Natural Resources Conservation Service

CONSERVATION PRACTICE STANDARD

WASTE STORAGE FACILITY

(No.)

CODE 313

DEFINITION

A waste storage impoundment made by constructing an embankment and/or excavating a pit or dugout, or by fabricating a structure.

PURPOSE

To temporarily store wastes such as manure, wastewater, and contaminated runoff as a storage function component of an agricultural waste management system.

CONDITIONS WHERE PRACTICE APPLIES

- Where the storage facility is a component of a planned agricultural waste management system
- Where temporary storage is needed for organic wastes generated by agricultural production or processing
- Where the storage facility can be constructed, operated and maintained without polluting air or water resources
- Where site conditions are suitable for construction of the facility
- To facilities utilizing embankments with an effective height of 25 feet or less where damage resulting from failure would be limited to damage of farm buildings, agricultural land, or township and country roads.
- To fabricated structures including tanks, stacking facilities, and pond appurtenances.

CRITERIA

General Criteria Applicable to All Waste Storage Facilities.

Laws and Regulations. Waste storage facilities must be planned, designed, and constructed to meet all federal, state, and local laws and regulations. Waste storage facilities may need to be approved or permitted by the Kentucky Natural Resources and Environmental Protection Cabinet for Environmental Protection. Refer to KRS 224.10 (19).

Location. To minimize the potential for contamination of streams, waste storage facilities 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. Waste storage facilities 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.

Waste storage facilities shall be located as close to the source of waste and as far from neighboring dwellings or other areas of public use as practical.

Waste storage facilities shall meet the minimum distance requirements from public or private facilities as shown in Table 1, unless a greater distance is required by state or local laws and regulations.

Exception to these requirements may be

granted where an existing animal feeding operation, which includes animals, housing, and structures, etc. is located and currently operating at a distance closer to one or more of the public or private use facilities shown in Table 1. Such existing operations will not be required to strictly comply with the minimum distance requirements providing the following requirements are met:

1. Moving the operation to comply with the Table 1 distance requirements is not practical from economic, topographic, or other site specific limitations.
2. A storage facility is needed and can be constructed, operated and maintained without pollution of surface or ground water resources.
3. The waste storage facility is to be planned, designed, and constructed to manage the waste generated from the current size operation only; it is not to provide for an increase to the current number of animals utilizing this sensitive site.
4. All permit requirements for the waste storage facility must be met.

Table 1-Minimum Distance Requirements For Waste Storage Facilities

Public or Private Use Facilities	Minimum Distance From Waste Storage Facility
Churches, Schools, Businesses and public use areas	1500 feet
Dwellings	500 feet
Property Lines	75 feet
Potable Water Wells	300 feet
Natural Water Courses or Drainage Ditches	150 feet
Federal and State Roads	150 feet
County Roads	100 feet

Storage Period. The storage period is the maximum length of time anticipated between emptying events. The minimum storage period shall be based on the timing required for environmentally safe waste utilization considering the climate, crops, soil, equipment, and local, state, and federal regulations. A storage period of 180 days is recommended for most liquid waste storage structures. The minimum storage period criteria for all structures shall be as indicated in Table 2.

Table 2 – Minimum Storage Periods for Waste Storage Facilities

Days	Method of Disposal
120	Liquid or solid waste hauled
90	Liquid wastes pumped through irrigation delivery system
7	Milking parlor waste conveyed/w sprinkler irrigation and disposal area >200 feet from water conveyance

Additional Criteria for Liquid and Slurry Storage

Design Storage Volume. The design storage volume shall be equal to the required storage volume. The design storage volume shall consist of the total of the following as appropriate:

(a) Manure, wastewater, and other wastes accumulated during the storage period

(b) Normal precipitation less evaporation on the surface area (at the design storage volume level) of the facility during the storage period

(c) Normal runoff from the facility's drainage area during the storage period

(d) 25-year, 24-hour precipitation on the surface (at the required design storage volume level) of the facility

(e) 25-year, 24-hour runoff from the facility's drainage area

(f) Residual solids after liquids have been removed. A minimum of 6 inches shall be provided for tanks

(g) Additional storage as may be required to meet management goals or regulatory requirements

Domestic and industrial waste from wash down facilities, showers, toilets, sinks, etc. shall not be discharged into waste storage facilities.

