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Lagoon Sizing for Livestock Waste Control Facilities

The minimum sizing requirements for an anaerobic lagoon are outlined in the [Title 130-Livestock Waste Control Regulations](#). It provides a good starting point in the design of the livestock waste control facility (LWCF).

Differences

When either the Natural Resources Conservation Service's "[Agricultural Waste Management Field Handbook](#)" ([NRCS Handbook](#)) or the ANSI/ASAE EP403.4 FEB2011 (R2020) "[Design of Anaerobic Lagoons for Animal Waste Management](#)" is used for sizing, please note the following **differences**:

- The minimum freeboard requirement of 1.5 ft. for earthen structures in [Title 130, "Livestock Waste Control Regulations,"](#) is larger than that recommended by the NRCS Handbook (1.0 ft.) or ASAE (.3 m), because the NDEE includes additional depth for a 25-year, 24-hour storm event on the surface of the lagoon. Freeboard is the elevation difference between the designed full depth and the overflow depth.
- The waste storage volume (**WSV**) calculation methods differ. NRCS calculates the livestock waste produced, wastewater, clean water and flush water accumulated during the lagoon treatment period to determine the WSV. Also, NRCS calculates a sludge storage volume for a designed storage period. The Department's calculation assumes that the WSV (sludge accumulation, volume of manure, wastewater and clean water accumulated during the treatment periods) is equal to 20% of the minimum treatment volume (**MTV**). If a freshwater flush is used, the Department adds a 180-day accumulation of any freshwater flush to the required storage.
- The NDEE assumes that net precipitation (precipitation minus evaporation) on the berms, side slopes, and surface of the lagoon is negligible in lagoon sizing in Nebraska. For other locations in the nation, this may not be the case. If a separate calculation is made for net precipitation, be sure to include the rainfall and runoff for these contributing areas (berms, side slopes, and lagoon surface). The NRCS method calculates precipitation and evaporation from the lagoon during the treatment period. In certain instances, this calculation may be

advisable, such as in southeast Nebraska or if the interior slopes of the lagoon are relatively flat (greater than 4 horizontal to 1 vertical).

Lagoon Sizing Versus Other Required Plans

In addition to the minimum size requirements, Title 130 requires the application to include **Operational and Maintenance (O&M)** information. Also, applications for **CAFOs** must include Best Management Practices for Minimizing Odors. These required plans must be considered when sizing the lagoon. Increasing the lagoon size may be necessary due to site-specific operating requirements: i.e., to minimize odors, provide additional sludge capacity, or for flexibility in lagoon management. In all cases, management plans and the lagoon size must be compatible.

Other Design Requirements for Lagoons

[Title 130, Chapter 9](#), outlines location requirements for a lagoon. On-site physical constraints and the Title 130 requirements may impact the design depth and shape of the lagoon.

The ASAE standard document, the [NRCS Handbook](#), and the [MidWest Plan Service "Structures and Environment Handbook"](#) (available for purchase) provide additional information on recommended minimum operating depths, lagoon shapes and other information on design and operation of anaerobic lagoons. Generally, an anaerobic lagoon should be designed to operate at depths no less than 6 feet and the shape should be nearly round or square. For rectangular-shaped lagoons, the length should be no more than 4 times the width.

Design of lagoon inlets and loading waste into the lagoon should be done with care. Loading the lagoon on a daily basis is recommended. When daily loading is not possible, such as with pull plug pits, the pit cleanings should be scheduled sequentially over short time periods to minimize slug loading of the lagoon.

Site Considerations in the Operational and Maintenance Information

The **Operational and Maintenance** information must detail lagoon-loading procedures. When loading, waste should be delivered as near as possible to the center of the lagoon and be delivered in a manner that prevents damage to the lagoon liner. A splash pad or other erosion protection is often needed.

The O&M information should provide the operator with specific information on the following operating levels:

1. The maximum sludge accumulation depth.
2. The lagoon's MTV depth. (This is in addition to, or on top of, the sludge accumulation depth.)
3. The maximum level for the lagoon prior to the winter months (provide minimum 180-day storage, while accounting for sludge accumulation and MTV).
4. The maximum operating level for the lagoon.

The minimum treatment volume (**MTV**) can be determined from [Chapter 10 of the NRCS Handbook](#). The acceptable maximum loading rate for Nebraska's climate usually is 4 pounds of volatile solids per 1,000 cubic feet per day. However, if the operation plans to reduce odors by decreasing the loading rate and increasing the size of the lagoon, MTV must be increased. If a solids separating system is used as part of the livestock waste control facility (**LWCF**), an adjustment in the volatile solids rate may be warranted.

The lagoon design should include manufacturer information on the capacity and effectiveness of the solids separator. The O&M information should give the operator a schedule to provide the MTV as part of the start-up procedure for the lagoon, as well as give longer term operating procedures to maintain the MTV (See [Title 130, Chapter 8 & Chapter 11](#), 007).

The maximum operating level required by Title 130 must allow for 1.5 feet of freeboard. The 1.5 feet must be below the overflow depth. If a spillway or overflow tube is included in the design, the maximum operating level must be at least 1.5 feet below the spillway inlet, overflow tube or the top of the dike, whichever is lowest.

For confined livestock operations, Title 130 requires an available storage volume equal to at least 180 days of storage, plus freeboard, prior to the winter months. The O&M information must provide procedures for pumping if the lagoon has less than this volume remaining in the fall. The MTV must be maintained. This can be accomplished by not pumping below the MTV or by adding additional fresh water to the system to restore the MTV.

Size Considerations in the Management of Sludge

The maximum sludge level should be indicated in the application. The yearly sludge production can be estimated by using the NRCS Handbook, Chapter 10. Typically, the NRCS Handbook provides for 15 to 20 years of sludge accumulation in a design. The term, "sludge," as used here, includes sludge, sediment or other solid material that may accumulate on the bottom of a lagoon or holding pond.

The operator should be informed of:

1. The volume available in the lagoon for sludge accumulation,
2. The time estimated to accumulate this volume,
3. A means to monitor the accumulation,
4. A planned method to remove the sludge; and
5. A plan for land application of the sludge.

This information should be included as part of the **Operational & Maintenance** information and must be compatible with the **Nutrient Management Plan**.

Sludge removal may consist of removing the upper portion of the accumulated sludge while leaving intact the lower portion to prevent damage to the lagoon liner by equipment during sludge removal.

A description of the equipment to be utilized for sludge removal and its capacity must be included. The application also should give estimates of the amount of sludge applied per acre and the time required to apply the sludge. If large accumulations of sludge are allowed, the NDEE may require specific information on the means of removal, sampling, and land application of the material.

By adding the desired sludge storage volume, the MTV and the 180-day storage volume and allowing the required freeboard, a minimum lagoon size can be determined.

Questions?

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