NATURAL RESOURCES CONSERVATION SERVICE
CONSERVATION PRACTICE STANDARD

WASTE STORAGE FACILITY

(No.)

CODE 313

(Photo courtesy of the Natural Resources Conservation Service)

DEFINITION

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

PURPOSES

This practice may be applied as part of a conservation management system to support the following purposes.

- Provide temporary storage.
- Protect surface water.
- Protect ground water.
- Provide a safe environment for storing and handling manure.

CONDITIONS WHERE PRACTICE APPLIES

Where the storage facility is a component of a Comprehensive Nutrient Management Plan.

Where temporary storage is needed for manure, poultry litter, wastewater, feed waste, bedding, organic byproducts, and/or contaminated runoff generated by agricultural production or processing.

Where the storage facility can be constructed, operated, and maintained without polluting water resources.

Where the soils, geology, and topography are suitable for construction of the facility.

To facilities utilizing earthfill embankments with an effective height of 35 feet or less, failure of which by sudden breach would not be a threat to loss of life and damage would be limited to farm buildings, agricultural lands, or county roads.

To fabricated structure including tanks, stacking facilities, and pond appurtenances.

CRITERIA

General Criteria Applicable to All Purposes

All planned, designed, and constructed work shall comply with all federal, state, and local laws and regulations.

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 the floodplain, waste storage facilities shall be protected from inundation or damage from a 25-year, 24-hour storm event, or larger if required by laws, rules, and regulations. Waste storage facilities shall be located so the potential impacts from breach of the 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.

Storage facilities shall be located as far from public use areas, residences, and wells as possible, but in no case exceed the minimum distance requirements contained in **Table 1**.

Table 1 - Minimum Distance Requirements for Waste Storage Facilities [1/]

Public or Private Use Facilities	Minimum Distance from Waste Storage Facility
Any Public Use Area, Church, Picnic Area, Playground, etc.	300 feet
Residence or Place of Habitation Other Than Owner or Tenant	300 feet
Potable Wells, Private	200 feet
Potable Wells, Public	300 feet
Perennial Streams	100 feet
Area Specified by State or Local Ordinance	Greater of State or Local Distance or Distance Shown Above

[1/] For operations with existing waste storage facilities that are expanding, these requirements do not apply.

Storage Period. The storage period is the maximum length of time anticipated between emptying events during the most critical time of year. The minimum storage period shall be determined as follows:

1. Sufficient to prevent discharge to ground or surface waters.
2. Be based on the timing required for environmentally safe manure utilization considering:
   - Climate.
   - Crop capability to effectively utilize nutrients during active growing periods.
   - University fertilizer timing recommendations.
   - Soil trafficability.
   - Management flexibility to apply manure.
   - Local, state, and federal regulations.

Emergency Action Plan

An Emergency Action (Response) Plan shall be prepared for each waste storage facility. The plan will outline what steps will be followed in case of overflow, breaching, leakage, and the need for emergency land application. As a minimum, the plan must be readily available at each site and contain the following items in the event of an emergency:

- Farm name, owner, manager, address and phone number of farm, directions to farm.
- Fire or ambulance number.
- Information or steps to take to contain spill and contractor information to make repairs to minimize off-site damage.
- Sheriff's Department number, if there is potential for downstream damage to roads, residences, etc.
- Tennessee Department of Environment and Conservation (TDEC) Environmental Assistance Center number.
- County Health Department number.
- Tennessee One Call (1-800-351-1111).
- Tennessee Department of Transportation (TDOT) phone number.

Design Storage Volume. The minimum design volume shall be the volume required for the storage period. The storage volume shall include the total of the following, as appropriate:

1. Manure, wastewater, and other organic byproducts accumulated during the storage period.
2. If the facility is uncovered, normal precipitation less evaporation on the surface area of the facility during the storage period.
3. Normal runoff from the facility's drainage area during the storage period.
4. If the facility is uncovered, 25-year, 24-hour storm precipitation on the surface of the facility.
5. 25-year, 24-hour storm runoff from the facility's drainage area.
6. Residual solids after liquids have been removed.
7. Additional storage as may be required to meet management goals or regulatory requirements.

