

# Guidance for Environmental Review of Animal Feedlots

## A guide to the [Alternative Environmental Assessment Worksheet \(EAW\) Form for Animal Feedlots](#)

This guidance provides supplemental information for feedlot proposers about preparing an Environmental Assessment Worksheet (EAW) using the **Alternative EAW Form for Animal Feedlots (Dec 2024 revision)**. The EAW serves as a valuable tool, advising both the public and decision-makers while collecting information that guides permitting decisions. The primary function is to assess the potential environmental impacts of a proposed project and determine whether further environmental review is necessary. An EAW may also indicate how the project can be modified to lessen its environmental impacts. Such modifications may be imposed as permit conditions.

The Environmental Quality Board (EQB) also publishes [EAW Guidance](#) for the EAW process and preparation of an EAW in general. Information in the EQB Guidance may also be useful to feedlot proposers when gathering project-specific information necessary for preparing the alternative animal feedlot EAW form.

## General guidance

The project proposer is required to supply all reasonably accessible data or information to address questions within the EAW form, or as requested by the Responsible Governmental Unit (RGU). The Minnesota Pollution Control Agency (MPCA) is the RGU for Animal Feedlots as identified in Minn. R. 4410.4300, subp. 29. The final EAW (the version reviewed by the public) is required by law to be prepared by the MPCA. If a county will be issuing the feedlot permit, then they are the RGU (counties were not RGU's prior to January 1, 2001). If the county will be issuing the feedlot permit, then they are the RGU (counties were not RGU's prior to January 1, 2001).

## Pre-application meeting

Proposers are strongly encouraged to meet with the MPCA Environmental Review Unit and relevant permit programs prior to the submittal of a draft EAW. Pre-application meetings help to clarify the proposed project scope, desired construction timeframes, applicable MPCA EAW and permit requirements, and relevant steps required by law to complete the process.

## Item specific guidance

1. Enter the same name used on the application for feedlot permits. The name listed on the EAW should indicate the animal species. To avoid possible confusion with similar names feedlots, include a geographic reference (township. Section number). An example of a complete name is *Joe Jones Swine Facility – Norway Township*.
2. The Feedlot Proposer is the entity that has applied for or would receive the approval for the project and not a consultant, attorney, or other entity or person representing the proposer.
  - The person listed as the contact should be familiar with the technical nature of the project and the data provided on the EAW form. The contact may be an engineer or other consultant if so desired by the proposer.
3. The RGU for Animal Feedlots is the MPCA -Environmental Review Unit or the Local Government Unit (LGU). The MPCA will complete this section and the Tempo AI # upon receipt.

4. **Reason for EAW Preparation.** Complete the reason for the EAW preparation and if an EAW is required or discretionary for the proposed project. This determination can be reviewed in the recommended pre-application meeting with the RGU. Indicate which Subpart the project is relevant in Minn. R. [4410.4300, subp. 29\(A\) or subpart 29\(B\)](#), based on Animal Units and if the feedlot is located in a designated Sensitive Area.
- Tables 1 and 2 show the **mandatory EAW and exemption categories** effective July 1, 2003, for construction of new animal feedlots (Table 1) and expansion of existing feedlots (Table 2). The boxes below provide definitions of terms in the tables and the conditions established by the legislature that a feedlot must meet to be eligible for the new exemption.