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. Inlets from enclosed buildings shall be provided with a water-sealed trap and vent or similar device to control gas entry into the buildings or other confined spaces.

Emptying Component. Some type of component shall be provided for emptying storage facilities. It may be a facility such as a gate, pipe, dock, wet well, pumping platform, retaining wall, or ramp. Features to protect against erosion, tampering, and accidental release shall be incorporated as necessary.

Waste removed from storage facilities shall be utilized in accordance with NRCS conservation practice standard Nutrient Management, Code 590.

Accumulated Solids Removal. Provision shall be made for periodic removal of accumulated solids to preserve storage capacity. The anticipated method for doing this must be considered in planning, particularly in determining the configuration of ponds and type of seal, if any.

Safety. Design shall include appropriate safety features to minimize the hazards of the facility. Ramps used to empty liquids shall have a slope of 4 horizontal to 1 vertical or flatter. Those used to empty slurry, semi-solid, or solid waste shall have a slope of 10 horizontal to 1 vertical or flatter unless special traction surfaces are provided. Warning signs, fences, ladders, ropes, bars, rails, and other devices shall be provided, as appropriate, to ensure the safety of humans and livestock. Ventilation and warning signs must be provided for covered waste holding structures, as necessary, to prevent explosion, poisoning, or asphyxiation. Pipelines 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. Ponds and uncovered fabricated structures for liquid or slurry waste with walls less than 5 feet above ground surface shall be fenced and warning signs posted to prevent children and others from using them for other than their intended purpose. Fencing shall be constructed in accordance with NRCS conservation practice standard Fence, Code 382.

Erosion Protection. Embankments and disturbed areas surrounding the facility shall be treated to control erosion. Vegetative treatment efforts shall be according to NRCS Practice Standard Critical Area Planting, Code 342.

Liners. Liners shall meet or exceed the criteria in Pond Sealing or Lining, Code 521.

Additional Criteria for Waste Storage Ponds

Hazard Classification. The area downstream of the embankment must be evaluated to determine the impact of damage from a sudden breach of the proposed embankment on both structural and environmental features. This evaluation must consider all improvements and those improvements that may reasonably be expected to be made during the useful life of the structure. The result of this examination provides for the proper hazard approval classification of the embankment. Only hazard class (a) embankments are to be designed under this standard. See National Engineering Manual Part 520.23 for guidance in documentation of hazard classification.

Soil and foundation. The pond shall be located in soils with an acceptable permeability that meets all applicable regulation, or the pond shall be lined. Information and guidance on controlling seepage from waste impoundments can be found in the Agricultural Waste Management Field Handbook (AWMFH), Appendix 10D.

The pond 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.

A detailed subsurface investigation with special attention to the water table depth, depth to bedrock, groundwater resources, and seepage potential must be considered in each design. The investigation must evaluate soils to a depth no less than two feet below the final grade of any excavation. Deeper investigations may be required depending on site conditions. A determination as to whether a liner is needed will be based upon the site specific

subsurface investigation and information on controlling seepage in AWMFH Chapter 7.

All earthen manure storage facilities shall be investigated by a qualified geologist and/or soil scientist and a written report prepared that addresses the water table depth, and potential for groundwater pollution considering the hydrology, groundwater gradient, soil permeability, etc. Considerations of findings in the geology / soils report shall be included in the design, construction, and operation plans for the specific site.

Maximum Operating Level. The maximum operating level for waste storage ponds shall be the pond level that provides for the required volume less the volume contribution of precipitation and runoff from the 25-year, 24-hour storm event plus the volume allowance for residual solids after liquids have been removed. A permanent marker or recorder shall be installed at this maximum operating level to indicate when drawdown should begin. The marker or recorder shall be referenced and explained in the O&M plan.