Domestic and industrial waste from toilets shall not be discharged into waste storage facilities.

Inlet. Inlets shall be of any permanent type designed to resist corrosion, plugging, and freeze damage incorporating erosion protection as necessary. 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 6 inches and a minimum slope of 0.5 percent, except that a minimum diameter of 4 inches may be used to convey milk center wastewater. Access will be provided to the pipe for rodding should blockage occur.

Pipes and open inlets that convey wastewater and/or manure to earth storage facilities shall be designed and installed in a manner to prevent erosion of the side slope. This will be accomplished by:

- Extending the pipe or inlet beyond the slope of the facility.
- Installing an armoring surface such as rock riprap or concrete on the slope.
- Using flexible pipe that will conform to the surface of the slope and safely convey effluent into the facility.

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

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.

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 structures and type of seal, if any.

Maximum Operating Level. The maximum operating level shall be the 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.

Erosion Protection. Disturbed areas shall be vegetated according to conservation practice standard Critical Area Planting, Code 342.

Nutrient Management. Manure, wastewater, and other organic byproducts utilized as a nutrient source for vegetation shall be land applied in accordance with conservation practice standard Nutrient Management, Code 590. For uses other than land application, conservation practice standard Waste Utilization, Code 633, shall be followed.

Waste Storage Ponds and/or Fabricated Structures. Earth Embankments or Excavated Ponds and/or Fabricated Structures can be used to store various forms of organic byproducts and/or contaminated runoff.

Additional Criteria for Waste Storage Ponds

Hazard Classification. The area downstream of the embankment must be evaluated carefully to determine the impact of damage from a sudden breach of the proposed embankment (See **Considerations**). This evaluation must consider all improvements that may reasonably be expected during the useful life of the structure. The results of this examination provide 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 520.21, for guidance in documenting hazard classification.

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.

Soils and Foundation. Earthen storage structures shall be located in soils that can achieve a maximum allowable specific discharge of 0.0028 ft/day (1×10^{-6} cm/sec) or shall be sealed by mechanical treatment or by the use of

an impermeable liner. (NOTE: This rate may be reduced one order of magnitude when credit is given to the sealing effect of manure from ruminants.) Information and guidance on controlling seepage from earthen storage structures can be found in the Agricultural Waste Management Field Handbook (AWMFH), Appendix 10D. Where possible, avoid sites with gravelly soils and shallow soils over fractured or cavernous rock.

Soils Investigation. A detailed soils investigation with special attention to the water table depth and seepage potential must be considered in each design where earthen in-ground liquid storage is proposed. The investigation must evaluate soils to a depth of two feet below the planned bottom grade of the storage structure. Deeper investigations may be required in karst regions.

A soils/geologic investigation shall be performed by a soil scientist and qualified geologist. A qualified geologist is defined as an individual who is a Registered Professional Geologist licensed by the State of Tennessee or an individual who meets the requirements for the title of Certified Professional Geologist, as defined by the American Institute of Professional Geologists. A licensed engineer or a NRCS person with the appropriate level of engineering approval authority should be on-site to provide proposed dimensions and bottom elevation of the structure, answer questions/concerns that the soil scientist and geologist may have, and document elevations and locations of the excavated pits. Proper equipment must be available on-site to perform the investigation.

Liners. Self-sealing ponds are not an acceptable means of containing waste. The subgrade shall be a dense base regardless of liner method. Liners shall not be constructed to an elevation at or below the seasonal high water table, unless methods to maintain the liner integrity are considered in the design. All liners shall be protected from damage during filling, agitating, and pumping operations. Where a liner is required, a qualified individual must be on site during construction to verify proper liner construction and to perform necessary quality control testing. The structure shall be sealed by one of the liners as described below:

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

   Materials that are usually acceptable as liner material without a permeability test are soils that have a Plasticity Index (PI) greater than 16 and classify as CL, CH, MH, SC, or GC based on the Unified Soil Classification System (USCS). Soils may need to be tested to determine the compaction and moisture requirements in order to not exceed the maximum allowable specific discharge.

