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Manure Storage Systems

EXPERT REVIEWED

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Introduction

Manure storage structures are defined in the state CFO and CAFO rules as "any pad, pit, pond, lagoon, tank, building, or manure containment area used to store or treat manure, including any portions of buildings used specifically for manure storage or treatment." Manure storage structures must be designed and managed to contain manure, wastewater, contaminated runoff, and manure mixed with litter or bedding without any discharge to the waters of the state.

If discharge of manure occurs, contamination of water sources can cause nutrient enrichment resulting in algae blooms, reduction of oxygen levels, and fish kills. Contamination with bacteria and elevated nitrogen compounds (ammonia or nitrates) can also cause a human health risk. Typically, stored manure and wastewater are applied to cropland or pastureland so plant nutrients can be used by growing crops.

While all livestock operations permitted in Indiana must abide by the conditions listed in the their current permit, all liquid manure storage structures constructed since 2002 must have at least 180 days storage capacity. This storage must contain the following:

- manure from the animals;
- any bedding used, if applicable;
- net average rainfall during this time that falls on an uncovered manure storage and on any area that drains into the manure storage;
- expected run-off from a 25-year, 24-hour rainfall event that falls on any area that drains to the storage;
- process wastewater (parlor wastewater, silage leachate); and
- 2-ft of freeboard if the storage is uncovered. It should be noted that an uncovered storage does not need to include the expected rainfall from a 25-year, 24-hour rainfall event that falls on the storage surface since the required 2-ft of freeboard should be large enough to contain this in Indiana.

This fact sheet defines different types of manure storage structures, explains the primary design and construction criteria required in Indiana, set back distance considerations, safety and odor control measures, and closing requirements.

Manure Storages

The type of storage structure used depends upon the physical consistency of the manure to be stored and whether manure treatment is a part of the manure management system. A solid manure storage structure is generally a concrete pad with at least three side walls where the manure is stacked. In poultry operations, solid manure is often stored in the same building housing the animals, either in the form of litter (bedding) in floor level pen facilities or in deep underfloor pits in the case of layers. In some poultry facilities, solid manure is transferred on a daily basis to an outside roofed storage.

Liquid manure on Indiana farms is typically stored in one of the following types of structures:

- deep pits under the building floor housing the animals,
- outside below ground earthen pits or concrete storages,
- outside above ground tank storages,
- treatment lagoons, and
- holding ponds.

Typically, deep pits under building floors, earthen pits, and above ground tanks are used to store slurry liquids for swine and dairy. Treatment lagoons are earthen structures that store diluted manure for an extended period and encourage biological treatment to minimize organic matter (BOD), nitrogen, and the settling of nutrients in a sludge layer at the bottom of the lagoon. Treatment lagoons are sometimes used for dairy, swine, and beef cattle operations. Below ground outside earthen storages are typically used to store undiluted manure. They are much smaller than a properly functioning treatment lagoon and any treatment that takes place is incidental. With cattle, these storages typically form a crust on top which traps odors within the waste. With swine and poultry manure, no crust is formed so earthen storages can be expected to be a more significant source of odor. Holding ponds are used to store dilute contaminated runoff water, processed wastewater from the production unit, milk house wastewater, and other dilute wastes.

Design

Proper design of manure storages and treatment lagoons is important for the safe and efficient handling of manure and wastewater and requires using proper construction criteria and sizing the structure large enough to meet at least the 180 day storage requirement for a specific size of the operation. In the case of a treatment lagoon, it also involves sizing properly to ensure proper bacterial action to accomplish proper treatment and odor control.

The 2-foot freeboard level (2-foot below) required for all uncovered storage structures means that producers must start emptying a storage structure when the liquid level reaches the 2-foot freeboard at the top of the storage and not allow the liquid go higher than this level. It is important to protect the earthen berms from failure and prevent catastrophic losses of manure.

An emergency spillway must be installed in newly permitted manure storages and lagoons that receive precipitation runoff from an area that is at least half the size of the manure storage surface. This does not include the surface area of the uncovered storage itself. The emergency spillway must direct any storage overflow to a secondary containment, other manure storage structure or an approved vegetative management system. Any of these overflow structures must be designed to handle the run-off from a 50-year, 24-hour precipitation event.

