conducts the odor investigations, excluding Jefferson County, is comprised of forty-eight environmental scientists.

Enforcement and penalties

- First-time offenders with no extraordinary circumstances are typically documented as a violation by an inspection report with a requirement to alleviate the odor. Multiple or high-impact violations result in the issuance of a Notice of Violation (NOV) with a requirement to submit a corrective action plan to alleviate the odor. Failure to respond to ongoing odor violations are referred to the Division of Enforcement to seek a penalty and coordinate corrective action and settlement of the violations.
- DfAQ does not issue many NOV letters after a single violation. If facilities are responsive and work with the division, an NOV may not be issued in the first place.
- The maximum civil penalty limit is set by statute at no more than \$25,000 per day, per violation. The enforcement staff use the administrative law precedent case *NREPC versus Maggard*, which lays out the general factor to consider when assessing a penalty below the maximum amount.
- Fines are rare in enforcement.
- Odor correction plans are used in response to enforcement actions and are not normally part of DfAQ's permitting process. The effectiveness of the plan is determined by the results. If the odor violations continue, the plan did not work.
- Odor issues are situational and site dependent. Therefore, the detail of each plan is negotiated on a case-by-case basis.
- Technically, it only takes one investigation to result in enforcement, but discretion is used to allow time to fix the issue before resorting to an enforcement referral and penalty.
- Violations and enforcement are rare. An average of 5 percent of odor investigations result in a violation. Of those, few are referred for further enforcement.

Lessons learned

- DfAQ advocates writing odor rules the way Kentucky has done it. The plan took some of the subjectivity out of odor, and the odor inspectors resolve a lot of problems that do not make it to inspection reports or do not reach the threshold of 7:1 violation. The inspectors still work with the parties to offer suggestions to increase awareness.
- From the perspective of the industry, it is helpful to have an objective standard that is not "no odor" that also does not apply unless there is a citizen complaint. DfAQ works with facilities to bring the issue

to their attention and take the lead on efforts in cases where they may not be taking complaints more seriously.

- DfAQ is responsive to all citizen complaints of odor in the ambient air. The public may not be satisfied with the speed at which investigations take place or believe that an odor is strong enough to result in a violation, but it is helpful to have a responsive agency that addresses most violating odor problems in a timely manner by working with the source to identify that there is a problem that must be addressed.
- DfAQ is satisfied to have what they see as a fair, impartial, and reasonable odor standard that can be used to address quality of life issues in Kentucky.
- Program staff are satisfied with the form and implementation of the standard. The staff considers it less subjective than a nuisance type standard while not requiring an absolute “no odor” standard. The odor must be very strong to still be detectable after 7:1 dilution.
- There is nothing DfAQ would do differently based on the odor rules in law right now. The only perceived flaw is dealing with CAFO issues, as there is only so much an agricultural operation can do to address odors in a cost-effective manner. This makes for difficult negotiations.
- DfAQ suggests Minnesota write a law how it appears for Kentucky: use a 7:1 ambient standard and use field olfactometry with a complaint trigger that would start an investigation.

Colorado

The [Air Pollution Control Division](#) (APCD) in the Colorado of Public Health and Environment is responsible for odor investigation and enforcement in the state. The Colorado state law [Regulation II 5 CCR 1001-4](#) (Odor Emission) guides odor management. MAD interviewed a representative of APCD.

Methodology and implementation

- Colorado is concerned with both quality of life and public health in respect to odor management. In drafting these rules, APCD looked at precedents of when similar rules were drafted in the 1970s and found both areas were considered.
- An odor complaint is based on any correspondence received in the state, regardless of magnitude. Complaints are received via phone, email, and online.
- An odor investigation will take place when an odor complaint is made. This involves visiting the site and determining if a violation of exceeding a dilution threshold of 7:1 exists and, if so, pursuing various routes to address it as outlined in APCD’s enforcement and penalties based on the case.
- The most common facilities APCD receives complaints about include oil and gas development, cannabis (both production and residentially), and any industry close to neighborhoods. More complaints may come as cities expand closer to industry.
- Exemptions currently exist for agriculture.
- It is rare that APCD cannot find the source of an odor. It is more common that they pinpoint the source but cannot find a reading that approaches the dilution threshold of 7:1.
- All investigations and enforcement rely on the steps outlined in Regulation II; all permits reference the thresholds established by Regulation II.
- While there are exemptions for agriculture, this rule generally applies to businesses because they have permits that need to abide by regulation constraints.

