NATURAL RESOURCES CONSERVATION SERVICE

CONSERVATION PRACTICE STANDARD

WASTE TREATMENT LAGOON

(No.)

CODE 359

DEFINITION

A waste treatment impoundment made by constructing an embankment and/or excavating a pit or dugout.

PURPOSE

To biologically treat waste, such as manure and wastewater, and thereby reduce pollution potential by serving as a treatment component of a waste management system.

Normally, the Natural Resources Conservation Service (NRCS) will design one primary cell lagoons (anaerobic) in Louisiana. In cases where additional treatment of the wastewater is needed, an aerobic lagoon can be designed to follow the anaerobic lagoon.

This standard does not apply to, "Waste Storage Facilities".

CONDITIONS WHERE PRACTICE APPLIES

- Where the lagoon is a component of a planned agricultural waste management system.
- Where treatment is needed for organic wastes generated by agricultural production or processing.
- On any site where the lagoon can be constructed, operated and maintained without polluting air or water resources.
- To lagoons utilizing embankments with an effective height of 35 feet or less where damage resulting from failure would be limited to damage of farm buildings, agricultural land, or township and country roads.
- A water supply is adequate to fill the lagoon to 3 feet before operation and to maintain the design depth when the lagoon becomes fully operational.

CRITERIA

General Criteria for All Lagoons.

Laws and Regulations. All Federal, state, and local laws, rules, and regulations governing the construction and use of waste treatment lagoons must be followed. The owner or operator must be responsible for securing necessary permits where required. Any lagoon with a discharge may be required to have a permit. *This standard does not cover installations with planned discharges.*

Dead animals shall not be disposed of in lagoons.

Location. To minimize the potential for contamination of streams, lagoons should be located outside of floodplains. However, if site restrictions require location within a floodplain, they shall be protected from inundation or damage from a 25-year flood event, or larger if required by laws, rules, and regulations. Lagoons shall be located so the potential impacts from breach of embankment, accidental release, and liner failure are minimized; and separation distances are such that prevailing winds and landscape elements such as building arrangement, landforms, and vegetation minimize odors and protect aesthetic values. *Lagoons will be located such that the outside toe of the levee or embankment will be a minimum distance of 10 feet from a property line and as far as possible from a neighboring dwelling in the direction of prevailing winds. The maximum operating waterline that is produced by containing the design storage volume will be a minimum distance of 100 feet from a water well.*

Policy. The Natural Resources Conservation Service will only design lagoon systems with no

discharge. This means the system will be capable of storing the runoff from a 25-year, 24-hour storm event and the 25 year, 24 hour precipitation on the lagoon surface. The maximum operating level will be marked by an appropriate gauge. Whenever this elevation is exceeded, the lagoon will be promptly drawn down and the effluent distributed over lands owned, or controlled, by the operator. The Natural Resources Conservation Service will also assist the landowner/ operator in preparing a notification to the Department of Environmental Quality (DEQ) informing them of the installation.

Soil and Foundation. The lagoon shall be located in soils with an acceptable permeability that meets all applicable regulation, or the lagoon shall be lined. *A minimum of 2 soil logs, to a depth of at least 2 feet below the planned bottom of the lagoon, shall be taken at the location of the lagoon.* Should the geologic investigation indicate the need for a liner, information and guidance can be found in the Agricultural Waste Management Field Handbook (AWMFH), Appendix 10D, "Geotechnical, Design, and Construction Guidelines". Liners shall meet or exceed the criteria in NRCS Conservation Practice Standard, "Pond Sealing or Lining", Code 521.

The lagoon shall have a bottom elevation that is a minimum of 2 feet above the seasonal high water table unless features of special design are incorporated that address buoyant forces, pond seepage rate, and non-encroachment of the water table by contaminants. The water table may be lowered by use of perimeter drains, if feasible, to meet this requirement.

Waste Production. Each lagoon system will be designed on an individual basis. Design values in Chapter 4 of the Agricultural Waste Management Field Handbook for the waste production of various agricultural operations shall be used for design when the management system does not correspond with one of the categories shown in Table 5 of this standard.

