

**NATURAL RESOURCES CONSERVATION SERVICE  
CONSERVATION PRACTICE STANDARD**

**Waste Treatment Lagoon  
(No.)  
No. 359**

**Definition**

An impoundment made by excavation or earthfill for biological treatment of animal or other agricultural waste.

**Purpose**

To biologically treat organic waste, reduce pollution, and protect the environment.

**Conditions Where Practice Applies**

This practice applies where: (1) an overall waste management system has been planned; (2) waste generated by agricultural production or processing needs treatment; (3) a lagoon can be located near the source of the waste and a minimum of 91 m (300 ft) from a neighboring residence or public area; (4) soils are suitable for retaining the waste or can be sealed; and (5) a water supply is adequate to fill the lagoon about half full before operation and to maintain the design depth when the lagoon becomes fully operational.

**Federal, State, and Local Laws<sup>1</sup>**

***Design and construction activities shall comply with all federal, state, and local laws, rules, and regulations governing pollution abatement, health, and safety. The owner or operator shall be responsible for securing all required permits or approvals and for performing in accordance with such laws and regulations. NRCS employees are not to assume responsibility for procuring these permits, rights, or approvals, or for enforcing laws and regulations. NRCS may provide the landowner or operator with technical information needed to obtain the required***

***rights or approvals to construct, operate, and maintain the practice.***

***Permits may be required from the following agencies:***

- 1. West Virginia Department of Health***
- 2. West Virginia Department of Agriculture***

***Planning Considerations***

***Water Quantity***

1. Effects on the water budget, especially on volumes and rates of runoff, infiltration, evaporation, transpiration, deep percolation, and ground water recharge.
2. Variability of the practice's effects caused by seasonal or climatic conditions.
3. Effects of the demand of operation and maintenance on the water supply.

***Water Quality***

1. Effects on erosion and the movement of sediment, pathogens, and soluble and sediment-attached substances carried by runoff and seepage.
2. Effects of nutrients on surface and ground water quality, particularly the onsite water supply for humans and livestock consumption.
3. Effects on the visual quality of onsite and downstream water resources.
4. Short-term and construction-related effects on the quality of downstream water.

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5. Effects on the movement of dissolved substances below the root zone toward ground water.
6. Effects on wetlands and water-related wildlife habitats.

### Design Considerations

**Types.** Waste treatment lagoons are of three general types-anaerobic, naturally aerobic, and mechanically aerated. Anaerobic lagoons require less surface area than naturally aerobic lagoons but may give off odors.

Naturally aerobic lagoons are relatively odor free. Mechanically aerated lagoons are comparable in size to anaerobic lagoons and are generally odor free, but they require energy for aeration.

*The following is a description of each type:*

**1. Aerobic Lagoon - A waste treatment pond constructed to decompose and stabilize wastes by use of sunlight, air, bacteria, and relatively high level of dissolved oxygen.**

**2. Anaerobic Lagoon - A waste treatment pond having the same purpose as aerobic lagoons except the bacteria which break down wastes do not require the presence of oxygen.**

**3. Mechanically Aerated Lagoon - A waste treatment pond which acts aerobic because of the presence of oxygen from mechanical aerators and is comparable in size to anaerobic lagoons.**

**All types of waste treatment lagoons are efficient in treating most agricultural wastes when properly designed, operated, and maintained. However, there are certain limitations. Lagoons shall not be used for the treatment of storm runoff from feedlots or loafing areas. The shock loading effect prevents proper treatment. This runoff needs to be collected in waste storage structures or ponds and disposed of by land application methods. Milking center wastes do not respond well to anaerobic treatment. Therefore, lagoon treatment of these wastes shall be by the aerobic process.**

**Location.** The lagoon should be located near the source of waste and as far from neighboring dwellings as practicable, a minimum distance of 91 m (300 ft). If possible, locate the lagoon where prevailing winds will carry odors away from residences and public areas. Runoff from outside drainage areas should not enter the lagoon. The lagoon shall not be located on a flood plain unless it is protected from inundation or damage by a 25-year frequency flood event.