Since treatment lagoons are designed to break down the organic matter in the manure, considerable dilution water volume must be added. Properly designed and managed lagoons reduce both odors and solids in the manure. In general, the volume required for a treatment lagoon is two to three times larger than for slurry storages that contain only manure and average rainfall. The other disadvantage is that the plant nutrient value of lagoon effluent is considerably less than manure from a deep underfloor pit, earthen, or above ground tank storage structure.

In Indiana, construction criteria must follow NRCS standards for construction. In Indiana, IDEM rules provide storage structure performance standards and basic site restrictions. The design and construction standard referenced in IDEM guidance is the NRCS Conservation Practice Standard Code #313, titled Waste Storage Facility. Underground steel storage tanks for manure are prohibited in Indiana. Plastic and fiberglass tanks and above ground tanks must be designed with sufficient strength to withstand design loads, must be water tight, and must be installed to ensure seasonal high-water table is below the tank or else the tank must be anchored to prevent flotation. Above ground tanks must have shut-off valves for all inlet and outlet pipes to prevent spills.

Set Backs

There are specific set backs and restrictions in Indiana's regulations for the siting of manure storage facilities for permitted operations:

- 1000 ft from a public water supply well or surface intake structure,
- 300 ft from surface waters of the state, drainage inlets, sink holes, and off-site water wells, and
- 100 ft from on-site water wells, property lines, and public roads.

If a solid manure storage structure is roofed, then the setback can be reduced to at least 100 ft from surface waters, drainage inlets, sink holes, and off-site water wells. The base of a liquid manure storage structure must be at least 2 ft above bedrock, except for karst areas where the distance is determined on a site-specific basis. Additional specific design requirements are identified in IDEM's rules regarding the need for drainage systems for a seasonal high-water table and a sampling port and additional design standards for potential environmentally-sensitive locations.

Best management practices are recommended when siting manure storage structures. These include:

- locating storage facilities away from public view,
- not placing storages in the path of prevailing winds that could reach neighboring residences,
- using tree buffer strips to present a more pleasant scenery for the operation, and

- using good housekeeping practices to help the farmstead and manure storage facilities look clean, neat, and attractive.

Safety and Odor Control Measures

Although odor control measures can be expensive, several control technologies and practices have been implemented by producers to minimize odors from manure storage facilities. These include:

- covering outside storage structures (all types of structures can be included here),
- regular addition of dilution water to treatment lagoons,
- aeration of liquid treatment storage facilities, and
- implementing new feed management practices.

Covers for outside storages include biocovers, permeable, semi-permeable and impermeable, synthetic rubber, or polyvinyl, etc. Proper dilution of manure in lagoon treatment systems helps ensure more complete biodegradation of organic matter and reduces odor emissions. Aeration systems are very costly to operate due to high energy demand; however, aerated wastes are virtually odor free. In any case, proper management and operation of the manure storages are imperative for successful odor control. Changing diet formulations to reduce nutrient excretions and/or using feed management practices to improve nutrient utilization can help to reduce odors and gas emissions. Research is currently being conducted at several universities to identify better methods of measuring and controlling odor.

Agitation of manure in the storage during manure removal can create significant dangerous gas emissions and odors. Hydrogen sulfide, especially when emitted from manure in enclosed areas can be lethal to humans and animals. Always keep agitation nozzles below the liquid surface in a deep pit or lagoon. To minimize odors, do not agitate manure when air dispersion is toward neighboring residences.

Closing Storages

If a permitted animal production unit plans to close or discontinue the use of a manure storage structure, the operator must notify IDEM and follow specific steps. Until all manure is removed from the storage facility, the same requirements and principles of management of the storage must be followed as stated in the initial permit.

Procedures for closing manure storages are summarized below:

- all manure must be removed and land applied at requirements in the initial permit,
- all appurtenances and conveyances must be removed from uncovered manure storages,
- fill in the storage structure with appropriate fill, and
- cap the top of the storage structure with clay or slowly permeable soil to reduce the infiltration of rainwater.

If the structure will be used for another purpose, (for example, as a fresh water farm pond), IDEM must be notified and specific procedures used for cleaning the structure and the transfer of use.

