

Siting Animal Production Facilities and Evaluating Odor Control Options Using the Odor Footprint Tool

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Species: Swine, Poultry, Dairy and Beef
Use Area: Animal Housing and Manure Storage
Technology Category: Facility Siting
Air Mitigated Pollutants: Odor

Description:

As animal production and rural communities have changed, and the facilities in which livestock and poultry are raised have grown in size, neighbors of animal feeding operations increasingly are expressing concerns about degradation of air quality. The presumed presence of offensive odors commonly is near the top of the list of issues and complaints. Livestock and poultry producers, community planners and officials, and rural residents in general, benefit from having objective, easily visualized information upon which to make well-informed decisions regarding odor impact, siting of facilities, and odor control.

The Odor Footprint Tool (OFT) is a worksheet/spreadsheet that provides objective, science-based information on the risk-based impact of odors generated by livestock facilities. The user enters information about the livestock facilities for a given site, the site location (for selection of regional weather data), use of supplemental odor control, and any special terrain around the site. After using the Odor Footprint Tool, the user obtains minimum setback distances in four directions matching up with targets for avoiding odor annoyance (Figure 1).

NEBRASKA ODOR FOOTPRINT TOOL			
Setback Distance Results			
Project title:	Example	Prepared for:	
Site location:	Southeast, NE	Prepared by:	
		Date prepared:	
		Source Facility 1	Source Facility 2
Type of facility:		Swine, Finishing Bldg Deep pit	Swine, Nursery Bldg Deep pit or Shallow pit
		Manure Storage Steel/concrete tank	
Number of identical facilities:		4	1
Total plan area:	(sq. ft.)	32,000	6,000
Total number of animals:		4,000	1,500
Base odor control:		No supplemental odor control implemented	No supplemental odor control implemented
Alternate odor control:		Biofilter: All cool season air is vented.	Geotextile cover (at least 2.4 mm thick)
Terrain:		North Flat terrain	East Flat terrain
			South Flat terrain
		Terrain Adjusted Separation Distance (miles)	
BASE PLAN		North	East
	90%	0.33	0.07
	94%	0.45	0.14
	96%	0.62	0.26
	98%	1.12	0.41
	99%	1.97	0.69
			South
			0.24
			0.39
			0.52
			0.98
			1.84

Figure 1. An example of information provided and results obtained when using the Odor Footprint Tool.

Mitigation Mechanism:

The Odor Footprint Tool does not directly mitigate emissions. By using the Odor Footprint Tool, producers and their advisors can mitigate neighbor impacts of odor and air-borne pollutants through improved siting of facilities. They can also use the Odor Footprint Tool to assess the benefit of odor control technologies in terms of reduced area of odor impact, which encourages the utilization of effective control technologies.

An odor footprint is a visual picture (top view) of the risk-based odor impact of livestock facilities. Specifically, it outlines the area that is not expected to meet a selected target for avoiding odor annoyance. The minimum separation (or 'setback') distance needed from the livestock facility in a given direction is the extent of an odor footprint in that direction.

Odor footprints generated directly from dispersion modeling show the extent of risk-based odor impact in precise detail, but require specialized resources and expertise. Once baseline modeling is performed for a location, simplified footprints can be developed fairly readily for the region using commonly available resources and expertise. Simplified footprints show risk-based impact areas relative to the largest setbacks needed in one or more directions. The resulting footprints typically show fairly conservative pictures of risk-based impact areas.

The Odor Footprint Tool provides minimum separation distances to maintain in four directions around animal production facilities to meet selected risk-avoidance targets. These directional setback distances extend to the north, south, east, and west of the given facilities (Figure 2); or to the northeast, southeast, southwest and northwest. The orientation of the setback distances aligns one direction with the direction of maximum exposure to annoying odors. The science behind the separation distances comes from the use of best-available research on the rates at which farm odors are given off, move and disperse. Use of historical weather records from a representative location within a region and field validation with trained human odor assessors (Stowell et al., 2008) help make the results credible.

The Odor Footprint Tool is intended to be used as a planning and screening tool to help make timely, well-informed decisions when siting livestock facilities and evaluating odor control options. Producers, their advisors, local officials, and interested rural residents should find utility in using the Odor Footprint Tool on an informational basis. There are pros and cons of including the Odor Footprint Tool as part of local/county ordinances, and considerable thought needs to be given as to how this can be done expediently and fairly across differing types of animal production operations.

Applicability:

The Odor Footprint Tool applies directly to odor given off by animal production facilities. Conceptually, the results for odor have application for airborne pollutants in general, in terms of the relative shapes of footprints; but the Odor Footprint Tool is currently calibrated only for assessing odor transport (Koppolu et al., 2004).

The Odor Footprint Tool is best suited for use with housed swine, cattle and poultry. Tables 1 and 2 list the facility types for animal housing and manure storage, respectively, that accommodate use of the Odor Footprint Tool. For swine, especially, greater differentiation is made between production groups and types of facilities. The results best represent spatially concentrated animal housing and manure storage facilities.