**Table 1. New animal feedlot construction.**

	Non-sensitive areas		Sensitive areas	
	Exempt?	EAW mandatory?	Exempt?	EAW mandatory?
Number of animal units				
1,000 or more	No	Yes	No	Yes
500-999	Yes, if exemption conditions met.	No	No	Yes
300-499	Yes, if exemption conditions met.	No	No	No
50-299	Yes	No	No	No
Less than 50	Yes	No	Yes	No

**Table 2. Expansion of existing feedlots.**

		Non-sensitive areas		Sensitive areas	
		Exempt?	EAW mandatory?	Exempt?	EAW mandatory?
Number of animal units	Total number of animal units after construction				
1,000 or more	1,000 or more	No	Yes	No	Yes
500-999	Less than 1,000*	Yes, if exemption conditions met.	No	No	Yes
100-499	Less than 1,000*	Yes, if exemption conditions met.	No	No	No
50-99	Not applicable	Yes	No	No	No
Less than 50	Less than 50	Yes	No	Yes	No

**\*If the total cumulative capacity of the animal feedlot of 1,000 animal units or more, the feedlot is not exempt.**

Such animal feedlots are exempt if:

- The application for the animal feedlot includes a written commitment by the proposer to design, construct and operate the facility in full compliance with MPCA feedlot rules; and
- The county board holds a public meeting for citizen input at least ten business days before the MPCA or county issues a feedlot permit unless another public meeting for citizen input has been held regarding the feedlot to be permitted.

For suggestions about holding a public meeting for citizen input consult "[New Exemptions for Environmental Review of Feedlots From 2003 Legislative Session](#)".

5. **Project Location.** Include the location of the feedlot and the manure application fields. Provide the required maps showing all significant project features, environmental conditions, and jurisdictions.
6. **6. Project Description.** If this project is an expansion of an existing feedlot, or if there may be future expansions, it may result in a "phased action." Minnesota Rule requires all parts of phased action be reviewed, which could impact

what is covered in the EAW. Phased actions are discussed in [Guide to Minnesota Environmental Review Rules \(May 2010\)](#) Questions about phased actions can be referred to the RGU.

7. **Climate Adaptation<sup>1</sup> and Resilience<sup>2</sup>.** Following the recommendations provided in EAW Items 7a. and 7b. below will enable the proposer to document the link between local climate patterns and project components within the EAW. This will allow reviewers a standardized method to evaluate climate change impacts efficiently and effectively on the proposed project, the surrounding area, and how the impacts will be considered in the design, construction, operation, and maintenance of the project over the projected lifetime. For additional guidance, refer to the [Minnesota Environmental Quality Board Environmental Assessment Worksheet \(EAW\) guidance for climate adaptation and resilience.](#)

**Note to Proposer:** All figures and tables shown below shall be completed and specific to your project and inserted into the EAW to be submitted.

- **7a.** Describe the climate trends in the general location of the project and how climate change is anticipated to affect that location during the life of the project.
- **Describe historic climate trends<sup>3</sup> and future climate projections<sup>4</sup>.** Determine historical climate trends data for conditions at the start of the project (1980-present) and future projected climate data for conditions during the life of the project (present–lifetime).
- To standardize climate review, address the following four recognized Climate Trends in Minnesota and two Projected Changes that are anticipated to affect the project location during the life of the project.
  - Climate trends (data-driven; changes that are already occurring):
    - Average annual temperature increasing
    - Average annual precipitation increasing
    - Cold weather warming
    - Heavier, more damaging rains
  - Projected changes (model-driven; changes that are projected to occur in the coming years and decades):
    - Increasing risk of heat waves
    - Increasing risk of drought