- APCD receives 150–200 complaints a year that result in about 150 investigations.
- About twenty-five certified individuals are dedicated to doing odor investigations on a state level. When including municipalities, eighty individuals conduct odor investigations.

Enforcement and penalties

- The facility is notified immediately of a violation by APCD. The facility is given time to address the issue, then given a second reading. If complaints continue, they are logged. A more thorough investigation will be conducted for a facility that has received multiple violations.
- A compliance plan can be enacted that would address the underlying cause of the odor and performance of the facility. The plans are developed by APCD with some possible correspondence with the facility to ensure the plan is realistic.
- APCD sees a successful compliance plan as one that is measurable so it can be proved that conditions have been met. Examples of this include timelines, numerical metrics, and readings per day or month relevant to what needs to be addressed.
- APCD also aims to have a plan that can be maintained long term that would prevent any new complaints to be made against the source.
- Fines can be levied on a source that range from a few hundred to thousands of dollars depending on the severity of the violation. It is very rare for violations to occur and even more rare for any fines to be levied on a facility.

Lessons learned

- From the perspective of APCD, the way the regulation quantifies odor (7:1) works well as a ratio of clean air and odorous air. They noted that Denver experienced difficulty in trying to base rules on the number of complaints received over time, which they said can feel like a “witch hunt.” The rule is more methodical about measuring what is in the air compared to how clean the air should be.
- Although they like a volume-based approach to quantifying clean versus odorous air, APCD thinks the 7:1 ratio could be lowered to a smaller ratio like 5:1. In the past, they have found facilities that are emitting odorous air but are not technically in violation of the standard because they could not find a reading at a 7:1 ratio.
- When asked what suggestions they may have for a state undertaking this rulemaking, they recommended using a volume-based approach. More categorizations would also be useful because it is difficult to have broad categories for odor rules across many industries. Isolating a facility in question can be difficult, and it may help to broaden the boundary for the odor reading to contain multiple industries at once (e.g., measuring the boundaries of a car painting business next to a dry cleaner together).
- It is effective to reach out to any source ahead of time to try to work with them to reduce any odor emission prior to finding a definitive violation that would break the threshold outlined in law.

Missouri

The [Missouri Department of Natural Resources](#) (MDNR) is responsible for odor investigation and enforcement in the state. The Missouri state law [Section 10 CSR 10-6.165](#) (Restriction of Emission of Odors) guides odor management. MAD interviewed three representatives from MDNR.

Methodology and implementation

- Section 10 CSR 10-6.165 is a rule focused on odor rather than odor nuisances. It will not evaluate whether or not an odor is a nuisance, but rather if an odor concentration, pleasant or bad, is in violation of their 7:1 dilution threshold standard.
- One aspect Missouri is concerned with, in relation to odor management, is quality of life.
- Odor complaints are gathered via phone, or an online platform set up by MDNR.
- After receiving a complaint, an investigation will take place. Prior to investigating, a check will be made to ensure the complaint does not reside in a different jurisdiction dedicated to handling air issues or if the complaint is for an exempted facility. The investigation itself consists of surveillance of the area to detect any odors, then measuring any odors found with a Nasal Ranger to see if it exceeds the 7:1 dilution threshold.
- Agriculture operations and pyrolysis of charcoal facilities are considered exempt from this rule.
- When MDNR is unable to determine the odor source, they consider wind direction and the kind of odor being emitted to tie it to a source. It is rare that the origination of an odor cannot be found, as a 7:1 violation is a strong odor.
- The rules have been in place since the 1960s, so it is not known what articles or sources were used that defined the criteria behind the methodology of this rule. However, stakeholder meetings are held by MDNR, and the Nasal Ranger has been demonstrated to show how odor is investigated and enforced.
- This rule applies across the state in Missouri (minus exempted facilities), though MDNR have not received complaints on residential areas resulting in a violation of the 7:1 dilution threshold.
- On average, eighty to one hundred odor investigations are conducted each year with more complaints being received (for the same source).
- No one at MDNR is dedicated to just odor investigations.

Enforcement and penalties

- If a violation occurs, MDNR's regional office issues a notice of violation (NOV) to the source. Most cases start with compliance assistance; MDNR inspectors work with the facility to try to resolve the issue without elevating it. If that cannot happen, the case is referred to the compliance enforcement section in the Air program.
- From that point, a penalty may be assessed, and a consent agreement is created between the agency and source. This agreement is a legal document that may include corrective actions, documentation of the violation(s), and penalties.
- Penalties are levied from a grid that calculates how much a penalty should be based on the perceived harm caused by a violation. The maximum fine is \$10,000 per day, per violation.
- MDNR considers a successful odor compliance plan one with the ability to control an uncontrolled process to reduce odor emissions. An example process noted was installing a control device, adding a

timeline, including milestones with stipulated penalties associated with the timeline, and proving that it works in reducing odor emissions.