Design storage volume. The lagoon shall have the capability of storing the following volumes:

(a) Volume of accumulated sludge(4-year minimum) for the period between sludge removal events;

(b) Minimum treatment volume (anaerobic lagoons) or minimum loading rate (aerobic lagoon);

(c) Volume of manure, wastewater, and other wastes accumulated during the treatment period (minimum 30 days);

(d) Depth of normal precipitation on the area inside the top of the levee less evaporation from the surface area of the lagoon at the required volume level during the treatment period plus any runoff from contributing drainage areas during the treatment period (minimum 30 days);

(e) Depth of the 25-year, 24-hour storm precipitation on the area inside the top of the levee and storm event runoff from contributing drainage areas.

Inlet. Inlets shall be of any permanent type designed to resist corrosion, plugging, freeze damage, and ultraviolet ray deterioration, while incorporating erosion protection as necessary. A ramp, pipe, or other adequate means of delivering animal waste to the lagoon may be used. When a pipe is used, it will meet the quality requirements given under **Pipe** and have a minimum diameter of 8 inches and a minimum slope of 1 percent, except that a minimum diameter of 4 inches may be used for milking center waste. Inlets shall be provided with a water-sealed trap and vent, or similar device if there is a potential, based on design configuration, for gases to enter buildings or other confined spaces.

Outlet. Outlets from the required volume shall be designed to resist corrosion and plugging. No outlet shall automatically discharge from the required volume of the lagoon. Features to protect against erosion, liner damage, tampering, and accidental release shall be incorporated as necessary. When it becomes necessary to design a two cell system an overflow pipe shall be installed in the anaerobic lagoon so that discharge water is withdrawn from a depth of 1 ½ feet below the design water surface. A tee on the pipe entrance shall be used for this purpose. The top of the tee shall be opened to the atmosphere to prevent siphoning. The minimum diameter of this overflow pipe shall be 6 inches.

Emergency Spillway *An emergency spillway which will have the capacity to safely carry the peak discharge from a 25 year 24 hour storm applied to the entire drainage area, including the lagoon surface, shall be provided to protect the facility from overtopping; and be so located as not to discharge directly onto an adjacent property or*

*water body***.** The spillway crest shall be placed at the elevation of the water surface produced by containing the design storage volume within the facility. The elevation of the water surface, when the spillway is flowing at design capacity will not cause flooding of any buildings (milking center, etc.). The spillway shall have a minimum bottom width of 10 feet and a 3 horizontal to 1 vertical side slopes.

Pipe. Smooth steel pipe or plastic pipe may be used for the inlet or transfer pipe. Smooth steel pipe may be new or good quality used pipe with a minimum wall thickness of ¼ inch. For plastic pipe to have adequate crushing strength it shall have the equivalent strength of an 80 PSI rated (SDR-51) pipe for depth of fill over the pipe not to exceed 10 feet. Plastic pipe must be PVC pipe meeting the requirements of the American Society for the Testing of Material (ASTM), specification D-2241 or D-1785. All pipe joints shall be made watertight by the use of watertight couplings or by welding. Cantilever lengths shall not exceed 5 feet and shall be well secured to prevent flotation.

Facility for drawdown. Measures that facilitate safe drawdown of the liquid level in the lagoon shall be provided. Access areas and ramps used to withdraw waste shall have slopes that facilitate a safe operating environment. Docks, wells, pumping platforms, retaining walls, etc. shall permit drawdown without causing erosion or damage to liners.

Depth. The minimum design operating depth for an anaerobic lagoon shall be 8 feet. If subsurface conditions prevent practical construction of anaerobic lagoons to a depth of 8 feet, a minimum depth of 6 feet may be used provided the volume requirements are met. The design operating depth for an aerobic lagoon shall be between 3 and 5 feet.