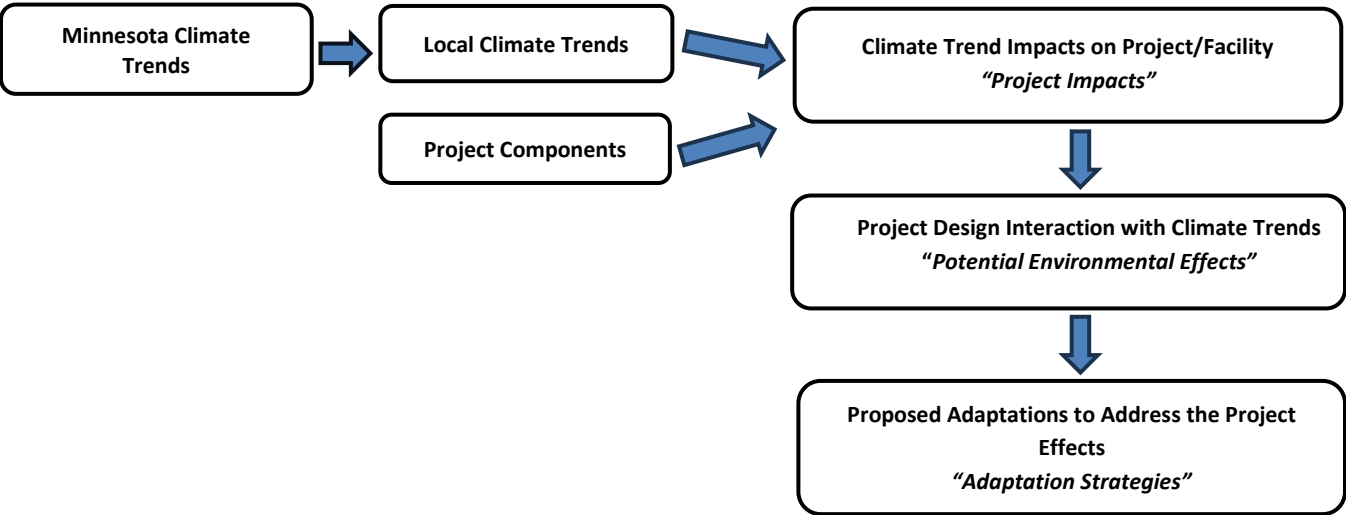
<sup>1</sup> **Climate Adaptation:** Taking action to prepare for and adjust to both the **current and projected** impacts of climate change. For both natural and built systems, humans may intervene to help adjustment.

<sup>2</sup> **Climate Resiliency:** The capacity of social, economic, and environmental ecosystems to cope with a hazardous event, trend or disturbance resulting from climate change.

<sup>3</sup> **Climate Trend:** The observed change in climate variables over a specific period, based on historical data and provide insights into how our climate has evolved.

<sup>4</sup> **Climate Projection:** Predictions of future climate conditions based on mathematical models. Projections consider different scenarios, such as greenhouse gas emissions, land use changes, and other factors.

Figure 1. Climate adaptation and resilience review process.



**Determine the general location of the project.** Establish the most representative geographic unit or location of the project (County/Local Trends).

This item is intended to lay the groundwork for understanding how climate change is likely to affect the area where the project is located throughout the life of the project, shown as “Project Impacts” in Figure 1.

Historic climate trends and projected climate changes are in the first column of Table 3 below. If additional climate trends or projections are included, assess any impacts through each Resource Category and Project Component in Item 7b.

Provide the resource tools used to determine climate trends and projections for the project area in Table 4 below.

Note that when running Minnesota CliMAT, seasonal timeframes may illustrate predicted climate changes better than the annual timeframe.

Table 3. Summary of reported climate trends (*examples shown in italics*).

State of Minnesota historic climate trends (data-driven) and projected climate changes (model-driven)	County/local trends	Project impacts (climate effects on project location)
Average annual temperature increasing		e.g., Site may be subject to increased air conditioning loads to grid, interior and exterior infrastructure.
Average annual precipitation increasing		<i>e.g., Increased run-off and erosion may affect soil/site stability.</i>
Cold weather warming		<i>e.g., Decreased snow cover may affect vegetation cover that leads to increased soil erosion.</i>
Heavier, more damaging rains		<i>e.g., Vegetation changes, stressors, more exposed soils in winter.</i>
Increasing heat waves		<i>e.g., Construction materials may break down quicker in high heat conditions.</i>
Increasing risks of drought		<i>e.g., Limitations on groundwater, surface water for use in dust reduction.</i>
Optional: additional relevant climate variables		