**Solids removal.** To reduce sludge buildup, remove solids from waste of animals, such as dairy cattle, fed high roughage rations. A solids trap or a separator may be provided between the waste sources and the lagoon. This may be a concrete or earth structure that can be emptied periodically. A minimum of 7 days storage should be provided, based on a minimum of 23 L (6 gal/day/horse or cow and 3.8 L (1 gal/day/sheep or hog, except that a minimum of 3 days storage may be provided for milking center waste. If earth structures are used, a minimum of two should be planned so that one can be dried and cleaned while the other is functioning

### Design Criteria

**Soil and foundation.** Locate the lagoon on soils of slow to moderate permeability or on soils that can seal through sedimentation and biological action. Avoid gravelly soils and shallow soils over fractured or cavernous rock. If self-sealing is not probable, the lagoon shall be sealed by mechanical treatment or by the use of an impermeable membrane.

**Waste production.** Waste treatment lagoons are designed on the basis of 5-day biochemical oxygen demand (BOD<sub>5</sub>) or volatile solids (VS) loading. Design loading shall be based on the maximum weight of animals using the lagoon and on other waste introduced. Information on waste production is provided in Chapter 4 of the Agricultural Waste Management Field Manual. Reliable local determinations should be used if available.

**Loadings.** Anaerobic waste treatment lagoons are designed on the basis of daily VS loading per 1,000 ft<sup>3</sup> of lagoon volume. Maximum loading shall be as indicated in figure 1 or according to state regulatory requirements,

whichever is more stringent. If a high degree of odor control is necessary, loading rates should be decreased.

Naturally aerobic lagoons are designed on the basis of daily BOD<sub>5</sub> loading per hectare (acre) of lagoon surface. Allowable loading shall be as indicated in figure 2 or according to state regulatory requirements, whichever is more stringent.

Mechanically aerated lagoons are designed on the basis of BOD<sub>5</sub> or ultimate BOD loading and on the basis of the equipment manufacturer's performance data for oxygen transfer and mixing. If used for odor control, aeration equipment shall provide a minimum of 0.5 kg (1 lb) of oxygen for each half kilogram (pound) of BOD<sub>5</sub> contributed daily. For complete treatment, refer to the design procedures provided in the Agricultural Waste Management Field Manual.

**Volume.** The maximum operating level shall be set to provide the designed loading plus a volume sufficient to store the following:

1. Manure and waste water<sup>1</sup>
2. Normal precipitation less evaporation on lagoon surface<sup>1</sup>
3. Solids accumulation<sup>2</sup>

<sup>1</sup>Accumulated between periods of drawdown.

<sup>2</sup>For the period between solids or sludge removal.

The maximum operating level shall be sufficient distance below any automatic outflow device, pipe, or emergency spillway to provide storage for the 25-year, 24-hour precipitation on the lagoon surface. The maximum operating level should be marked with an appropriate staff gage set in the lagoon or by other means to indicate when drawdown is needed.

The minimum operating level after drawdown should normally be that level needed for the design loading except when the lagoon is in drawdown to permit sludge removal or addition of dilution water.

***The required size or volume of a lagoon is based upon the waste loading on a daily basis. The following tables present design data for sizing lagoons for animal wastes:***

**1. Anaerobic Lagoon**

***a. Sludge Accumulation - Anaerobic lagoons will accumulate sludge which must be stored between cleanouts. The following table provides data to estimate storage requirements.***

**Anaerobic Lagoon Sludge Accumulation**

<u>Kind of Animal</u>	<u>Volume (cubic feet per year per 1000 lbs. of animal weight)</u>
<b>Dairy cattle</b>	<b>120</b>
<b>Beef cattle</b>	<b>100</b>
<b>Horse</b>	<b>110</b>
<b>Swine</b>	<b>120</b>
<b>Sheep</b>	<b>140</b>
<b>Poultry</b>	<b>220</b>

***b. Bacterial Action - The minimum volume required will be computed by using data included in the following table.***

**Anaerobic Lagoon Loading Rate**

<i>Kind of Animal</i>	<i>Volatile Solids (lbs/day per 1000 lbs of animal weight)</i>	<i>Volume (cubic feet per 1000 lbs. of animal weight)<sup>1</sup></i>
<i>Dairy cattle</i>	<i>6.5</i>	<i>1300</i>
<i>Beef cattle</i>	<i>5.2</i>	<i>1040</i>
<i>Horse</i>	<i>8.8</i>	<i>1760</i>
<i>Swine</i>	<i>5.2</i>	<i>1300</i>
<i>Sheep</i>	<i>7.4</i>	<i>1850</i>
<i>Poultry</i>	<i>10.5</i>	<i>2625</i>

<sup>1</sup> *Based on a maximum loading rate of 5 pounds of volatile solids per day per 1000 cubic feet of lagoon volume for cattle and horses and a maximum loading rate of 4 pounds for swine, sheep, and poultry.*