Definitions

- **Aerobic lagoon** – (See lagoon and oxidation pond.)
- **Aeration** – A process forcing intimate contact between air and liquid
- **Anaerobic digestion** – Conversion of organic matter in the absence of oxygen under controlled conditions to gases such as methane and carbon dioxide
- **CFO** – Confined Feeding Operation
- **CAFO** – Concentrated Animal Feeding Operation
- **Effluent** – Water, wastewater, or other liquid, treated or untreated, being discharged from a reservoir, basin, or treatment facility
- **Holding pond** – An earthen structure used to temporarily store runoff water, wastewater, semi-solid slurry, or liquid manure for a period of time
- **Influent** – Water, wastewater, or other liquid flowing into a reservoir, basin, or treatment facility
- **Lagoon** – An earthen facility for the biological treatment of manure and wastewater. It can be aerobic, artificially aerated, anaerobic, or facultative depending on the loading rate, design, and type of organisms present
- **Manure** – The fecal and urinary excretion of livestock and poultry. This material may also contain bedding, spilled feed, water, or soil. It may also include milking center wastewater, contaminated milk, hair, feathers, or other debris. Manure may be described in different categories related to solids and moisture content. The transition from one category to another, e.g., slurry to semi-solid is not sharply defined. The transition does not depend on percent solids alone but is affected by animal species and diet, amount of bedding, feed spillage, and other residues in the manure.
- **Liquid manure** (thin slurry) – Manure that by its nature, or after being diluted by water, can be pumped easily. Normally fibrous material such as chopped straw or waste hay is not present.

- **Slurry manure** – Manure in which the percent total solids approximates that of excreted manure for some species. The total solids content could vary by a few percent depending on whether water is added or a slight drying occurs. It can be handled with conventional, centrifugal manure pumps, and equipment.
- **Semi-solid manure** – Manure that has had some bedding added or has received sufficient air drying to raise the solids content such that it will stack but has a lower profile than solid manure, and seepage may collect around the outer edge. It can be pumped with positive displacement pumps or handled with a front-end loader.
- **Solid manure** – Manure that has had sufficient bedding or soil added, or has received sufficient air drying to raise the solids content to where it will stack with little or no seepage. It is best handled with a front-end loader.
- **Manure storage** – A storage facility to contain manure for some period of time prior to its ultimate utilization, usually classified by type and form of manure stored and/or construction of the storage, e.g., above or below ground liquid manure tank, solid manure storage, etc.
- **Manure tank** – A fabricated structure with vertical side walls and an impervious floor, constructed to store semi-solid, slurry, or liquid manure. The tank may be located either in-ground or above-ground. The in-ground tank is usually constructed of concrete. The above-ground tank is usually constructed of concrete or steel. Both usually contain provisions for agitation and pumping.
- **Solid manure storage** – A manure storage facility in which accumulations of solid manure are stored before subsequent handling and field spreading. The manure is generally stacked on a concrete slab ("stacking slab") but may also be simply stacked on the soil for short term storage. Liquids, including urine and precipitation, may or may not drain from the unit.

Additional information

ID-120 Design and operation of livestock waste lagoons http://www.ces.purdue.edu/extmedia/ID/ID-120.html

MWPS-18 Section 2 Manure storages http://www.mwps.org

Indiana CFO rule, Passed as a state statute 1971 [revised as a rule in 1997 and 2002] IC-13-18-10.

Indiana CAFO rule, 2004. 327IAC 15-15. Adopted by IDEM in order to administer the Federal CAFO Clean Water Act program.

Purdue Extension Publications:

ID-322-W 2004 NPDES Permit Program for Concentrated Animal Feeding Operations

ID-312 Best Environmental Management Practices for Farm Animal Production (set of 12 pubs which includes ID-300 through ID-311)

ID-300 Land Application Records and Sampling

ID-301 Emergency Action Planning For Livestock Operations

ID-302 Farm Animal Production: Mortality Management

ID-303 Farm Animal Production: Inspecting Your Confined Feeding Operation

ID-304 Farm Animal Production: Feeding Strategies to Lower Nitrogen and Phosphorus in Manure

ID-305 Farm Animal Production: Building Good Neighbor Relationships

ID-306 Farm Animal Production: Disposal of Farm Medical Wastes

ID-307 Farm Animal Production: Manure Nutrient Recycling

ID-308 Farm Animal Production: Land Application of Manure and Environmentally Sensitive Field Characteristics

ID-309 Farm Animal Production: Manure Applicator Calibration

ID-310 Farm Animal Production: Odor Control Options for Confined Feeding

ID-311 Farm Animal Production: Comprehensive Nutrient Management Plans (CNMP)

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