The Odor Footprint Tool may be utilized to assess the reduction in the size of a facility's odor footprint due to use of proven odor control technology. Table 3 highlights odor control technologies that are currently incorporated into the Odor Footprint Tool. We anticipate adding to this list as independent field research verifies expected percentage reductions in odor.

The Odor Footprint Tool is designed for use on a regional basis within a state. Presently, required modeling has been performed to facilitate using the Odor Footprint Tool in Nebraska (six regions) and South Dakota (3 regions).

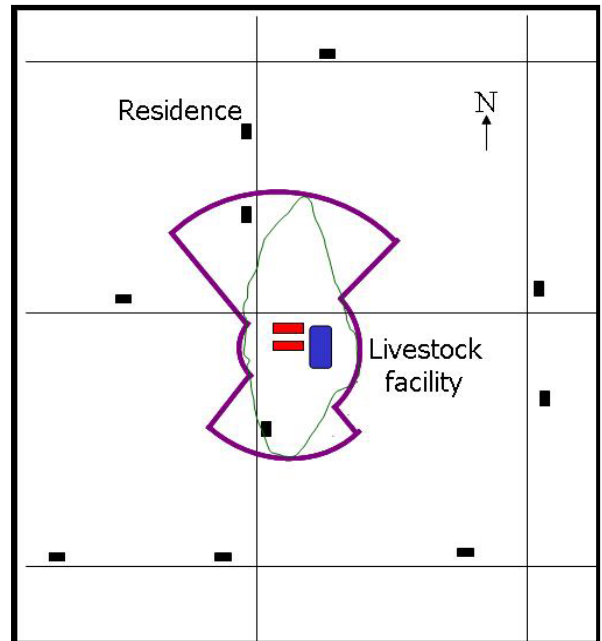


Figure 2. Odor footprints illustrate the risk-based odor impact of livestock facilities.

Table 1. Applicable animal housing facilities for use with the Odor Footprint Tool.

Species	Type/Stage of Production	Type of Facility
Cattle	Beef	Dirt/concrete lot (area is seldom dry)
	Dairy	Scraped freestall barn
		Slatted-floor barn over deep pit
		Loose housing, scraped
		Tiestall barn
Swine	Gestation	Deep-pit building
		Shallow-pit building, (e.g. pull plug system)
	Farrowing	Shallow-pit building, (e.g. pull plug system)
	Nursery	Deep or shallow pit
	Finishing	Deep-pit building
		Shallow-pit building, (e.g. pull plug system)
		Hoop barn, deep-bedded & scraped
Cargill / open front, scrape		
		Loose housing, scrape
		Open concrete lot, scrape
Poultry	Broiler	Floor-raised on litter
	Turkey	Litter

Table 2. Applicable manure storage facilities for use with the Odor Footprint Tool.

Type of Facility	
Manure storage facility	Earthen basin
	Steel or concrete tank, above or below ground
	Crusted stockpile

Limitations:

Calibrated odor emission numbers are not presently publicly available for some facilities commonly found in U.S. central plains states and other areas – such as open cattle feedlots (“dry lots”) and anaerobic treatment lagoons. A reasonable amount of information is needed on both the amount of odor emitted by the facility and how odor leaves the site. In both cases, this information is less challenging to obtain from animal housing/buildings than from open, expansive surfaces that are directly influenced by the elements.

The Odor Footprint Tool presently does not account for odors that may result from land application of manure. These infrequent, but certainly not inconsequential events need to be considered for their additional odor impact.

The Odor Footprint Tool is not calibrated to use raw, unscaled emission rates or emission numbers scaled for use with another setback estimation tool (e.g. OFFSET).

Application of the Odor Footprint Tool is limited by the degree of difference in weather patterns between the site and the weather station locations. To obtain reasonably realistic odor footprints and setback information, baseline dispersion modeling needs to be performed using representative weather data (from a not-too-distant regional airport, National Weather Service station, etc.).

A major goal for the Odor Footprint Tool is that it be easy to use. To avoid the tool being too complicated, time-consuming, and expensive for practical use in the field, the Odor Footprint Tool incorporates a number of assumptions and simplifications – such as limited definition of the precise shape of the odor footprint. When application of the tool does not fit the description given in the preceding section very well, or a more precise and defensible picture of the shape of the odor footprint is required, dispersion modeling for the given specific situation is recommended.

Cost:

The primary costs associated with the Odor Footprint Tool are upfront costs of calibrating and validating the dispersion model for use with livestock odors and performing dispersion modeling using weather data for a specific area. In Nebraska and South Dakota, these costs have been largely covered by grant funds made available to the respective Land-Grant Universities.

There is no direct cost charged for using the publicly available versions of the Odor Footprint Tool to obtain directional setback distances; nor is there any charge for getting basic Extension information/assistance by phone/e-mail when using the tool. While developing plans for a new or expanded facility, a producer may work with a private consultant who uses the Odor Footprint Tool. In these situations, it is reasonable to expect to pay for consultant time associated with using the tool (< 1 hour involved in most cases), getting their technical response and recommendations, creating project-specific visuals (e.g. illustrating directional setbacks on aerial photograph or plat map), and presenting material to permitting authorities, local zoning commissions, lenders, etc.