- It is rare that investigations result in enforcement, but about ten letters of warning are issued per year. Many inspectors will proactively work with sources even if a formal violation is not found to prevent any future violations.

Lessons learned

- This rule works well for the public because it gives the community ample opportunity to reach out to MDNR if there is a source that is emitting odors of concern.
- MDNR has found success in being able to proactively work with facilities to take care of any sort of odor emissions, even if they are not direct violations of the rule. Odor issues can point to other issues such as water or control devices.
- MDNR encouraged the use of the Nasal Ranger as a nationally recognized instrument in measuring odors.
- When asked what suggestions they may have for a state undertaking this rulemaking, MDNR said to be aware that there are no perfect rules for odor. Odor is a difficult issue to address given its subjectivity. Given its subjectivity, one rule cannot solve all problems and may be perceived by the public and industry as being too restrictive or lenient.

Nevada

The [Nevada Division of Environmental Protection](#) (NDEP) is responsible for odor investigation and enforcement in the state. The Nevada state law [NAC 445B.22087](#) (Odors) guides odor management. MAD interviewed a representative from NDEP.

Methodology and implementation

- “Anything that tends to be offensive to the senses” is the regulatory language used that constitutes an odor nuisance. NDEP looks at hazards and air pollutants as well.
- Complaints are sent in via phone, and any complaint received is investigated.
- The most common facilities NDEP receives complaints about are asphalt plants and battery recycling facilities.
- There are no exempt facilities for this odor rule.
- It is rare that NDEP is unable to determine the origination of an odor. They can generally determine where an odor originates from but may not have specifics behind it.
- This rule applies to all stationary source air permits. Any residential complaint would be referred to a county.
- NDEP receives on average fifteen to thirty complaints a year, which leads to five to ten investigations each year.
- There are eight staff dedicated to doing odor investigations, two supervisors and six staff in the compliance program. Other teams such as the permitting team can be brought in as needed to solve a specific problem.

Enforcement and penalties

- If a rule is violated, NDEP speaks with twenty people affected by the odor to get an understanding of what they are experiencing. An odor measurement is then taken with a Nasal Ranger. NDEP reaches out right away to the facility they have received a complaint about to work with them.
- NDEP uses a 7:1 dilution threshold. A formal violation at this threshold level is extremely rare.
- NDEP still works with facilities to solve any odor problems that fall below the 7:1 threshold by going over processes and controls and talking about what people are experiencing and will resolve the issue that way. The compliance staff are the people who initiate the meeting between NDEP and a facility. Sometimes a facility hires a third party to evaluate the process and make recommendations.
- NDEP does not take the role of approving plans but do contribute to a facility's permits.
- The individual we spoke with was not aware of any investigations that resulted in enforcement.

Lessons learned

- NDEP feels their rule works well because people can reach out to them with a complaint that starts the discussion. They can often refer individuals to a county based on the complaint.
- NDEP feels that industry is receptive to work with NDEP to solve problems.
- NDEP feels that better coordination can exist between their agency and counties, especially in the event of staff change over time. Having some sort of mechanism in place to keep coordination going may help prevent disruptions from staff turnover.
- When asked for suggestions they have for a state undertaking this rulemaking, NDEP suggested more collaboration between states to learn what is working well.

Municipalities

Des Moines

The Des Moines [Neighborhood Inspections Division](#) (NID) is responsible for odor investigation and enforcement in Des Moines. The Des Moines Code of Ordinances [Article V](#) (Odor Control) guides odor management. Two representatives from NID and MAD reviewed a PowerPoint presentation that described an overview of their odor enforcement program.

Methodology and implementation

- The city code is 100 percent complaint-based and will not investigate any odor without receiving any complaints. The requirement is to receive ten complaints in a six-hour period.
- NID receives complaints via phone, online form, and fax. The telephone answering service Answer Plus is used when receiving complaints.
- When the condition of receiving at least ten complaints in a six-hour period is triggered, NID maps out the complaints received, charts out the weather, and reviews descriptions of the odor. NID will drive upwind from the source it is coming from to investigate.