**Table 4. Climate trends and projections resource tools.**

	Climate trend tools	Tools used in the EAW	How the tool was used
	Options from EQB guidance		
Current trends	<a href="https://state.mn.us/climate-trends">Minnesota Climate Trends (state.mn.us)</a>		
Projected changes	<a href="#">Minnesota CliMAT (CMIP6)</a>		
Climate hazard projections	<a href="#">Climate Mapping for Resilience and Adaptation (CMRA) Assessment</a>  <a href="#">Climate Resilience Evaluation and Awareness Tool (CREAT) Climate Scenarios Projection Map</a>		
Additional information	<a href="#">National Climate Assessment (NCA4 Volume II or more recent), especially Chapter 21: Midwest</a>  <a href="#">Chapter 28: Reducing Risk; Maps in Chapters 6 &amp; 7.</a>  <a href="#">Intergovernmental Panel on Climate Change Assessment Report (IPCC 6 or more recent)</a>  <a href="#">Interactive Atlas</a>  <a href="#">National Oceanic and Atmospheric Administration (NOAA) Climate.gov</a>		

- **7b. For each Resource Category in the table shown below: describe how the project’s proposed activities and how the project’s design will interact with those climate trends. Describe the proposed adaptations to address the project effects identified.**

To understand how this project and the climate trends identified in Item 7a could impact the environment, it is important to understand what components of the project are being affected. Project Components include all the new (or removed) elements of this project that could be affected by climate trends, including elements of the site design and the processes/activities happening at the site.

For the Resource Category “Project Design,” determine 3-4 main components of the Proposed Activity. Describe how the project’s proposed activities and how the project design will interact with the described climate trends and projections, described in Item 7a. Describe proposed adaptations to address the climate change risks and vulnerabilities.

Examples of main project components (pick 3-4):

**Site design (physical layout)**

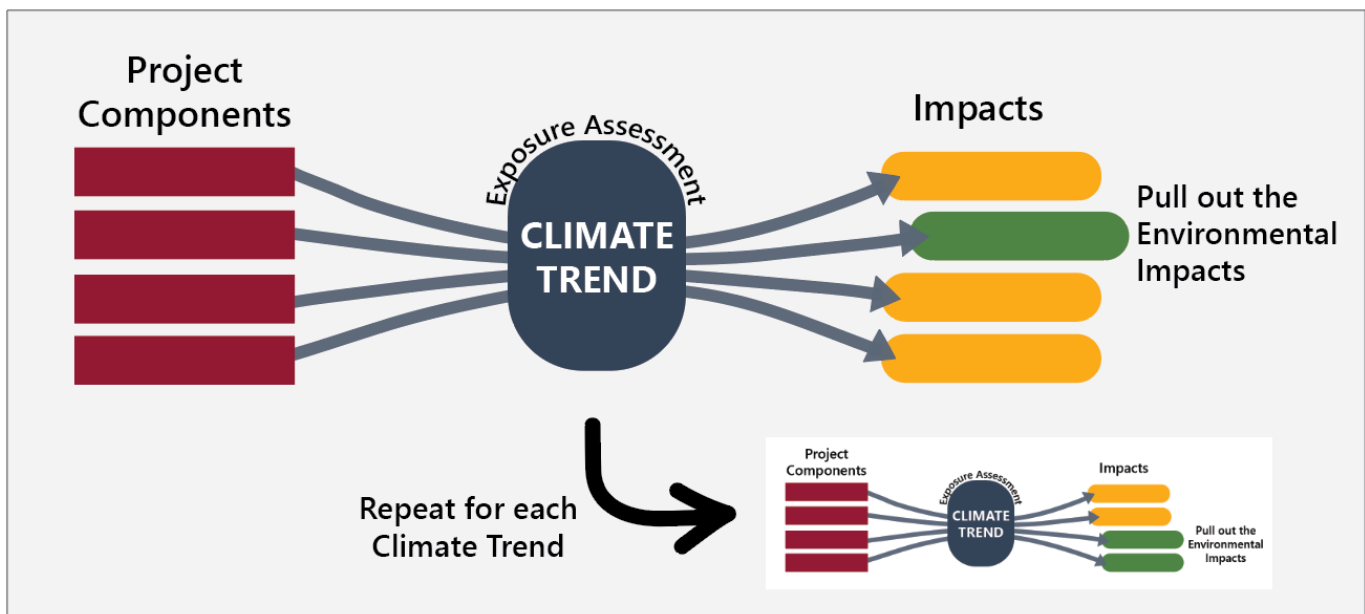
- More, less, or altered buildings.
- More, less, or altered impervious surfaces.
- More, less, or altered habitat/ green space.
- More, less, or altered tree cover.