Liners. The subgrade shall be dense base regardless of liner method. Liners shall be constructed at an elevation above the seasonal high water table unless methods to maintain the liner integrity are considered in the design. The storage pond shall be sealed by one of the liners as described below.

1. Compacted Earth. Earthen liners shall be designed in accordance with NRCS AWMFH Appendix 10D, Geotechnical Design, and Construction Guidelines to achieve a maximum allowable specific discharge of 0.0028 ft/day (1×10^{-6} cm/sec).

Compacted earth liners shall have a minimum thickness of 1 foot on pond sides and bottom measured perpendicular to the finished surface. The final liner thickness shall be determined using AWMFH Appendix 10D.

The liner shall be compacted the required density to ensure the maximum allowable specific discharge is not exceeded. Compaction requirements shall be verified in accordance with ASTM D – 698 or by methods approved by the engineer. Compacted earth liners shall have side slopes of 3 horizontal to 1 vertical (3:1) or flatter, except where compacted earth liners are part of (brought up with) an earthfill.

2. Flexible Membrane. Flexible membrane liners shall be designed and constructed in accordance with the NRCS conservation practice standard Pond Sealing or Lining–Flexible Membrane, Code 521A.

3. Bentonite. Bentonite liners shall be designed and constructed in accordance with the NRCS conservation practice standard Pond Sealing or Lining–Bentonite, Code 521C.

4. Concrete. Concrete liners shall be designed and constructed in accordance with NRCS Construction Specification 32, Structure Concrete.

a. For side slopes and bottoms that will not have any vehicular traffic, use a minimum 4 inch thick concrete slab. No joints are required. Wire mesh or fiber reinforcement is required.

b. For concrete lined areas such as approaches, ramps, and bottoms that will have vehicular traffic of any kind, use a minimum 4 inch thick concrete slab placed over a minimum 4 inch thick layer of compacted gravel base. Joints and reinforcement shall be required by design analysis.

c. Concrete lined side slopes shall be 2 horizontal to 1 vertical (2:1) or flatter, except for concrete push-off ramps. Concrete push-off ramp slopes shall be 1 horizontal to 1 vertical (1:1) or flatter on cut slopes and 2 to 1 on embankment slopes.

5. Natural Clay Base. Natural clay base liners shall have a minimum thickness as defined in NRCS AWMFH Appendix 10D. The soil shall meet the criteria for a unified soil classification of CL, CH, MH, SC, or GC. Natural clay liners shall have side slopes of 2 horizontal to 1 vertical (2:1) or flatter.

Inlet. Inlets may be pushoff ramps, paved slopes or pipe inlets.

Paved slopes shall be no flatter than 4 horizontal to 1 vertical (4:1) and will not be used when appreciable bedding materials are used.

Pipe inlets may be steel, concrete, aluminum, or PVC as required in NRCS conservation practice standard for Pond, Code 378. If

corrugated steel is used, it shall be adequately protected with an appropriate coating.

All pipes shall be designed to carry the required flow and shall be installed on a slope of 1 percent or greater and preferably 1.5 percent or greater. Where solids are being conveyed, the pipe diameter shall be sized to prevent plugging. Minimum pipe diameter will be 6 inches.

Pumped inlets shall be sized to meet the requirements of the pumping equipment. Gravity flow inlet pipes for liquid only may outlet at or above the design volume elevation. The slope of the pond at the pipe outlet shall be protected from erosion by paving or by extending the pipe outlet to a point where the discharge will not fall on the slope. Pipes shall be supported on pilings of pressure treated wood, steel, concrete, or masonry and anchored to prevent dislodging or flotation.

Large diameter gravity loading pipes for solids and liquids shall outlet at the bottom of the pond, and the effective head (vertical difference between the top of the drop inlet and the design volume elevations) shall be no less than 4 feet.