Enforcement and penalties

- Article V allows NID to label a facility as two kinds of odor generators: the first is a nonsignificant odor generator that occurs when ten complaints are received for a facility within a six-hour period. Being listed as a nonsignificant odor generator does not have a major repercussion attached to it and is a way to catch the attention of a facility to address any odor emissions. After an odor generator has been identified as a nonsignificant odor generator three times, however, it will be identified as the second kind, a significant odor generator, which has more legal implications behind enforcement.

Lessons learned

- NID underwent an odor study, and it was recommended by those conducting the study to use a Nasal Ranger and build a program off the device. They did not move forward with this recommendation because conditions could not be replicated by the time inspectors could get to the source. This would also be difficult to independently verify in court due to the time and condition constraints.
- One tool NID looked into was Envirosuite, a monitoring device that provides real-time measurements of the most common chemical compounds identified in the odor study, such as hydrogen sulfide. These devices track real-time measurements and are centrally located around known odor emitters. This tool allows for an immediate alert that can be used instead of having inspectors drive out and lose time.
- There has been no immediate pushback from odor-emitting facilities on the use of these devices, though there is hesitation from facilities for where the devices are placed and how weather and conditions may affect odor emission. NID has a good relationship with facilities and work with them to address complaints when any come in.

Denver

The Denver [Department of Public Health & Environment](#) (DPHE) is responsible for odor investigation and enforcement in Denver. The Denver Code of Ordinances [Sec. 4-10](#). (Nuisance) alongside the Colorado state law [Regulation II 5 CCR 1001-4](#) (Odor Emission) guide odor management. MAD interviewed a representative from DPHE.

Methodology and implementation

- Anything that would impact the quality of life regardless of whether an odor has a repulsive smell or not would be considered an odor nuisance.
- DPHE is concerned with quality of life when regulating odor. It is still a subjective term (the enjoyment of life or the use of property), but it is easier to measure and assess than public health. Some compounds can be threatening to public health, but the science around public health and odor has not caught up.
- There are two ways an odor nuisance is determined in Denver: one is when an odor exceeds a dilution threshold of 7:1 (Colorado Air Quality Control Commission Regulation 2) and the other is when DPHE receives five or more complaints from individuals representing separate households or businesses within the city within a thirty-day period relating to a single odor description (Sec. 4-10). These do not have to happen concurrently.
- DPHE has an online system as well as a 311 system to report an odor complaint. Many residents have a direct line to a lead investigator for challenging facilities.

- No facilities are exempt from these odor rules.
- The most common facilities DPHE receives complaints about are cannabis grow operations and pet food manufacturing.
- Investigations can be challenging due to the unique topography of Denver. In the event DPHE is unable to determine the origination of an odor, they will triangulate where it is coming from, move downwind from it, and take a Nasal Ranger reading. Some odors have a distinct smell and DPHE will oftentimes have a decent sense of the sector type this odor is coming from. The next step would be to understand what is going on with the facility.
- These rules apply universally within Denver, but the big sectors are: Pet food manufacturing; Marijuana growing, processing, manufacturing, or consumption; Rendering and meat byproduct processing; Asphalt shingle and coating materials manufacturing; Petroleum refining; Sewage treatment; Wood preservation; and, any other activity determined by the board through a rulemaking to cause, or be likely to cause, nuisance odors.
- DPHE is considering adding other industrial sectors (to be named at a later date) in response to growing citizen concerns.
- Last year, DPHE received several hundred concerns that made it into their system. DPHE mentions the role of social media that can be important here to regarding community engagement. Every complaint is investigated, though what the investigation will entail depends on a number of factors.
- There are three staff in the DPHE who are specifically trained in odor investigations.

Enforcement and penalties

- Given the high dilution threshold, it is rare to have a violation of Colorado Regulation 2 despite receiving many more complaints about various facilities. The nuisance ordinance is more effective and flexible when this happens.
- The DPHE feels the penalty may not be a strong enough deterrent but would like to see more data and have these data be more transparent to the public.
- The odor control plan is seen as an important tool in reducing odor emissions. It is an official document of what the facility is doing around odor. It includes the control technologies used to minimize odors. The plan also has information around what kind of training facility staff is receiving. It requires the facility to document complaints received directly. It gives DPHE something to enforce against as well—not just a bad smell but a failure in meeting the odor control plan. It is an official document signed by a certified professional that is used to document what is happening at a facility and drive change.
- Odor control plans are only good if they are implemented. There needs to be something in the plan to ensure odors are minimized if a facility is non-compliant.
- Very few nuisance matters result in a fine, though this may change in the future as there has been an emphasis on enforcement rather than compliance assistance.