**Site processes(activities)**

- More, less, or altered hazardous waste.
- More, less, or altered products /by-products/ waste.
- More, less, or altered transportation to and from the site.
- More or less emissions (covered in the GHG section).

Consideration of the interactions between the project components with the climate trends follows the Exposure Assessment process as illustrated in Figure 2, below. Each individual project component is compared against the identified climate trend to evaluate the potential impacts and determine which may impact the environment.

**Figure 2. Exposure assessment**



For the Resource Category “Project Design” in the table below, describe how three or four of the project’s components (Site Design and Site Processes) will interact with each climate trend and projection, shown as “Potential Environmental Effects” in Figure 1, and column four in the table below. Describe proposed adaptations to address the project effects and build resilience to climate change, shown as “Adaptation Strategies” in Figure 1 and column five in the table below.

The remaining Resource Categories (Land Use, Water Resources, Water Resources, HazMat, and Fish/Wildlife/Plants/Sensitive Resources) shall be addressed in their respective item numbers.

**Table. 5. Interaction of proposed activities with each climate trend and projection listed in Item 7a (examples show in italics).**

Resource category	Climate trends and climate projections	Project components	Potential environmental effects <ul style="list-style-type: none"> <li>Identify climate change risks and vulnerabilities.</li> <li>Identify long-term impacts that climate conditions pose to proposed activities.</li> </ul>	Adaptation strategies (with applicable timeframe – construction to end of expected lifespan).
Project design	Average annual temperature increasing	<i>Increased impervious surfaces.</i>	<i>Environmental impact not foreseen with interaction between impervious surfaces and average temperature increasing.</i>	<i>Decrease impervious surfaces where possible.</i>
		<i>Increased constructed surfaces, such as dark roofing and asphalt.</i>	<i>Increased heat absorption during the day that is radiated at night, which increases heat island effect and amplifies warming temperatures of climate change.</i>	<i>Use of light-colored building materials and surfaces to reduce heat absorption. Regular maintenance and updates to infrastructures, as needed, for life of project.</i>
		<i>Increased quantity of concrete and building construction materials, and infrastructure.</i>	<i>Infrastructure more vulnerable to damage and deterioration from elevated temperatures.</i>	<i>Use of construction materials that are resilient to increasing temperatures for the life of the project.</i>
		<i>Increased traffic on Township Road 7 and County Road 24</i>	<i>Increased degradation of blacktop may occur with increased temperature, especially with a milder winter.</i>	<i>Monitor condition of roadway coordinating with local road authorities.</i>
	Average annual precipitation increasing	Repeat project components for each climate trend and projection.	<i>Discuss potential environmental effects with each project component.</i>	<i>List adaptation strategies for each project component.</i>

Resource category	Climate trends and climate projections	Project components	Potential environmental effects <ul style="list-style-type: none"> <li>Identify climate change risks and vulnerabilities.</li> <li>Identify long-term impacts that climate conditions pose to proposed activities.</li> </ul>	Adaptation strategies (with applicable timeframe – construction to end of expected lifespan).
	Cold weather warming			
	Heavier, more damaging rains			
	Increasing risk of heatwaves			
	Increasing risk of drought			
Land use	Address in Item 20			
Water resources	Address in Item 12			
Contamination/hazardous	Address in Item 13			
Materials/wastes				
Fish, wildlife, plant communities and sensitive ecological resources (rare features)	Address in Item 14			