Outlet. No outlet shall automatically release storage from the required design volume. Manually operated outlets shall be of permanent type designed to resist corrosion and plugging.

Embankments. The minimum elevation of the top of the settled embankment shall be 1 foot above the waste storage pond's required volume. This height shall be increased by the amount needed to ensure that the top elevation will be maintained after settlement. This increase shall be not less than 5 percent. The minimum top widths are shown in Table 3. 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 unless provisions are made to provide stability.

If the embankment top is to be used as a road, the minimum width shall be 16 feet for one-way traffic and 26 feet for two-way traffic. Provisions shall be made for protecting the emergency spillway from damage. Guard rails or other safety measures shall be used where necessary.

Table 3 – 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

Compaction of the embankment fill material shall be in accordance with the specified design requirements for compaction and moisture content. As a minimum, compaction shall be equivalent to, or better than, the following:

1. Layers of fill shall not exceed 9 inches in thickness before compaction. Compaction shall be accomplished by routing the hauling and spreading equipment over the fill in such a manner that every point on the surface will be traversed by not less than two tread tracks of the loaded equipment traveling in a direction parallel to the main axis of the fill.

2. Clayey soils shall be compacted with a "sheepsfoot" or tamping roller (See AWMFH Appendix 10D for guidance on compaction).

Emergency Spillway. An emergency spillway, combination of spillways, or additional storage shall be provided to protect the waste storage pond from overtopping the embankment when a 25-year, 24-hour storm event is exceeded and the design volume is filled. The crest of the emergency spillway shall be located at or above the same elevation as the top of the 25-year, 24-hour storm storage. The emergency spillway shall be designed to pass a 25-year, 24-hour storm without overtopping the embankment. There shall be a minimum of 1 foot of freeboard above the designed depth of flow in the emergency spillway. Emergency spillway requirements however do not apply to waste storage ponds without drainage areas and with less than 3 feet of storage above natural ground.

The emergency spillway shall be placed in undisturbed soil when possible. When it must be placed in fill material precautions shall be taken to insure the integrity of the structure. Where a waste storage pond empties into another waste storage pond and the liquid

level is positively controlled by an adequately sized overflow pipe, no emergency spillway is required for the primary waste storage pond.

Pipe emergency spillways shall be 6 inch minimum diameter and meet the requirement in NRCS conservation practice standard for Pond, Code 378.

Excavations. Unless supported by a soil investigation, excavated side slopes shall be no steeper than 2 horizontal to 1 vertical.

Additional Criteria for Fabricated Structures

Foundation. The foundations of fabricated waste storage structures shall be proportioned to safely support all superimposed loads without excessive movement or settlement.

Where a non-uniform foundation cannot be avoided or applied loads may create highly variable foundation loads, settlement should be calculated from site-specific soil test data. Index tests of site soil may allow correlation with similar soils for which test data is available. If no test data is available, presumptive bearing strength values for assessing actual bearing pressures may be obtained from Table 4 or another nationally recognized building code. In using presumptive bearing values, adequate detailing and articulation shall be provided to avoid distressing movements in the structure.

Foundations consisting of bedrock with joints, fractures, or solution channels shall be treated or a separation distance provided consisting of a minimum of 1 foot of impermeable soil between the floor slab and the bedrock or an alternative that will achieve equal protection.

Table 4 - Presumptive Allowable Bearing Stress Values[1]

Foundation Description	Allowable Stress
Crystalline Bedrock	12000 psf
Sedimentary Rock	6000 psf
Sandy Gravel or Gravel	5000 psf
Sand, Silty Sand, Clayey Sand, Silty Gravel, Clayey Gravel	3000 psf
Clay, Sandy Clay, Silty Clay, Clayey Silt	2000 psf

[1] Basic Building Code, 12th Edition, 1993, Building Officials and Code Administrators, Inc. (BOCA)

Liquid Tightness. Applications such as tanks, that require liquid tightness shall be designed and constructed in accordance with standard engineering and industry practice appropriate for the construction materials used to achieve this objective.