Lessons learned

- DPHE offers compliance assistance to industry. DPHE would love to see more self-regulation of facilities and believe this is a growing trend. DPHE has seen a decrease in marijuana-related odor complaints, for example.

- It is important for regulating agencies to have a dedicated staff and good documentations of standard operating procedures, so everyone is clear on how things are meant to work. Having a documented process helps ensure consistent regulation.
- When asked if they would do anything differently in retrospect, DPHE said they would not change much.
- DPHE recommends working with local government partners. A lot happens at local agencies, and they will know specific industries and communities and their respective concerns. Provide technical and financial assistance to local agencies and work with them to build the infrastructure needed to operate. They will be important allies in compliance and enforcement on a statewide level.
- DPHE recommends that agencies think about the importance of zoning. Issues are exacerbated, in part, from gentrification that is occurring, and proper zoning could lessen the burden on communities.

Minneapolis

The [Minneapolis Health Department](#) (MHD) is responsible for odor investigation in Minneapolis. [Title 3, Chapter 47](#) of the Minneapolis Code of Ordinances relating to Air Pollution and Environmental Protection: Energy and Air Pollution guides odor management in the city. MAD interviewed two representatives from MHD.

Methodology and implementation

- An odor nuisance is determined by using an olfactometer and measuring the odor and area of complaint. If the odor can be detected at a 7:1 dilution threshold, it is considered a nuisance odor and MHD moves forward with enforcement, if possible.
- MHD is concerned with quality of life with odor management.
- Nearly all complaints MHD receives comes through 311 calls. Every complaint is investigated.
- The most common complaints received are for industrial areas or industrial zoned areas. Complaints also come in on coffee companies that are roasting beans.
- No facilities are exempt from an odor investigation or complaints.
- MDH uses a 7:1 dilution threshold based on studies commissioned by the national legislature.
- MHD uses the Nasal Ranger to measure odorous air.
- MHD receives on average one hundred complaints per year for the city. Each complaint is investigated, and investigations can be compiled into a case for repeat offenders.
- There are four staff at MHD dedicated to doing investigations, one for each district. Seasonal technicians will occasionally help as well.

Enforcement and penalties

- If MHD detects an odor beyond a 7:1 dilution threshold, they will send out an order to correct the emission with a due date of about a week followed up by a reinspection similar to the first inspection. If the odor is still detected at the 7:1 dilution threshold MHD will move into violation.
- It is very rare that MHD will need to move into violation and enforcement.
- There have been verbal agreements between facilities and MHD, but there have been no formal odor control plans created.

Lessons learned

- MHD finds that odor is a uniquely difficult area to regulate and enforce due to its subjective nature. By quickly getting an inspector on site with a Nasal Ranger, MHD can reduce some of the subjectivity.
- MHD recommends limiting bias as much as possible. Sensitivity training and certifications can establish which inspectors have acceptable sensitivity and operate more objectively.
- Odor can be an indicator that something is going on that could be detected with an air quality sensor.
- MHD suggests using odor as an aid to enforce air quality as it might not be feasible to directly enforce based on odor. When measuring odor, research how to limit sensitivity bias if odor rules are written for direct enforcement.
- Panels of residents may also be helpful because neighborhoods can vary in terms of industry and the sensitivity of the residents. A panel of residents can determine what a nuisance is in their neighborhood.
- MHD has found most industries try to be good neighbors, especially in grandfathered zones, and will voluntarily attempt to reduce their odor emissions without an order to do so. Industries may become defensive and less willing to work with agencies if enforcement is threatened before they are asked to address an odor emission.

Non-government entities

RK & Associates

RK & Associates is a [consulting group](#) that offers services in odor science, including odor abatement measures, odor control system design, off odor in products, and fundamental sensory properties that include threshold, character, and quality. MAD interviewed a representative from RK & Associates to learn more about the background behind odor sciences and the services the group has provided to facilities related to odor law.

Methodology and implementation

- RK & Associates offers a training for regulating agencies, with a focus on helping the staff understand how odor science plays a role. The federal government does not have a standard for odor regulation, so it is something left to states and municipalities to determine.
- A regulation needs to make a distinction between odor detection and odor nuisances and how that is enforced. Maintaining a uniform, objective standard across the state will help regulate odor nuisances. Having different odor standards for different industries may be challenged in courts by those industries.
- A focus on public health is not always a part of odor regulations because odors themselves do not cause long-term health effects; the chemical producing the odor is what causes the health effects.
- RK & Associates uses two tools in odor evaluation, including a Forced Choice Dynamic Triangle Olfactometer (Model 103) and a scentometer. They are aware of Envirosuite but have seen concerns associated with the device and odors. Specifically, it does not register odor concentration but rather a concentration of a chemical compound that is odorous, which would not be an objective measure for odor.