**2. Aerobic Lagoon**

*Loading rates shall be in accordance with the following table.*

**Aerobic Lagoon Loading Rate**

<i>Kind of Animal</i>	<i>BOD<sub>5</sub> (lbs/day per 1000 lbs of animal weight)</i>	<i>Surface Area (acres per 1000 lbs of animal weight)<sup>1</sup></i>
<i>Dairy cattle</i>	<i>1.6</i>	<i>.047</i>
<i>Beef cattle</i>	<i>1.3</i>	<i>.038</i>
<i>Horse</i>	<i>1.5</i>	<i>.044</i>
<i>Swine</i>	<i>2.7</i>	<i>.079</i>
<i>Sheep</i>	<i>2.2</i>	<i>.065</i>
<i>Poultry</i>	<i>3.8</i>	<i>.112</i>

<sup>1</sup> *Based on a maximum loading rate of 34 pounds of BOD<sub>5</sub> per day per acre of lagoon surface.*

*The loading rate for wastes from milking centers (parlors, milkhouses, etc.) shall be 0.1 pound BOD<sub>5</sub> per cow milked per day. This is equivalent to 125 square feet of lagoon surface per cow. However, the minimum surface area shall not be less than 5,000 square feet for any single operation.*

**Depth.** The minimum depth of liquid shall be 1.8 m (6 ft) for mechanically aerated and anaerobic lagoons, and 0.61 m (2 ft) for aerobic lagoons. If subsurface conditions prevent practical construction of anaerobic lagoons to a depth of 1.8 m (6 ft), a lesser depth may be used if volume requirements are met. The maximum depth for mechanically aerated and anaerobic lagoons is dictated by the site and the equipment.

The maximum operating depth for aerobic lagoons shall be 5 ft.

**Bottom and edges.** The bottom of aerobic lagoons shall be approximately level. The edges of all lagoons below the planned waterline shall be constructed as steep as soil conditions permit to reduce areas of shallow water and to inhibit weed growth.

**Earth embankment.** The design height of the embankment shall be increased by the amount needed to insure that the design top elevation is maintained after settlement. This increase shall not be less than 5 percent. The minimum top width shall be as shown below.

<i>Total height of embankment</i>		<i>Top width</i>	
<i>m</i>	<i>ft</i>	<i>m</i>	<i>ft</i>
<i>3.1 or less</i>	<i>10 or less</i>	<i>1.8</i>	<i>6</i>
<i>3.4-4.3</i>	<i>11-14</i>	<i>2.4</i>	<i>8</i>
<i>4.6-5.8</i>	<i>15-19</i>	<i>3.1</i>	<i>10</i>
<i>6.1-7.3</i>	<i>20-24</i>	<i>3.7</i>	<i>12</i>
<i>7.6-10.4</i>	<i>25-34</i>	<i>4.3</i>	<i>14</i>
<i>10.7 or more</i>	<i>35 or more</i>	<i>4.6</i>	<i>15</i>

For this standard, the maximum effective height of the dam is 10.7 m (35 ft). The combined side slopes of the settled embankment shall not be less than 5 horizontal to 1 vertical. The minimum elevation of the top of the settled embankment shall be 0.3 m (1 ft) above the maximum design water surface in the lagoon. **(The dam shall be hazard class (a).)**

**Inlet.** If freezing is not a problem, an open inlet, such as a concrete channel, may be used. If freezing is a problem, the inlet shall consist of

a pipe having a minimum diameter of 15 cm (6 in) and a minimum slope of 1 percent, except that a minimum diameter of 10 cm (4 in) may be used for milking center waste. The inlet pipe should terminate a sufficient distance from the shoreline to ensure good distribution. It should be far enough below the surface to avoid freezing or be provided with other protective measures. Access should be provided to the pipe for rodding in case of blockage. A water-sealed trap and vent or a similar device shall be provided on pipelines from enclosed buildings that discharge to enclosed settling tanks or beneath the lagoon surface. Such a device helps to prevent gases from entering the building. Inlet lines shall be made of materials that will not separate at the joints, that will be watertight, and that can withstand sunlight, weather, and earth and traffic loading.