Structural Loadings. Waste storage structures shall be designed to withstand all anticipated loads including internal and external loads, hydrostatic uplift pressure, concentrated surface and impact loads, water pressure due to seasonal high water table, and frost or ice pressure and load combinations in compliance with this standard and applicable local building codes.

The lateral earth pressures should be calculated from soil strength values determined from the results of appropriate soil tests. Lateral earth pressures can be calculated using the procedures in TR-74. If soil strength tests are not available, the presumptive lateral earth pressure values indicated in Table 5 shall be used.

TABLE 5 - LATERAL EARTH PRESSURE VALUES[1]

Soil		Equivalent fluid pressure (lb/ft^2/ft of depth)			
		Above seasonal high water table[2]		Below seasonal high water table[3]	
Description[4]	Unified Classification[4]	Free-standing walls	Frame tanks	Free-standing walls	Frame tanks
Clean gravel, sand or sand-gravel mixtures (maximum 5% fines)[5]	GP, GW, SP, SW	30	50	80	90
Gravel, sand, silt and clay mixtures (less than 50% fines) Coarse sands with silt and and/or clay (less than 50% fines)	All gravel sand dual symbol classifications and GM, GC, SC, SM, SC-SM	35	60	80	100
Low-plasticity silts and clays with some sand and/or gravel (50% or more fines) Fine sands with silt and/or clay (less than 50% fines)	CL, ML, CL-ML SC, SM, SC-SM	45	75	90	105
Low to medium plasticity silts and clays with little sand and/or gravel (50% or more fines)	CL, ML, CL-ML	65	85	95	110
High plasticity silts and clays (liquid limit more than 50)[6]	CH, MH	-	-	-	-

[1] For lightly-compacted soils (85% to 90% maximum standard density.) Includes compaction by use of typical farm equipment.
[2] Also below seasonal high water table if adequate drainage is provided.
[3] Includes hydrostatic pressure.
[4] All definitions and procedures in accordance with ASTM D 2488 and D 653.
[5] Generally, only washed materials are in this category
[6] Not recommended. Requires special design if used.

Lateral earth pressures based upon equivalent fluid assumptions shall be assigned according to the following conditions:

- **Rigid frame or restrained wall.** Use the values shown in Table 3 under the column "Frame tanks," which gives pressures comparable to the at-rest condition.
- **Flexible or yielding wall.** Use the values shown in Table 3 under the column "Free-standing walls," which gives pressures comparable to the active condition. Walls in this category are designed on the basis of gravity for stability or are designed as a cantilever having a base wall thickness to height of backfill ratio not more than 0.085.

Internal lateral pressure used for design shall be 65 lb/ft^2 where the stored waste is not protected from precipitation. A value of 60 lb/ft^2 may be used where the stored waste is protected from precipitation and will not become saturated. Lesser values may be used if supported by measurement of actual

pressures of the waste to be stored. If heavy equipment will be operated near the wall, an additional two feet of soil surcharge shall be considered in the wall analysis.

Tank covers shall be designed to withstand both dead and live loads. The live load values for covers contained in ASAE EP378.3, Floor and Suspended Loads on Agricultural Structures Due to Use, and in ASAE EP 393.2, Manure Storages, shall be the minimum used. The actual axle load for tank wagons having more than a 2,000 gallon capacity shall be used.

If the facility is to have a roof, snow and wind loads shall be as specified in ASAE EP288.5, Agricultural Building Snow and Wind Loads. If the facility is to serve as part of a foundation or support for a building, the total load shall be considered in the structural design.

Service Life and Durability. Planning design, and construction shall ensure that the structure is sound and of durable materials commensurate with the anticipated service life, initial and replacement costs, maintenance and operation costs, and safety and environmental considerations.
Guidance in evaluating the service life of various materials is given in Table 6. The materials indicated meet the requirements of this standard. The service life of materials not shown shall be based on performance data.