Operating levels. The maximum operating level (water level) shall be the lagoon level that provides the required volume less the 25-year, 24-hour storm event precipitation on the surface of the lagoon and contributing drainage area. The maximum drawdown level for anaerobic lagoons shall be the lagoon level that provides volume for the required minimum treatment volume plus the volume of accumulated sludge between sludge removal events. The maximum drawdown level for aerobic lagoons shall be the lagoon level that provides for the volume of manure, wastewater, and clean water accumulated during the treatment period plus the volume of accumulated sludge between sludge removal events. Permanent markers shall be installed at these elevations. The proper operating range of the lagoon is above the maximum drawdown level and below the maximum operating level. These markers shall be referenced and explained in the Operation and Maintenance (O&M) Plan.

Also the maximum water level in the lagoon shall be a minimum of 1-foot below the lowest elevation of the holding slab or confinement area draining into the lagoon if the area is drained by gravity flow.

Sludge removal. *Removal of sludge to preserve the treatment capacity of the lagoon shall be considered during planning.* A ramp with 10:1 slope or flatter may be used to facilitate clean-out equipment. Steeper slopes may be used if special traction surfaces are provided. Features to protect against erosion, liner damage, tampering, and accidental release shall be incorporated as necessary.

Waste Utilization. Waste removed from the facility shall be utilized in accordance with NRCS Conservation Practice Standards, "Nutrient Management", Code 590, or "Waste Utilization", Code 633. When the maximum operating level is exceeded, the effluent shall immediately be removed. Final disposal in these cases may be by liquid spreading systems, irrigation system, or other land application measures. Flow concentrations, ponding, and runoff from the land will not be permitted.

Erosion Protection. Embankments and disturbed areas surrounding the lagoon shall be vegetated or otherwise stabilized to control erosion. This includes the inside slopes of the lagoon. Refer to NRCS Conservation Practice Standard "Critical Area Planting", Code 342.

Safety. Design shall include appropriate safety features to minimize the hazards of the lagoon. The lagoon shall be fenced around the perimeter and warning signs posted. *A "WARNING" sign (90 in^2 minimum) shall be placed on each straight section of fencing, not to exceed a spacing of 300 feet.* Fencing shall meet the requirements of NRCS Conservation Practice Standard, "Fence", Code 382, with safety as the objective. The fence shall be located so that maintenance and clean-out equipment will have access to the lagoon.

Adequate maneuvering space should be provided for operating loading and unloading equipment. Push-offs must be structurally sound and must be provided with railings, safety bars, or other devices to prevent humans, animals and equipment from falling into the lagoon.

Design Criteria – General.

Classification. Lagoons resulting from both excavation and embankment are classified as "Embankment Lagoons" when the design depth of liquid against the embankment is 3 feet or more. When the design depth of liquid against the embankment is between 0 and 3 feet, the impondment may be designed as an embankment or an excavated lagoon. Slopes of the excavated portion and the embankment portion of a lagoon shall be continuous, with no breaks in grade.

Runoff from Outside. If an embankment is not used, a levee shall be constructed around the entire periphery of the lagoon to prevent entrance of any outside runoff. It shall have a minimum 1-foot settled height above the adjacent normal ground with a minimum top with of 8 feet and side slopes of 3 horizontal to 1 vertical, or flatter. The top should slope away from the lagoon. The levee shall be constructed adjacent to the lagoon with the slope toe blending with the top of the slope of the lagoon. If a diversion is used to divert water it shall be design and installed according to NRCS Conservation Practice Standard, "Diversions", Code 362.

Excavations. Unless supported by a soil investigation, *all excavated side slopes shall be no steeper than 2 horizontal to 1 vertical. However, if a compacted clay liner is to be used to control seepage, no slope shall be steeper than 3 horizontal to 1 vertical.*

Design Criteria – Loading.

Anaerobic Lagoon. Use 0.0065 pound volatile solids per day per cubic foot of lagoon. This is the maximum loading rate to be used. A lower loading rate may be used when in the opinion of the designer it is necessary. Refer to AWMFH Figure 10-22 for additional loading rate criteria.