***The inlet pipe over the lagoon shall be well supported on concrete, masonry, or treated posts and extended past the toe. At the discharge point, the pipe shall be at least 18 inches above the water level. During cold weather it may be necessary to place the inlet below the water surface by using an elbow and downpipe to help control freezing.***

***Pipe materials which are buried shall be those accepted for sanitary sewer construction. Exposed sections of inlet pipes shall be steel or polyvinyl chloride (PVC 1120 or 1220 conforming to ASTM D 1785 or ASTM D 2241). Consideration will be given to the character of the wastes, heavy external loadings, abrasion, soil material, and similar problems.***

***Multiple cell lagoons may be used where local conditions permit. However, the primary cell shall meet the minimum loading requirements set forth in this standard.***

***Each cell in a multiple cell lagoon shall have its own inlet. Inlet lines to secondary cells may consist of pipes through the separating dikes. Inlets and outlets shall be located to minimize short-circuiting within the lagoon.***

**Outlet.** Waste treatment lagoons shall not discharge to surface waters unless the owner determines through the state regulatory agency that such discharge will not contravene established water quality standards. Lagoons

having a maximum design liquid level of 0.91 m (3 ft) or more above natural ground shall be provided with an emergency spillway or an overflow pipe to prevent overtopping. The crest of the emergency spillway or the invert of the emergency overflow pipe shall be at least 0.31 m (1 ft) below the top of the settled embankment. The emergency spillway, if used, shall have a minimum bottom width of 1.2 m (4 ft). The emergency overflow pipe, if used, shall have a minimum diameter of 15 cm (6 in).

**Protection.** If the lagoon will create a safety hazard, it shall be fenced and warning signs posted to prevent children and others from using it for purposes other than intended. The embankment and surrounding areas should be vegetated to control erosion. Vegetative screens or other methods should be used to shield the lagoon from public view and to improve visual conditions.

## Plans and Specifications

Plans and specifications for installing waste treatment lagoons shall be in keeping with this standard and shall describe the requirements for applying the practice to achieve its intended purpose.

***Plans for animal waste disposal systems must show all pertinent features such as dimensions, location, and details of inlets and outlet structures. They shall be accompanied by an engineering report fully covering the proposed project, including the number and types of animals served and possible expansion considerations. The report will describe the surrounding environment within a one mile area. It shall cover soil and groundwater conditions and factors influencing aesthetic conditions. Specifications must cover all materials, equipment, and methods of construction.***

***All designs for animal waste disposal systems must be developed with assistance from an engineer.***

***Applicable West Virginia Practice Standards will apply to components of the system. Construction specifications for the embankment standard shall apply.***

## Operation and Maintenance

Operation and maintenance shall be performed according to the written operation plan provided for in the overall waste management plan.

*Following are some items which shall be considered in managing a lagoon:*

- 1. Fill the new lagoon with water to the design depth.*
- 2. The first loading should be gradual to allow the formation of the proper bacterial action.*
- 3. A lagoon functions best if wastes are added daily. Large loadings at irregular intervals can cause a lagoon to malfunction.*
- 4. Provisions shall be made to keep bedding material, straw, oil, and other floating material out of the lagoon. Bedding can plug sewer lines and is slow to decompose.*
- 5. Maintain water at the design level for good bacterial action. Waste solids must be covered with water at all times.*
- 6. Anaerobic lagoons will accumulate sludge. Periodic sludge removal will be required to restore the lagoon to its design volume.*
- 7. Sludge can be removed by pumping with liquid manure equipment and then field spreading; or lagoon can be taken out of operation, pumped empty, allowed to dry, and the sludge removed mechanically. This method requires a recovery period before the lagoon returns to normal bacterial activity.*
- 8. Mosquito breeding can be controlled by adding larvacide.*
- 9. Unbalanced conditions frequently occur during startup or when environmental factors abruptly change, such as after excess solids are removed or when the lagoon contents warm up in the spring. Additional alkalinity should be added to aid digestion. Lime, sodium bicarbonate, sodium nitrate, ammonium, and anhydrous ammonia can be used.*

*10. Lagoon pumping may be required at certain times to maintain the design liquid level. These wastes should be disposed of on the land by sprinkler irrigation or spreading with a tank wagon.*

*11. The lagoon shall be inspected periodically, the grass kept mowed, and the embankment and edges kept free of weeds, shrubs, and trees. Grass clippings from mowing operations should be removed from the lagoon.*

*12. Cleanout settling facilities before or as soon as they have reached the maximum design level.*

*13. Duckweed may become a problem on aerobic lagoons. Control may be exercised by maintaining ducks (approximately 10 ducks per acre). Chemical control may be exercised by the use of approved herbicides manufactured for this purpose.*

<sup>1</sup>*Bold italics is information added to the National standard by West Virginia.*