8. **Cover Types.** [See standard EAW Climate Guidance](#) to identify acreage of Cover Types as it relates to Green Infrastructure.
9. **Permits and Approvals required.** Note that *final decisions are prohibited until all appropriate environmental review has been completed*. See Minn. R., Ch. 4410.3100.
10. **Land uses.** Local planning and zoning officials and tribal governments should be consulted about the consistency of the project with any applicable local ordinances. It may be prudent to obtain a letter from the local unit documenting project consistency with local ordinances and to attach a copy to the EAW submission.

Discuss the compatibility of the project activities with the current land use, proposed land use, and zoning, as it relates to the projected climate changes for the project location, described in EAW Item 7b.

- **Current and Proposed Land Use:** Describe the existing and proposed human use of the land, representing the economic and cultural activities (e.g., agricultural, residential, industrial, mining, and recreational uses).
  - **Planned Land Use:** As determined by Comprehensive Plan, Watershed Plan, and any other applicable plan for land use, water, or resource management by a local, regional, state, or federal agency.
  - **Zoning:** As determined by special district overlay such as shoreland or floodplain, and the local zoning designation.
11. **Geology, soils, and topography / landforms.** Distinguish geological characteristics of the project site versus manure application site(s).
  12. **Water Resources.** Describe surface water and groundwater features on or near the project site and manure application areas in the table and on attached maps. Indicate whether any geologic site hazards to ground water or sensitive areas to surface waters are present at the feedlot, manure storage area, or manure application sites. If yes, describe the features, show them on a map, and discuss proposed design and mitigation measures to avoid or minimize potential impacts. If known, address any cumulative impacts of the proposed project or expansion to these water resources.
    - **Water appropriation.** If the project uses more than 10,000 gallons per day or one million gallons per year, DNR requires a permit application to appropriate water. (Minn Stat. 2023.103G.287). A DNR Preliminary Well Construction Assessment is required before the construction of a new water supply well, and a permit application and a valid water appropriation permit is required prior to appropriation of groundwater. Please describe the water source, depth of wells or surface water features, and total volume of water needed for animal use, cooling, and cleaning. Describe proposed measures to ensure maximum efficiency of water use and conservation. For projects on or near Indian Reservations, a tribal permit application may be required for water appropriation. Contact relevant tribal officials for more information if your project is on or near an Indian Reservation.
    - **Other surface waters.** In addition to the standard EAW requirements, describe permanent controls to manage or treat runoff. Identify water resources affected and give the DNR Public Waters Inventory number (PWI) if the water resources affected are on the PWI. Describe proposed mitigation measures to avoid or minimize impacts.
    - **Manure management.** Describe how manure will be collected, stored, transferred (if applicable) and applied. Include a description of any manure processing activities such as liquid solid separation and anaerobic digestion. Attach copy of Manure Management Plan (MMP). If an anaerobic digester will process manure, list any other feedstocks used in the digester.
  13. **Contamination/Hazardous Materials/Waste** – Discuss project-related site conditions on and adjacent to the site. Discuss potential environmental effects from pre-project site conditions, and measures to avoid, minimize, or mitigate adverse effects. Describe solid wastes generated/stored during construction and/or operation of the project. Describe chemicals/hazardous materials used/generated/stored during construction and/or operation of the project including method of storage. Describe the quantities of dead animals anticipated, the method for storing and disposing of carcasses, and frequency of disposal.