Aerobic Lagoon. Use 55 pounds of BOD_5 per surface acre per day. When an aerobic lagoon will follow an anaerobic lagoon as a secondary treatment, assume 2/3 reduction of BOD_5 in the anaerobic lagoon. The remaining 1/3 will be treated in the aerobic lagoon.

Design Criteria – Volume.

Anaerobic Lagoon. The following volume components will be determined and equal the total volume requirements of an anaerobic lagoon:

(a) The digestion volume and the 60-day retention volume shall both be determined and the larger of the two values used. *It will be necessary to determine the water use and manure production per animal;*

(b) The volume required to store a minimum of 4 years of sludge buildup shall be included. This shall be based on:

1. Total solids (TS) production per day (lbs.);
2. 75 percent volatile solids (VS) reduction by digestion (lbs.);
3. A ratio of 100 percent sludge to 20 percent solids applied to dry solid weight;
4. Weight of sludge of 70 pounds per cubic foot (pcf),

The volume required to store a minimum of 4 years of sludge can be calculated using the following equation:

Sludge storage (ft^3)= (#TS – (#VS x 75%) (4 years) (365 days) (100% / 20%) / 70 pcf.;

(c) To this volume must be added a minimum of 30 days of manure and wastewater storage

(d) Also the volume to store the precipitation and runoff from the required storm events must be added. Refer to (d) and (e) under **Design Storage Volume** of this standard.

Design Criteria – Area.

Aerobic Lagoon. The following components will be determined and will equal the required size of an aerobic lagoon:

(a) Use 100% of the BOD_5 loading to compute the surface area required for primary treatment in an aerobic lagoon If an aerobic lagoon will provide secondary treatment of the waste, it is assumed there will be a 2/3 reduction in BOD_5 in the anaerobic lagoon. Compute the surface area required for the digestion of the remaining 1/3 of the BOD_5. Compute the volume of the

aerobic lagoon required for a 60-day retention of the liquid. Use the larger lagoon from these two calculations;

(b) Also the volume to store the precipitation and runoff from the required storm events shall be added. Refer to (d) and (e) under **Design Storage Volume** of this standard.

Design Criteria – Mechanically Aerated Lagoons.

Loading rate. Mechanically aerated waste treatment lagoons' treatment function shall be designed on the basis of daily BOD_5 loading and aeration equipment manufacturer's performance data for oxygen transfer and mixing. Aeration equipment shall provide a minimum of 1 pound of oxygen for each pound of daily BOD_5 loading.

Operating levels. The maximum operating level shall be the lagoon level that provides the required lagoon volume less the 25-year, 24-hour storm event precipitation and shall not exceed the site and aeration equipment limitations. A permanent marker or recorder shall be installed at this elevation. The proper operating range of the lagoon is below this elevation and above the minimum treatment elevation established by the manufacturer of the aeration equipment. This marker shall be referenced and described in the O&M plan.

Design Criteria – Embankment.

Foundation Cutoff. A cutoff of relatively impervious material shall be provided under the embankment except in those cases where a layer of such material exists at the surface of the foundation. The layer of impervious material shall be thick enough to prevent seepage under the embankment. If required, the cutoff shall extend along the centerline of the embankment and its abutments as required and be deep enough to extend into a relatively impervious layer. The cutoff trench shall have a bottom width adequate to accommodate the equipment used for excavation, backfill, and compaction operations and have side slopes not steeper than 2 horizontal to 1 vertical.

Minimum Elevation. *The minimum elevation of the top of the settled embankment shall be 1 foot above the crest of the emergency spillway.* This height shall be increased by the amount needed for settlement. This increase shall be not less than 5 percent. Actual allowance for shrinkage (in excess of the minimum) shall be determined for the individual site, based on soil type, moisture condition, type equipment used, contractor, and experience in the area. The minimum allowable settlement shall be as shown in Table 1.

Table 1- Minimum Allowable Settlement

Construction Equipment	Allowable Settlement in percent
Bulldozer, & Bulldozer & Dragline Combinations [1]	10
Carryall & Scrapers	5
[1]Drageline construction alone for embankments is not permissible. The use of draglines is permissible where the embankment is compacted in layers of 9 inches or less in thickness by bulldozers, scrapers or similar equipment to obtain the desired compaction of the embankment.	

