USDA
NATURAL RESOURCES
CONSERVATION SERVICE
MARYLAND
CONSERVATION PRACTICE
STANDARD

WASTE TREATMENT LAGOON

CODE 359
(Reported in No.)

DEFINITION

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

PURPOSE

Waste treatment lagoons serve as components of waste management systems and are constructed 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) lagoons can be located near the source of waste and a minimum of 300 feet from neighboring residence or public area; (4) soils are suitable for retaining the waste or can be sealed; (5) runoff from the watershed can be directed around the lagoon; and (6) 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.

Local Requirements

This practice can only be applied when the laws, rules, and regulations established by the Maryland Department of the Environment and local units of Government are met. Local regulations related to such items as depth to groundwater and structure setback need to be incorporated.

Embankments are limited to hazard class (a). Refer to NEM 520.21 for guidance covering the documentation of hazard classification. This standard does not apply to waste storage ponds or to waste storage structures.

CONSIDERATIONS

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

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.
5. Effects on the movement of dissolved substances below the root zone toward ground water.

Conservation practice standards are reviewed periodically, and updated if needed. To obtain the current version of this standard, contact the Natural Resources Conservation Service.

6. Effects on wetlands and water-related wildlife habitats.

Types

Waste treatment lagoons are of two general types: anaerobic and aerobic. The term "anaerobic" implies an absence of air or free oxygen and refers to the type of bacteria required to break down the wastes. Since anaerobic bacteria cannot survive in the presence of free oxygen, an anaerobic lagoon should be designed to limit oxygen into the system. These lagoons will be deep and will have a low surface area-to-volume ratio.

Aerobic lagoons may either be naturally aerobic or mechanically aerated; both are designed to promote the growth of bacteria which are oxygen dependent. The naturally aerobic lagoons have a large surface area in order to enhance the movement of wind across the lagoon surface and, thus, to increase oxygen transfer to the water. This type of lagoon is shallow in order to provide natural mixing of oxygen throughout its full depth. The shallow depth also allows sunlight to penetrate nearly to the bottom, thereby promoting algae growth. Algae in the presence of sunlight produce large quantities of oxygen. Mechanically aerated lagoons have oxygen added through mechanical mixing of the water.

Location

The lagoon shall be constructed to avoid leakage and potential ground water pollution. The lagoon should be located near the source of waste and as far from neighboring dwellings as practicable, a minimum of 300 feet. If possible, locate the lagoon where prevailing winds will carry odors away from residences and public areas. Runoff from adjacent drainage areas should not enter the lagoon. If the only practical alternative is to locate the structure within the 100-year floodplain, the facility must be designed or modified so as to minimize potential harm to or within the floodplain. The lagoon shall not be located in a floodplain unless it is protected from inundation or damage by a 25-year-frequency flood event.

It is best to start loading in the Spring so that several more months of bacterial action can assure good operation.

Soils and Foundation

Site soil characteristics will be investigated by borings made at least two feet below the planned lagoon bottom. Lagoons must be placed in impervious soils or soils suitable for sealing.

Soils in regions where fractured limestone exists must be sealed with at least 24 inches of compacted clay material before using the lagoon. Sandy soil or other soil that may not be self-sealing will be treated with 12 inches of compacted clay, an approved sealant or liner, or a combination of these. The lagoon bottom shall be watertight, sealed from groundwater, before the lagoon is used.

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 in the separator should 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.

CRITERIA

Anaerobic Lagoons

Sizing - The maximum operating level of an anaerobic lagoon is a volume requirement plus a depth requirement. The volume requirement is the sum of the minimum treatment volume, ft^3 (MTV), manure volume and wastewater volume, ft^3 (WSV), and sludge volume, ft^3, (SV). The MTV is based on the volatile solids loading rate given in Table 1. Information on the WSV and SV is provided in Chapter 4 of the Agricultural Waste Management Field Handbook. The minimum sludge accumulation period shall be 15 years. A minimum depth of 6' must be maintained in anaerobic lagoons except

during sludge cleanout. In addition, depth must be provided to accommodate the normal precipitation less evaporation on the lagoon surface, the 25-year, 24-hour storm precipitation on the lagoon surface, and freeboard. The combination of these volumes and depths is illustrated in Figure 1. The terms are explained in Chapter 10 of the Agricultural Waste Management Field Handbook.