**14. Fish, wildlife, plant communities, and sensitive ecological resources (rare features).** The DNR Division of Ecological and Water Resources maintains the Natural Heritage Information System (NHIS), a collection of databases that provides the most comprehensive information on Minnesota's rare natural features (e.g., MBS Sites of Biodiversity Significance, DNR Native Plant Communities). The NHIS public layers are available to view via the Minnesota Conservation Explorer (MCE) or to download from the Minnesota Geospatial Commons. To identify potential impacts to rare features, request a Natural Heritage Review via the MCE. MCE will automatically assess potential impacts to Minnesota's rare features and provide a Natural Heritage Review letter or a notice that further review by DNR staff is needed before a Natural Heritage Review letter can be issued. The Natural Heritage Review letter informs project proposers of any potential impacts to rare features and includes actions to follow state law and recommended measures to avoid or minimize disturbance to ecologically significant areas or state-listed species. The Natural Heritage Review letter should be attached to the EAW and the project proposer should address all issues mentioned in the letter when answering EAW Item 14.

To identify potential impacts to federally listed species, conduct a federal regulatory review using the U.S. Fish and Wildlife Service's (USFWS) online Information for Planning and Consultation (IPaC) tool. Use the information provided when answering EAW Item 14.

**15. Cultural Resources.** Prior to submittal of the EAW, conduct the following due diligence. Contact the State Historic Preservation Office (SHPO) to request a project review. Using the [MN OSA Public Viewer](#), determine if any historic structures, archeological sites, and/or traditional cultural properties are within one mile of the site. If so, contact the Office of the State Archaeologist (OSA) and the Minnesota Indian Affairs Council (MIAC) to request a project review.

**16. 16. Visual.** Proposers need to inquire with local and tribal ordinances and zoning in their area about visual effects.

**17. 17. Air.** Contact the MPCA during the pre-application period for information about required air modeling. For feedlots Hydrogen sulfide, ammonia, and odor are modeled.

- Hydrogen Sulfide is modeled and compared to the MAAQs for 5-day. Hydrogen sulfide is also modeled and compared to the 13-week Inhalation Health Risk Values (iHRV). Note, the method of identifying the High-Third-High during the 5-year modeling run will also indicate modeled violations of the annual MAAQs standard for hydrogen sulfide.
- Ammonia is modeled and compared to the hourly and annual iHRVs for ammonia.
- Odor is modeled and evaluated according to the odor rating system developed by the University of Minnesota.

Modeling of air emissions for feedlots is done according to the MPCA Air Dispersion Modeling Practices manual. An Air Emissions Risk Analysis (AERA) may be required per MPCA's Environmental Review Unit EAW [Air Assessment Practice Guidance](#). The study and results must be summarized in the EAW to provide information about the potential for significant air or odor impacts.

To address potential cumulative air impacts, the modeling must include appropriate background concentrations for hydrogen sulfide (H<sub>2</sub>S) and ammonia (NH<sub>3</sub>). Guidance on obtaining an appropriate background hydrogen sulfide concentration can be found in [Guidelines on Air Quality Models, 40 CFR Ch. I \(7–1–99 Edition\), Appendix W to Part 51 \(section 9.2\)](#). The modeling protocol developed by the proposer should be reviewed by the MPCA in a pre-application meeting before the modeling study is undertaken. Modeling requirements: H<sub>2</sub>S, NH<sub>3</sub>, odor. Be sure AERA is included.

**18. Greenhouse Gas (GHG) Emissions/Carbon Footprint** – Use the [MPCA Feedlot GHG Calculator](#) to determine animal emissions from the project. For all other GHG emissions, there are many calculation tools available. Proposers may utilize the tool that best fits their needs to calculate emissions from the project. One option is the [Simplified GHG Emissions Calculator | US EPA](#). For more tools, refer to the [Environmental assessment worksheet \(EAW\) guidance June 2024 \(Table 6\)](#). Proposers must reference the tool utilized. If calculating emissions using a spreadsheet; cite the emission factors.