Side Slope. The combined side slopes of the settled embankment shall not be less than 5 horizontal to 1 vertical, and neither slope shall be steeper than 2 horizontal to 1 vertical.

Top Width. The minimum top widths shall be as shown in Table 2.

Table 2- Minimum Top Widths

Total Embankment Height, ft.	Top Width, ft.
15 or less	8
15 – 20	10
20 – 25	12
25 – 30	14
30 – 35	15

CONSIDERATIONS

General.

A waste treatment lagoon should be located near the source of waste and as far from neighboring dwellings as practicable. If possible, locate the facility where it is not visible from residences and public areas, and prevailing winds will carry odors away from these areas. Waste treatment lagoons should be located a minimum of 300 feet from an adjacent property dwelling. Vegetated screens should be considered when the facility would be visible from residences or public areas

The location, layout and design of the facilities should be compatible with the surrounding landscape. Existing landforms and vegetation,

along with land shaping and vegetative plantings, shall be considered to minimize an adverse impact upon visual resources.

Non-polluted runoff should be excluded from the lagoon to the fullest extent possible except where its storage is advantageous to the operation of the agricultural waste management system.

An inlet pipe should extend a minimum of 5 feet past the bottom toe of the lagoon to ensure good distribution. Access should be provided to the pipe for rodding in case of blockage.

To minimize frequency of solids removal from the lagoon, direct polluted runoff through vegetative filter strips, low-gradient channels, or debris, sediment or settling basins to remove readily settleable solids. For design of waste storage structures see NRCS Conservation Practice Standard, "Waste Storage Facility", Code 313.

Equipment should be available for removing waste from the lagoon, processing them for energy, or applying them to the land at locations, times and rates shown in the overall management plan.

Due consideration should be given to environmental concerns, economics, the overall waste management system plan, and safety and health factors.

Development of an emergency action plan should be considered for lagoons where there is a potential for significant impact from breach or accidental release. The plan shall include site-specific provisions for emergency actions that will minimize these impacts.

Considerations for minimizing the potential for and impacts of sudden breach of embankment or accidental release from the required volume.

Features, safeguards, and/or management measures to minimize the risk of embankment failure or accidental release, or to minimize or mitigate impact of this type of failure should be considered when any of the categories listed in Table 3 might be significantly affected.

The following should be considered either singly or in combination to minimize the potential of or the consequences of sudden breach of embankments when one or more of the potential impact categories listed in Table 3 may be significantly affected:

1. Additional freeboard;
2. Storage volume for the wet year rather than normal year precipitation;
3. Reinforced embankment -- such as, additional top width, flattened and/or armored downstream side slopes;
4. Secondary containment;
5. Water level indicators or recorders.

The following should be considered to minimize the potential for accidental release from the required volume through gravity outlets when one or more of the potential impact categories listed in Table 3 may be significantly affected:

Table 3 - Potential Impact Categories from Breach of Embankment or Accidental Release

1. Surface water bodies -- perennial streams, lakes, wetlands, and estuaries
2. Critical habitat for threatened and endangered species
3. Riparian areas
4. Farmstead, or other areas of habitation
5. Off-farm property
6. Historical and/or archaeological sites or structures that meet the eligibility criteria for listing in the National Register of Historical Places

1. Outlet gate locks or locked gate housing;
2. Secondary containment;
3. Alarm system;
4. Another means of emptying the required volume.

Considerations for minimizing the potential of lagoon liner seepage.

Sites with categories listed in Table 4 should be avoided unless no reasonable alternative exists. Under those circumstances, consideration should be given to providing an additional measure of safety from lagoon seepage when any of the potential impact categories listed in Table 4 may be affected.