   Compacted earth liners shall have a minimum thickness of 1 foot on structure side slopes and bottom measured perpendicular to the finished surface. The final liner thickness shall be determined using procedures in Appendix 10D of the AWMFH. The liner material shall be placed in layers not over 9 inches thick and compacted to the required density to ensure the liner does not exceed the maximum allowable specific discharge. Moisture content before compaction shall be approximately 2 percent wet of optimum. Compaction requirements shall be verified in accordance with ASTM D 698.

   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 operation. The compacted earth liner shall be covered with not less than 1 foot of compacted on-site material measured perpendicular to the finished surface.

2. Flexible Membrane - A flexible membrane liner designed and constructed in accordance with the NRCS conservation practice standard Pond Sealing and Lining - Flexible Membrane, Code 521-A.

3. Bentonite - A bentonite liner designed and constructed in accordance with the NRCS conservation practice standard Pond Sealing and Lining - Bentonite or Other High Swell Clay Material, Code 521-C.

4. Concrete - A concrete liner designed and constructed in accordance with NRCS Construction Specification 32, Concrete and the following criteria:

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 wetted sand. Joints and reinforcement shall be as 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 horizontal to 1 vertical (2:1) or flatter on embankment slopes.

5. Natural Clay Base - In situ soils classified in permeability groups III or IV (Plasticity Index greater than 16 and classify as CL, CH, MH, SC, or GC) as defined in AWMFH, Appendix 10D, are acceptable provided they have a minimum thickness of 2 feet below the deepest excavation limits or are at dry densities equivalent to at least 90 percent Standard Proctor (ASTM D 698). Some lab testing of in situ soils may be necessary where the PI of the soil cannot be adequately estimated in the field. The required minimum thickness of the natural clay base liner shall be determined using AWMFH, Appendix 10D. Special precautions must be taken, if the soils contain high amounts of calcium. Subsurface investigations must demonstrate that suitable natural soil material exists for the minimum depth required below the design bottom elevation of the waste storage pond and that no unfavorable geologic conditions occur at the site.

   Natural clay based liners shall have side slopes of 2 horizontal to 1 vertical (2:1) or flatter.

Waste Storage Ponds Constructed in High Water Table Soils. Waste storage ponds constructed in high water table soils shall be based on a detailed risk assessment. The risk assessment shall include an analysis of the potential for ground water pollution considering the hydrogeology, ground water transmissivity, soil permeability, etc. Decisions to install waste storage facilities in high water table soils without liners must provide reasonable assurances that the facility will not cause surface or ground water pollution.

If during the risk assessment it is determined that the site is a potential hazard to ground water pollution, it shall be designed with a liner to prevent contamination of ground water. Methods to maintain the liner integrity shall be considered in the design.

Storage volume for waste storage ponds constructed in high water table soils shall be the volume above the natural high water level elevation.

Embankment Ponds. The minimum elevation of the top of the settled embankment shall be 1 foot above the required storage volume for storage ponds without emergency spillways, and 1 foot above the design depth of flow in the emergency spillway for storage ponds with emergency spillways. This height shall be increased by the amount needed to ensure that the embankment top elevation will be maintained after settlement. This increase shall be not less than 5 percent.

The minimum embankment top width shall be as shown in **Table 2**. 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. Guardrails or other safety measures shall be used where necessary. When the embankment top is used as a road, provision shall be made for protecting the emergency spillway from damage.