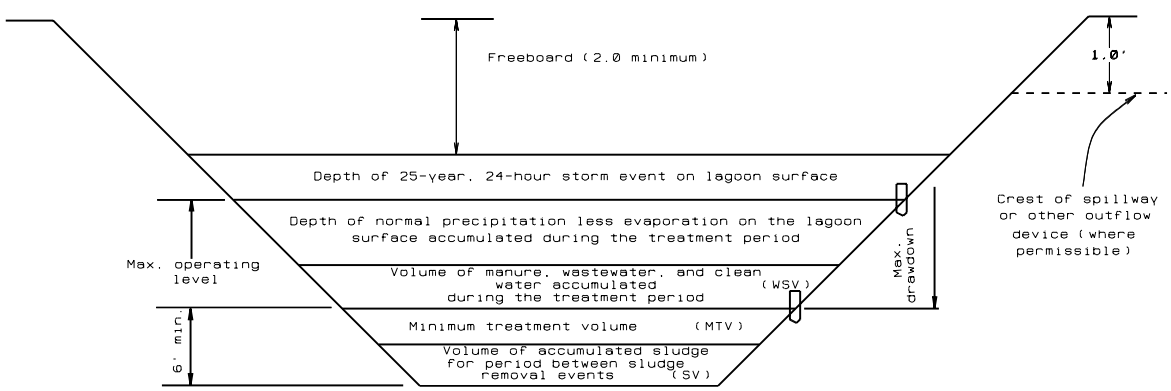
Multiple cells may be used. If a 2-stage lagoon is designed, effluent from the second stage will be of higher quality. The primary cell is designed to contain at a minimum the MTV and SV and the cell is not pumped below the minimum treatment level. The secondary cell is sized for the WSV plus one-half of the primary MTV plus the volume of rainfall minus evaporation and the 25-yr., 24-hr. storm. Do all pumping from the second cell.

TABLE 1

Anaerobic Lagoon Loading Rate (Pounds of volatile solids/1000 ft^3/day)

County	Pounds	County	Pounds
Allegany	2.4	Howard	2.6
Anne Arundel	2.7	Kent	2.6
Baltimore	2.5	Montgomery	2.6
Calvert	2.7	Prince George's	2.4
Caroline	2.7	Queen Anne's	2.7
Carroll	2.5	St. Mary's	2.8
Cecil	2.6	Somerset	2.8
Charles	2.7	Talbot	2.7
Dorchester	2.8	Washington	2.4
Frederick	2.5	Wicomico	2.8
Garrett	2.4	Worchester	2.8
Harford	2.6		

Figure 1. - Anaerobic Lagoon Cross Section



Note: The minimum treatment volume for an anaerobic waste treatment lagoon is based on volatile solids.

Aerobic Lagoons.

The design of aerobic lagoons is based on the amount of BOD_5 added per day and waste and sludge volumes. The BOD_5 loading rate determines lagoon surface area and the waste and sludge volumes dictate lagoon depth. See Table 2 for BOD_5 loading rates. Sludge (SV) and waste volumes (WV) are provided in Chapter 4 of the Agricultural Waste Management Field Handbook. The operating depth must range from 2 feet minimum to 5 feet maximum. In addition, depth must be provided to accommodate the normal precipitation less evaporation on the lagoon surface, the 25-year, 24-hour storm precipitation on the lagoon surface, and freeboard. The combination of these volumes and depths is illustrated in Figure 2. The terms are explained in Chapter 10 of the Agricultural Waste Management Field Handbook.

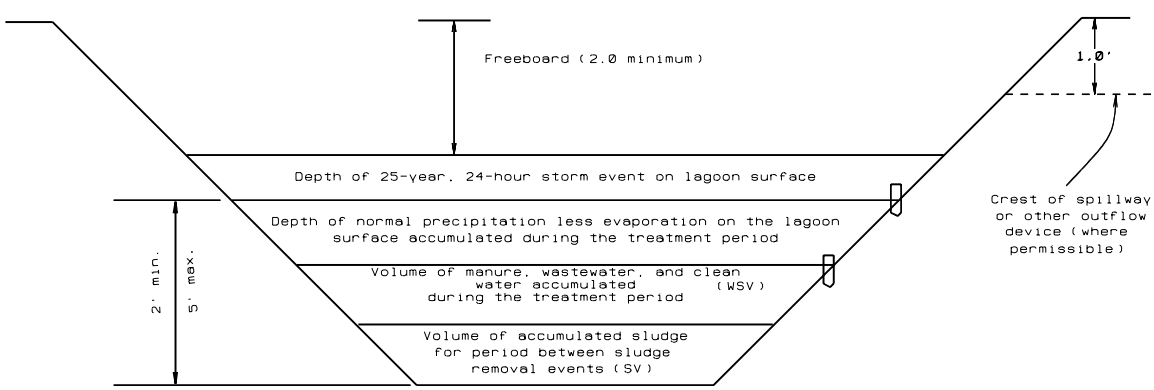
Mechanically aerated lagoons are designed on the basis of BOD_5 or ultimate BOD loading and on the basis of the equipment manufacturer's performance data for oxygen transfer and mixing. If used for odor control, aeration equipment shall provide a minimum of 1 lb. oxygen for each pound of BOD_5 contributed daily.