Some operations may want a more precise and technically defensible odor impact assessment – such as an operation seeking information to bolster its position concerning the expected level of odor impact of proposed new facilities or defending itself against a lawsuit concerning existing facilities. A preliminary estimate of baseline private consulting charges associated with performing and supporting site-specific dispersion modeling is \$15,000-30,000 per site. While such information and service has its place and value, going beyond using the relatively simple Odor Footprint Tool for planning and screening purposes probably cannot be justified economically for most common scenarios and herd/flock sizes.

Table 3. Applicable odor control technologies for use with the Odor Footprint Tool.

Odor Control Technology	
No supplemental odor control implemented on the facility	
Biofilter used to treat air from exhaust fans	Fully mechanically ventilated facility; biofilter treats 100% of exhaust air
	Mild-weather airflow is provided by fans; biofilter treats all airflow from these fans
	Biofilter treats only airflow from minimum ventilation fans
Oil sprinkling used to control dust within building	
Geotextile cover (at least 2.4 mm thick)	
Straw or natural crust on manure	2" thick
	4" thick
	6" thick
	8" thick
Impermeable cover	

Implementation:

To directly use the Odor Footprint Tool, a prospective user needs to access the worksheet or spreadsheet version of the OFT and follow instructions provided in the associated user's manual. On-line access to the Nebraska's OFT resources is now available via <www.manure.unl.edu>, within the Odor and Air Quality section. As an alternative to learning to use the Odor Footprint Tool, producers may contact Extension or work through a consultant/advisor.

Use of the Odor Footprint Tool is usually of greatest benefit when used early in the planning process. Therefore, we advocate that producer advisors and consultants be aware of the Odor Footprint Tool and, ideally, be trained to use the OFT. Training workshops conducted by University of Nebraska Extension are available for individuals who are likely to use the Odor Footprint Tool in regular interactions with producers. Training involves a commitment of 3-4 hours of contact time.

Regardless of who actually navigates the Odor Footprint Tool, information must be available on the:

- Proposed site location and what region(s) may be most representative of this location climate-wise;
- Type of facility(ies) to be built on the site;
- Basic dimensions of the facility(ies);
- Type of odor control being considered, if any;
- Desired or required annoyance-free frequency(ies) to be maintained; and
- The terrain surrounding the facility.

Technology Summary:

The Odor Footprint Tool is a worksheet/spreadsheet that provides objective, science-based information on the risk-based impact of odors generated by livestock facilities. The user enters information about the livestock facilities for a given site, the site location (for selection of regional weather data), use of supplemental odor control, and any special terrain around the site. After using the Odor Footprint Tool, the user obtains minimum setback distances in four directions matching up with targets for avoiding odor annoyance. The Odor Footprint Tool can help assess the reduction in the size of a facility's odor footprint due to use of proven odor control technology.

The Odor Footprint Tool is currently suited for assessing the risk-based odor impact of housed swine, cattle and poultry, as well as spatially concentrated manure storage facilities. The Odor Footprint Tool is not currently well-suited for use with large, open area sources (open lots, lagoons) or land application.

The Odor Footprint Tool is designed for use on a regional basis within a state where baseline dispersion modeling has been performed. Application of Odor Footprint Tool results in other areas will be limited by differences in regional weather patterns.

There is no direct cost charged for using the publicly available versions of the Odor Footprint Tool to obtain directional setback distances. The primary costs associated with the Odor Footprint Tool are upfront costs of calibrating and validating the dispersion model and performing dispersion modeling using weather data for a specific area.

Additional Resources:

The worksheet and spreadsheet versions of the Odor Footprint Tool are available at <www.manure.unl.edu>, within the Odor and Air Quality section, along with the following related resources.

Understanding Odor Footprints and the Odor Footprint Tool (FAQs)

Odor Footprints and the Odor Footprint Tool: An Overview

Determining Separation Distances Using the Odor Footprint Tool: User's Manual for the Worksheet-Based Tool

Determining Separation Distances Using the Odor Footprint Tool: User's Manual for the Spreadsheet Tool

Acknowledgments:

Funds to support research, development and/or demonstration of the Odor Footprint Tool were provided by:

Nebraska Department of Agriculture
USDA CSREES National Research Initiative
Nebraska Environmental Trust

Nebraska Pork Producers Association / NPB
South Dakota Pork Producers Association

References:

- Koppolu, L., D. Schmidt, D. D. Schulte, and L. Jacobson. 2004. Development of scaling factors (peak-to-mean ratios) through dispersion modeling with AERMOD and field-based odor measurements for livestock facilities. ASAE paper # 044196. ASAE, St. Joseph, MI.
- Stowell, R. R., K. R. Niemeir, and D. D. Schulte. 2008. Validating the Odor Footprint Tool Using Field Data. 2008 Nebraska Swine Report, EC 219, p. 39-41 Institute of Agriculture and Natural Resources, University of Nebraska - Lincoln.

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As published in the proceedings of:

MITIGATING AIR EMISSIONS FROM ANIMAL FEEDING OPERATIONS CONFERENCE

Iowa State University Extension
Iowa State University College of Agriculture and Life Sciences

Conference Proceedings

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