Table 6 – Service Life of Various Materials

Service Life	Material[1]
Short (Minimum of 15 years)	Wood; masonry, including concrete staves; flexible membranes; glass/fiber reinforced plastics/resins; steel coated with zinc, epoxy, vinyl and asphalt; reinforced concrete
Medium (minimum of 20 years)	Reinforced Concrete; glass fused steel
Long (minimum of 50 years)	Reinforced concrete; flexible membranes with earth covers

[1]The durability and estimated life of reinforced concrete is a function of the design and the quality of the concrete. A key aspect affecting durability is corrosion of the reinforcement which is directly related to cracking (design stress) and the reinforcement cover. The quality levels of reinforced concrete are discussed under “Structural Design”.

Structural Design. The structural design shall consider all items that will influence the performance of the structure, including loading assumptions, material properties and construction quality. Design assumptions and construction requirements shall be indicated on standard plans.

Tanks may be designed with or without covers. Covers, beams, or braces that are integral to structural performance must be indicated on the construction drawings. The openings in covered tanks shall be designed to accommodate equipment for loading, agitating, and emptying. These openings shall be equipped with grills or secure covers for safety, and for odor and vector control.

All structures shall be underlain by free draining material or shall have a footing located below the anticipated frost depth. Fabricated structures shall be designed according to the criteria in the following references as appropriate:

- Steel: “Manual of Steel Construction”, American Institute of Steel Construction.
- Timber: “National Design Specifications for Wood Construction”, American Forest and Paper Association.
- Concrete: “Building Code Requirements for Reinforced Concrete, ACI 318”, American Concrete Institute.
- Masonry: “Building Code Requirements for Masonry Structures, ACI 530”, American Concrete Institute.

Slabs on Grade. Slab design shall consider the required performance and the critical applied loads along with both the subgrade material and material resistance of the concrete slab. Where applied point loads are minimal and liquid-tightness is not required, such as barnyard and feedlot slabs subject only to precipitation, and the subgrade is uniform and dense, the minimum slab thickness shall be 4 inches with a maximum joint spacing of 10 feet. Joint spacing can be increased if steel reinforcing is added based on subgrade drag theory.

For applications where liquid-tightness is required such as floor slabs of storage tanks, the minimum thickness for uniform foundations shall be 5 inches and shall contain distributed reinforcing steel. The required area of such reinforcing steel shall be based on subgrade drag theory as discussed in industry guidelines such as American Concrete Institute, ACI 360, “Design of Slabs-on-Grade”.

When heavy equipment loads are to be resisted and/or where a non-uniform foundation cannot be avoided, an appropriate design procedure incorporating a subgrade resistance parameter(s) such as ACI 360 shall be used.

Additional Criteria for Holding Tanks

Holding tanks are used for liquid and slurry waste and may be open or covered, within or outside of enclosed housing, or beneath slotted floors. Holding tanks shall be essentially watertight.

Depending on the hazard involved to the environment, tanks shall be constructed of reinforced masonry, coated or glass-fused steel or reinforced concrete. In-ground tanks shall have exterior drainage or a minimum safety factor of 1.3 against uplift, when empty.

Holding tanks shall be sufficiently watertight to retain liquids required for agitating and pumping and to function as planned. Effluent seepage in amounts that would pollute surface or ground water shall be prevented by watertight construction or collected and utilized in a safe manner. Influent seepage in amounts that would infringe on the designed holding capacity shall be prevented by watertight construction or site drainage.

Central loading from an elevation at or above the top of the sidewall of open holding tanks allows more complete and uniform filling, particularly with manure containing bedding. Steel and other corrodible materials shall be adequately protected with concrete, paint, or other protective coatings to prevent corrosion.
Tank covers shall be designed to withstand both dead and live loads. The live load values for covers contained in ASAE EP378.3, Floor and Suspended Loads on Agricultural Structure Due to Use, and in ASAE EP393.2, Manure Storage, shall be the minimum used. The actual axle load for tank wagons having more than a 2,000 gallon capacity shall be used.