TABLE 2

Aerobic Lagoon Loading Rate (Pounds of BOD_5/Acre/Day)

County	Pounds	County	Pounds
Allegany	38	Howard	40
Anne Arundel	42	Kent	42
Baltimore	40	Montgomery	40
Calvert	43	Prince George's	42
Caroline	43	Queen Anne's	42
Carroll	39	St. Mary's	43
Cecil	41	Somerset	45
Charles	42	Talbot	43
Dorchester	43	Washington	39
Frederick	39	Wicomico	45
Garrett	38	Worchester	46
Harford	40		

Figure 2 - Aerobic Lagoon Cross Section



Note: An aerobic waste treatment lagoon has a required minimum surface area based on BOD_5.

Earth Embankment

Top Width - The minimum top width of the embankment is shown in Table 3. If the embankment needs to be crossed periodically by vehicles, the minimum top width shall be 10 feet. Guardrails or other safety measures are to be used where necessary.

TABLE 3	
Total Height of Embankment (Feet)	**Minimum Top Width (Feet)**
10 or less	6
11 - 14	8
15 - 19	10
20 - 24	12
25 - 34	14
35 or more	15

For this standard, the maximum effective height of the dam is 35 feet.

Side Slopes - The combined side slopes of the settled embankment shall not be less than five horizontal to one vertical (5:1) with neither slope steeper than 2:1. Slopes must be designed to be stable in all cases, even if flatter side slopes are required. Disturbed areas surrounding the facility shall be treated to control erosion.

Allowance for Settlement - The design height of the embankment shall be increased by 5 percent to insure that the design top of fill elevation will be maintained after all settlement has taken place.

Fill Material - The embankment shall be designed with a core of relatively impervious material conforming to USCS classes GC, CH, SC, or CL or as otherwise approved.

Inlet - Where freezing is not a problem, an open inlet consisting of a concrete ditch may be used. Preference should be given to "V" section ditches to keep velocities high during low flows. Where freezing is a problem, the inlet shall consist of a pipe with a minimum diameter of six (6) inches, a minimum slope of one (1) percent and minimum cover of 24 inches. Flushing type flow will keep pipe free of debris and during periods of no flow, pipe will remain dry and less likely to freeze. Access to the pipe for cleanout must be provided in case of blockage. The inlet pipe shall be rigidly supported and terminated beyond the inner toe of the cut or fill.

Outlet - Waste treatment lagoons shall not discharge to surface waters unless the owner determines through the state regulatory agency that such discharge meets water quality standards. Lagoons having a maximum design liquid level of 3 ft. or more above natural ground shall be provided with an emergency spillway or overflow pipe with an invert at least 1 ft. below the top of the settled embankment. The emergency spillway, if used, shall have a minimum bottom width of 8 ft. The emergency overflow pipe, if used, shall have a minimum diameter of 6 in.

Safety - Design shall include appropriate safety features to minimize the hazards of the facility.

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.

Operation And Maintenance

Lagoons must be managed properly if they are to function as designed. Specific instructions about lagoon operation and maintenance must be included in the overall waste management plan. There are several factors that are involved in the operation that have a direct affect on the success of the design.

Following construction, a lagoon must be precharged with fresh water before any waste can be placed in it. Normally an anaerobic lagoon is managed so that the liquid level is maintained at or below the maximum operating level. The liquid level is lowered to the minimum treatment level at the end of the treatment period.

The pH should be measured frequently. Many problems associated with lagoons are related to pH in some manner. For this reason, it is mandatory that the waste be sampled and an analysis be obtained so that the waste can be better utilized and that potential environmental problems are avoided.

Lagoons are designed based on a given loading rate. If an increase in the number of animals is anticipated, sufficient capacity to handle all of the expected waste load should be available. The most common problem in using lagoons is overloading, which can lead to odors, malfunctioning and sludge accumulation. Periodically, sludge accumulation levels should be checked to assure the lagoon is functioning as designed.

The maximum operating level should be marked with a staff gage set in the lagoon or by other means to indicate when drawdown is needed. The minimum operating level should be that level needed for the design loading except when the lagoon is drawn down to permit sludge removal or addition of dilution water.