Table 4 - Potential Impact Categories for Liner Failure

1. Any underlying aquifer is at a shallow depth and not confined
2. The vadose zone is rock
3. The aquifer is a domestic water supply or ecologically vital water supply
4. The site is located in an area of solutionized bedrock such as limestone or gypsum

Should any of the potential impact categories listed in Table 4 be affected, consideration should be given to the following:

1. A clay liner designed in accordance with procedures of AWMFH, Appendix 10D with a thickness and coefficient of permeability so that specific discharge is less than 1 x 10^{-6} cm/sec.;
2. A flexible membrane liner;
3. A geosynthetic clay liner (GCL) flexible membrane liner;
4. A concrete liner designed in accordance with slabs on grade criteria in NRCS Conservation Practice Standard, "Waste Storage Facility", Code 313 for fabricated structures requiring water tightness.

Considerations for minimizing the impact of odors

For sites located where odors are a concern, the following should be considered:

1. Reduce loading rates of anaerobic lagoons to at least one half the values of AWMFH Figure 10-22;
2. Covering the lagoon with a suitable cover;
3. Using naturally aerated or mechanically aerated lagoons;
4. Using composting in conjunction with a solid waste system rather than a liquid or slurry system;
5. Using an anaerobic digester and biogas capture system.

PLANS AND SPECIFICATIONS

Plans and specifications shall be prepared in accordance with the criteria of this standard and shall describe the requirements for applying the practice to achieve its intended use. The construction specifications shall be written for site specific conditions, and shall be included in the plans and specifications, and adhered to during construction. For guidance on specifications, see "WASTE TREATMENT LAGOON, SPECIFICATION".

OPERATION AND MAINTENANCE

An operation and maintenance plan shall be developed that is consistent with the purposes of the practice, it's intended life, safety requirements, and the criteria for design.

The plan shall contain the operational requirements for drawdown and the role of permanent markers. This shall include the requirement that waste be removed from the lagoon and utilized at locations, times, rates, and volume in accordance with the overall waste management system plan. In addition, the plan shall include a strategy for removal and disposition of waste with least environmental damage during the normal treatment period to the extent necessary to insure the lagoon's safe operation. This strategy shall also include the removal of unusual storm events.

As a minimum the following will be addressed in the plan:

Loading The anaerobic lagoon shall be filled with water to a depth of 3 feet before loading begins.

Floating Material Where feasible keep bedding material, straw, oil and other floating material out of the lagoons.

Maintenance The lagoon shall be inspected periodically, and grass kept mowed, and the embankment and edges kept free of weeds, shrubs and trees. Sludge removal shall be in accordance with the design unless actual accumulation rates vary from predicted values.

Road System An adequate road system shall be planned to provide access to the lagoon, appurtenant structures, and other pertinent parts of the system. If needed, an area for turning shall be provided where the fill is also used as a road. Adequate ramps shall be provided.

Lagoon Levels Whenever the lagoon level encroaches into the volume dedicated to store storm runoff, the excess volume shall be removed in a timely manner. This effluent shall not be allowed to enter the waters of the state.

TABLE 5 - DESIGN VALUES FOR ANIMAL WASTE TREATMENT LAGOON

Animal	Maximum Water Use Per Animal (Gal/Day)	Percent Confine	Anaerobic Lagoon [1] Loading Rate Cu. ft. / Animal	Aerobic Lagoon [2] Loading Rate Sq. ft. / Animal
Beef Cattle				
Veal Calves (100# - 450#)	17	100	190	55
First Stage Finish (450# - 750#)	70	100	760	206
Finish Out (750# - 1100#)	103	100	1105	351
Dairy Cows (1100# - 1500#)	200	100	2196	554
	100	50	1098	277
	50	25	550	139
Swine				
Farrowing (350# + 75#)	46	100	500	264
Breeder (350#)	18	100	191	106
Feeder (140#)	14	100	154	79
Nursery (30#)	4	100	53	26
Alligator	19	100	230	132

[1] Values include 4 years of sludge build up.

[2] Values for use only when aerobic lagoon is loaded with effluent from an anaerobic lagoon.

Note: Values in this table do not include storm storage and precipitation runoff.