19. **19. Noise** – Provide a discussion of how the project proposer determines the effect of noise in the vicinity of the project and define what is considered vicinity as it relates to noise. Reference state, local, tribal, and federal noise standards. Include a quality-of-life definition. For example - the cumulative impact of the proposed project on noise in the area, environmental justice concerns (Minn. Stat. 116.065).
20. **Transportation** Use the format and procedures described in the [Minnesota Department of Transportation's Access Management Manual, Chapter 5](#) or a similar local guidance.

# Appendix 1. Agency contacts and other resources

The following agencies may review an EAW or provide information on how to appropriately respond to questions on the EAW form.

## Minnesota State Agencies

- [Department of Agriculture](#)
- [Department of Health](#)
- [Department of Natural Resources](#)
- [Department of Transportation](#)
- [Environmental Quality Board](#)
- [Metropolitan Council](#)
- [Minnesota Geospatial Commons](#)
- [Minnesota Geological Survey](#)
- [Minnesota Indian Affairs Council \(MIACC\)](#)
- [Minnesota State Historic Preservation Office \(SHPO\)](#)
- [Minnesota Pollution Control Agency](#)
- [MPCA Tribal Contacts List](#)

## Federal agencies

- [Army Corps of Engineers](#)
- [National Fish and Wildlife Service](#)
- [Natural Resources Conservation Service](#)
- [US Forest Service](#)

## Appendix 2: Glossary of terms

**Animal units:** EQB's rules use animal units as defined in the MPCA chapter 7020 rules.

**Blind valley:** A valley that terminates abruptly at a point where its stream sinks, or once sank, underground. As sinks develop higher up the blind valley, the original valley termination may be dry under most flow conditions.

**Cave:** A natural underground room or series of rooms and passages large enough to be entered by a man; generally formed by solution of limestone.

**Dry valley:** Valley that lacks a permanent surface stream. Dry valleys are common on carbonate rocks with good primary permeability, such as the chalk, and occur on other permeable rocks such as sandstone. Dry valleys on cavernous limestone were formed when streams flowed on the surface, either before secondary permeability and cave systems developed, or when caves were blocked by ground ice in periglacial climates. The valleys became dry when underground drains formed or were re-opened, capturing first part and then all the surface drainage.

**Karst:** (noun): A landscape created on soluble rock with efficient underground drainage. Karst is characterized by caves, dolines, a lack of surface drainage and other climatically controlled features, and is mainly, but not exclusively, formed on limestone. The name derives from the German form of Kras – the Classical Karst straddling the border between Slovenia and Italy. In this original, temperate, karst the dominant landforms are dolines, but contrasting landscapes are the pinnacle, cone, and tower karsts of the tropics, and the fluviokarst and glaciokarst of colder climates. The uncapitalized term “kras” originally denoted bare, stony ground in the Slovene language. (adjective) Features, characteristics or functions produced by the solution of soluble geologic materials.

**Karst window:** Depression revealing a part of a subterranean river flowing across its floor, or an unroofed part of a cave.

**Resurgence:** Point at which an underground stream reaches the surface and becomes a surface stream. In European literature, the term is reserved for the reemergence of a stream that has earlier sunk upstream.

**Sensitive areas:** Shorelands; delineated flood plains (along Red River only includes 1,000 feet from bank); federal, state, or local wild and scenic river districts; within 1,000 feet of a karst feature (sinkhole, cave, disappearing spring, resurgent spring, karst window, dry valley, or blind valley); and vulnerable parts of delineated drinking water supply management areas.

**Sinkhole:** General terms for closed depression. They may be basin, funnel, or cylindrical shaped.

**Spring:** Any natural discharge of water from rock or soil onto the surface of the land or into a body of surface water.

From **A Glossary of Minnesota Karst Terminology**, Jeffrey A. Green, MnDNR, & Calvin A. Alexander, Jr., University of Minnesota, May 1999.