SPECIFICATIONS

These specifications are appropriate to all agricultural waste lagoons within the scope of the Conservation Practice Standard MD-359. All references to ASTM and AASHTO specifications apply to the most recent version.

Site Preparation

Areas designated for borrow areas, embankment, lagoon, and associated structures shall be cleared, grubbed and stripped of topsoil. All trees, vegetation, roots and other objectionable material shall be removed.

All cleared and grubbed material shall be disposed of outside and below the limits of the lagoon(s) as directed by the owner or their representative. When specified, a sufficient quantity of topsoil will be stockpiled in a suitable location for use on the embankment and other designated areas.

Geotextile

Any geotextile liner must be installed according to manufacturers' recommendations.

Earthfill

Material - The fill material shall be taken from approved designated borrow areas. It shall be free of roots, stumps, wood, rubbish, stones greater than 6", frozen or other objectionable materials. Fill materials for the center of the embankment shall conform to Unified Soil Classification GC, SC, CH, or CL. Consideration may be given to the use of other materials in the embankment if design and construction are supervised by a geotechnical engineer.

Placement - Areas on which fill is to be placed shall be scarified prior to placement of fill. Fill materials shall be placed in maximum 8 inch thick (before compaction) layers which are to be continuous over the entire length of the fill. The most permeable borrow material shall be placed on the outside face of the embankment.

Compaction - The movement of the hauling and spreading equipment over the fill shall be controlled so that the entire surface of each lift shall be traversed by not less than one tread track of the equipment or compaction shall be achieved by a minimum of four complete passes of a sheepsfoot, rubber tired or vibratory roller. Fill material shall contain sufficient moisture such that the required degree of compaction will be obtained with the equipment used. The fill material shall contain sufficient moisture so that if formed into a ball it will not crumble yet not be so wet that water can be squeezed out.

Structure Backfill

Backfill adjacent to pipes or structures shall be of the type and quality conforming to that specified for the adjoining fill material. The fill shall be placed in horizontal layers not to exceed four inches in thickness and compacted by hand tampers or other manually directed compaction equipment. The material needs to fill completely all spaces under and adjacent to the pipe. At no time during the backfilling operation shall driven equipment be allowed to operate closer than four feet, measured horizontally, to any part of a structure. Under no circumstances shall equipment by driven over any part of a concrete structure or pipe, unless there is a compacted fill of 24" or greater over the structure or pipe.

Stabilization

All borrow areas shall be graded to provide proper drainage and left in a sightly condition. All exposed surfaces of the embankment, spillway, spoil and borrow areas, and berms shall be stabilized by seeding, liming, fertilizing and mulching in accordance with the Maryland Natural Resources Conservation Service Standards and Specifications for Critical Area Planting (MD-342) or as shown on the plans.

Erosion and Sediment Control

Construction operations will be carried out in such a manner that erosion will be controlled and water and air pollution minimized. State and local laws concerning pollution abatement will be followed. Construction plans shall detail erosion and sediment control measures to be employed during the construction process.

SUPPORTING DATA AND DOCUMENTATION

The following is a list of the minimum data needed:

1. Soils investigation data including depth to seasonal high water.
2. Field survey which includes locating floodplains that may be affected.
3. Complete design computations including a completed AWMFH worksheet 10A-3 or 10A-4.
4. Drawings to describe structures and their relation to adjacent physical features. Include required sealing treatments or liners.
5. An operation and maintenance plan, or cross reference to a waste management system plan or conservation plan which incorporates the waste management and operation and maintenance plan.
6. Elevations along centerline of completed embankment.
7. At least one cross section of the completed embankment showing station, top width and side slopes.
8. Dimensions and elevations of any pipe used and kind of pipe.
9. Cross-sections of finished pool area to show depth and grade of bottom.
10. Cross-sections of the pool area at the same stations before and after soil liner placement and materials and methods used for all sealing and lining.
11. Statement that spoil disposal is in accordance with design or that any changes are satisfactory.
12. Statement that the following have been satisfactorily completed:
    a) Establishment of vegetation per practice specifications.
    b) Fencing required by practice specifications.
    c) Installation of safety devices.
13. Location of utilities.

REFERENCES

1. National Engineering Manual, USDA, Soil Conservation Service, 1982.

2. Agricultural Waste Management Field Handbook, Part 651, USDA, Soil Conservation Service, 1992.

3. National Handbook of Conservation Practices, USDA, Soil Conservation Service.

4. Midwest Plan Service, MWPS-18, Livestock Waste Facilities Handbook, 1975.

5. Maryland Technical Guide, Section IV.