All structures shall be underlain by free draining material.

A minimum of 6 inches of residual solids storage shall be provided for tanks.

Additional Criteria for Stacking Facilities

Solids stacking imply that the manure has a consistency that does not flow, but remains in place even during the wettest time of the storage period. Facilities receiving 100 percent of the manure production, with no provision for liquid separation, shall not be designed as stacking facilities.

Stacking facilities may be open or roofed and are used for wastes which behave primarily as a solid. The anticipated stacking angle of the manure must be considered in determining the wall height.

Stacking facilities shall be constructed of durable material such as reinforced concrete, reinforced concrete block or treated lumber. They shall be designed with adequate safety factors to prevent failure due to internal or external pressures, including hydrostatic uplift pressure and imposed surface loads such as equipment which may be used within, on, or adjacent to the structure. Lumber shall not be used for walls which support moving stacking elevators or similar loads.

Structural design criteria for stacking facilities shall be in accordance with the criteria for the various materials listed in the section "Structural Design" of this standard.

Floor Slabs. Concrete floors should normally slope away from the entrance toward the back of the storage area. The suggested design grade of the floors for beef and dairy manure stacking facilities is from 0.2 to 1.0 percent. Floors for poultry litter storage structures may be designed level.

Timber Walls. All post and lumber in contact with waste or exposed to moisture shall be pressure-treated in accordance with ASTM D 1760, "Standard Specification for Pressure Treatment of Timber Products."
Posts shall have a minimum size of 6 inch by 6 inch (nominal) and be placed in the ground from 3 to 6 feet deep, depending on the design analysis. Side planking shall be treated lumber with a minimum nominal thickness of 2 inches.

Seepage. Effluent seepage in amounts that would pollute surface or ground water shall be prevented by water tight construction or collected and disposed of in a safe manner.

Influent seepage in amounts that would infringe on designed storage capacity shall be prevented by watertight construction or site drainage.

Internal Drainage. Drainage of some liquids, including rainfall from the stacking area (especially those without a roof), should be considered. This is

best accomplished by use of a timber wall with the boards installed vertically, leaving 3/4-inch gaps between the boards. The timber wall drainage section may be included in a concrete or masonry block wall. Design criteria shall be the same as for timber walls.

Seepage shall be collected in a tank or waste storage pond, or properly treated in a lagoon or infiltration strip.

Poultry Litter Stacking Facilities. To prevent spontaneous combustion, poultry litter in the stacking facility should have less than 40 percent moisture. Dry and moist litter should not be layered. In addition, the height of the litter stack shall not exceed 7 feet, with litter to wood contact limited to 4 feet.

Vegetation. A protective cover of vegetation shall be established on all disturbed earth surfaces. Where necessary, temporary vegetation will be used until permanent vegetation can be established. Vegetative measures including seedbed preparation, seeding, fertilizing, and mulching shall comply with NRCS KY Conservation Practice Standard Critical Area Planting, Code 342.

CONSIDERATIONS

Waste storage facilities should be located as close to the source of waste and polluted runoff as practicable. In addition, they should be located considering prevailing winds and landscape elements such as building arrangement, landform, and vegetation to minimize odors and visual resource problems.

An auxiliary (emergency) spillway and/or additional embankment height should be considered to protect the embankment. Factors such as drainage area, pond size, precipitation amounts, downstream hazards, and receiving waters should be evaluated in this consideration.

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

Solids Separation. To minimize frequency of solids removal from waste storage ponds, route polluted runoff through vegetative filter strips, low-gradient channels, or debris basins to remove readily settleable solids. Settling facilities should have adequate capacity to store settled solids for a time period based on climate, equipment, clean out frequency, and method of disposal. If animal manure, such as from dairy cows, is flushed into a storage pond, a solids separator may be provided for removing fibrous solids to facilitate pumping and irrigation. Solid separators, debris basins, etc., shall be designed with appropriate liners to prevent seepage to the groundwater.