Lessons learned

- RK & Associates noted that when rules are difficult to work with and implement regulatory agencies are reluctant to establish an objective line of what is considered a nuisance. Having quantitative standards may help disputes between the community and an odor-emitting industry. Industry wants regulations to be a benchmark they can work with, and it is difficult to comply with regulations that are qualitative.
- RK & Associates mentioned rules that regulate odor well are the ones that do so with odor measurements such as dilution thresholds. Rules based on numeric standards show there is a level industry cannot exceed that is approved by the state agency and also provide a baseline on how a violating industry can remain in compliance and monitor their emissions with this rule.
- Lower dilution thresholds such as 5:1 or lower tend to be more difficult to apply as a standard because there is more pushback from various industries.

St. Croix Sensory

[St. Croix Sensory](#) (SCS) is an industry-leading laboratory headquartered in the St. Croix River Valley of Minnesota that offers sensory evaluation services as well as training for odor inspection and evaluation. MAD interviewed the president of SCS.

Odor research

- SCS evaluates the frequency, intensity, duration, and offensiveness of an odor to determine whether it should be considered a nuisance. Location is also considered (for example, if an odor is near a school or on open land). All these elements influence whether people would be bothered by an odor.
- When asked if their focus is more on quality of life or public health when researching odor, SCS said there is a blur between the two. Overall, it comes down to quality of life. However, if being around an odor causes a headache, it does not matter whether that is health-based or a quality-of-life question, it needs to be addressed. Legal cases seem to avoid the health question because it is hard to prove that odor is specifically causing health problems.
- Several countries outside the United States view odor as a potential pollutant that should be addressed similar to how hazardous waste is. Europe focuses it more than other countries on the dilution concept.
- The United States is inconsistent. There is no federal standard, and without statewide processes, there can be legal battles over what should be done. SCS mentioned an example of a state that did have a statewide process in place that proactively addressed an odor issue with cannabis. Colorado could address cannabis odors more objectively by having an existing set of standards in place before statewide legalization.
- To conduct an odor measurement, SCS collects bags of air from a source and then identifies how much dilution is needed to disperse that odor. Europe and Ontario also follow this process for odor evaluation. An additional method other agencies and organizations use to conduct an odor measurement is with a Nasal Ranger. The Nasal Ranger is a tool someone can use to document and start responding to an odor that has been detected. It is a dilution device, monitoring whether someone can smell an odor at each dilution (for example, a dilution of 7:1, 5:1, etc.). While both of these methods can work, what is important to consider is the objective of the data. How you regulate the odor should fit the tool being

used as well as what will come from an inspection (e.g., a fine, odor compliance plan, conversation with a facility). Most US Nasal Ranger customers do proactive and reactive monitoring.

- The sensitivity test kit SCS offers is a 1 to 16 scale used to identify extremes in odor sensitivity for individuals such as odor inspectors. This kit can note trends in how individuals assess odors and can adjust their ratings as needed to provide consistent measurements to an odor evaluation.

Odor regulation

- SCS's current president has not worked with other state or municipal agencies in writing odor rules, though the former president has done so. SCS is usually brought in by facilities or citizen groups that have asked for services related to odor regulation with a focus on the science and objectiveness of odor.
- SCS also works with other consulting groups. Monel Chemical Senses is a group that has worked with both industries in understanding smells and what the community thinks of smells as well as community groups by helping a group plan a legal case against a facility.
- When asked why the 7:1 dilution threshold is so common, SCS said they believe it stems from a rule that has been around a long time that states developed when first writing odor rules in the 1960s. SCS mentioned that Texas relies on a different method (FIDOL, see Common practices and agency recommendations) than a dilution threshold.

Lessons learned

- When asked what to include in effective odor rules, SCS suggested having a process in place that would have facilities cooperate by abiding by a standard and a process that requires some form of enforcement or penalty such as an odor plan if they violate this standard.
- SCS suggested creating a template or outline to use for various steps of odor management, including housekeeping, odor control, and modeling, for example.
- SCS suggested taking a cautious approach when writing this rule for the state. This rule should be carefully thought out and be more in-depth than creating a 7:1 standard and leaving it there. How the data is used and keeping facilities engaged in the process is important.