Water Quantity. Waste storage facilities will have an affect on the water budget. The affect will be dependent upon the size of the waste storage facility. The waste storage facility will cause an increase in evaporation and a decrease in downstream runoff where drainage is designed to the facility. The waste storage facility will not increase water demand at the site.

Water Quality. The waste storage facility should have an overall positive impact on water quality by storing animal waste and polluted runoff until it can be safely applied to the land. Where ponds are used for waste storage, there can be a positive effect on water related wildlife habitat by providing open water bodies. Water quality can be adversely impacted during initial construction due to erosion of the site but will be minimal using proper construction pollution prevention measures.

Freeboard for waste storage tanks should be considered.

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

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 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 4 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 7 may be significantly affected:

1. An auxiliary (emergency) spillway

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

Table 7 - 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.

The following options 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 7 may be significantly affected:

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 Waste Storage Pond Liner Failure.

Sites with categories listed in Table 8 should be avoided unless no reasonable alternative exists. Under those circumstances, consideration should be given to providing an additional measure of safety from pond seepage when any of the potential impact categories listed in Table 7 may be significantly affected.

Table 8 - 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 8 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 1×10^{-6} cm/sec
2. A flexible membrane liner over a clay liner
3. A geosynthetic clay liner (GCL) flexible membrane liner
4. A concrete liner designed in accordance with slabs on grade criteria for fabricated structures requiring water tightness

Considerations for Improving Air Quality/Minimizing the Impact of Odors

An anaerobic lagoon instead of a waste storage pond should be considered for sites located in rural areas where odors are a concern. This should be especially considered where odors would affect neighboring farms having enterprises that do not cause odors and/or neighbors who earn a living off-farm. The recommended loading rate for anaerobic lagoons at sites where odors must be minimized is one-half the values given in AWMFH Figure 10-22.

For sites located near urban areas practices such as the following should be considered to reduce odor emissions:

1. Covering the storage facility with a suitable cover.
2. Using naturally aerated or mechanically aerated lagoons.
3. Using composting in conjunction with a solid waste system rather than a liquid or slurry system.
4. Using a methane digester and 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.

Engineering plans, specifications and reports shall include:

a. Plan view of system layout.

b. Type and number of animals the structure is designed to serve.

c. Storage period.

d. Structural details of all components.

e. References to components supplied by others (pumps, etc.).

f. Special safety requirements.

g. Vegetative requirements.

h. Quantities.

i. Drainage/Grading plan as needed.

j. Soil and foundation findings, interpretations, and reports.

OPERATION AND MAINTENANCE

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

The plan shall contain the operational requirements for emptying the storage facility. This shall include the requirement that waste shall be removed from storage and utilized at locations, times, rates, and volume in accordance with the overall waste management system plan.

In addition, for ponds, the plan shall include an explanation of the permanent marker or recorder installed to indicate the maximum operating level.

The plan shall include a strategy for removal and disposition of waste with the least environmental damage during the normal storage period to the extent necessary to insure the pond's safe operation. This strategy is for the removal of the contribution of unusual storm events that may cause the pond to fill to capacity prematurely with subsequent design inflow and usual precipitation prior to the end of the normal storage period.

Development of an emergency action plan should be considered for waste storage facilities 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.

REFERENCES

ACI 318, 360, 530

ASTM D-653, D-698, D-2488

ASAE Specifications: EP378.3, EP393.2, EP288.5, S288

AWMFH, Chapter 7, Chapter 10

Basic Building Code, 12th Edition

ASTM D 1760, "Standard Specification for Pressure Treatment of Timber Products."

"Manual of Steel Construction", American Institute of Steel Construction

"National Design Specifications for Wood Construction", American Forest and Paper Association

National Engineering Manual, Part 520

NRCS Conservation Practice Standards: Critical Area Planting, Code 342 Pond, Code 378 Pond Sealing or Lining, Code 521 Nutrient Management, Code 590

TR-74, "Lateral Earth Pressures"