Table 2 - Embankment Top Width

Total Height of Embankment, Feet	Minimum Top Width, Feet
<20	10
>20 to 25	12
>25 to 35	14

The combined side slopes of the settled embankment shall be not less than 5 horizontal to 1 vertical (5:1), and neither slope shall be steeper than 2 horizontal to 1 vertical (2:1). All slopes must be designed to be stable. Where

embankments are to be mowed, 3 horizontal to 1 vertical (3:1) or flatter slopes are recommended.

Compaction of the embankment earthfill material shall be in accordance with the specified design requirements for compaction and moisture content.

Emergency Spillway. An emergency spillway, combination of spillways, or additional storage shall be provided to protect the waste storage pond from over-topping 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 over-topping 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 ensure 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 are permissible for storage ponds without drainage areas. Pipes shall be a minimum of 6 inches in diameter, be equipped with trash racks, antivortex devices, and antiseep collars, and have corrosion protection, if steel. They shall be designed and installed to prevent erosion. Pipes shall meet all the requirements of conservation practice standard Pond, Code 378.

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 drop inlet and the design volume elevations) shall be no less than 4 feet.

Excavated Ponds. Side slopes shall be stable and shall not be steeper than 1.5 horizontal to 1 vertical (1.5:1). When the soil structure of side slopes needs to be broken up and compacted, the minimum inside side slope shall be 3 horizontal to 1 vertical (3:1). A low embankment shall be constructed to prevent surface runoff from entering the pond. The embankment shall meet the criteria contained in the "Embankment" section of this standard.

Emptying Facilities. Some type of facility shall be provided for emptying the pond. Ramps used to empty liquids shall have a slope of 4 horizontal to 1 vertical (4:1) or flatter. Ramps used to empty slurry, semi-solid, or solid waste shall have a slope of 10 horizontal to 1 vertical (10:1) or flatter. Steeper slopes may be used, if special traction surfaces are provided.

Where agitators are used in ponds with liners, the tip of the propeller shall be kept a minimum of 3 feet from the liner surface or the liner shall be protected by a concrete pad.

Provisions 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 size and shape of the pond and type of seal, if any.

Staff Gauge. A staff gauge or other permanent marker shall be placed to clearly indicate the maximum level of storage allowed to accumulate in the facility before emptying must be initiated. The marker shall indicate the level at which sufficient storage remains to contain the 25-year, 24-hour runoff and precipitation.

Vegetative Protection. The embankment and side slopes shall be vegetated. Vegetation shall extend down to the maximum operating level of the storage facility.

Fabricated Structure

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 3**. The materials

indicated meet the requirements of this standard. The service life of materials not shown shall be based on performance data.

Foundation. The foundations of fabricated storage facilities 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.

Table 3 - Service Life of Various Materials

Service life	Material[1]
Short (minimum of 10 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 criteria 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."

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)

Structural Loading. 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 Technical Release (TR-74). If soil strength tests are not available, the presumptive lateral earth pressure values indicated in **Table 5** shall be used.

Lateral earth pressures based on equivalent fluid assumptions shall be assigned according to the structural stiffness or wall yielding as follows:

Rigid frame or restrained-wall. Use the values shown in **Table 5** under the column “Frame Tanks," which gives pressures comparable to the at-rest condition.

Flexible or yielding wall. Use the values shown in **Table 5** under the column "Freestanding Wall,” 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 lbs./ft.^{2}/ft. where the stored waste is not protected from precipitation. A value of 60 lbs./ft.^{2}/ft. 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 2 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 Structure Due to Use, and in ASAE EP393.2, 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.

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. Construction requirements shall be indicated on the plans.

Fabricated structures shall be designed according to the criteria in the following references:

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

Timber. "National Design Specifications for Wood Construction," National Forest and Products Association. All lumber in contact with the ground or compost shall be pressure-treated in accordance with Federal Specification, Wood Preservation: Treating Practices, TT-W-571i.

Concrete. "Building Code Requirements for Reinforced Concrete, ACI 318," American Concrete Institute.

Masonry. "Building Code Requirements for Masonry Structures, ACI 530," American Concrete Institute.

Table 5 - Lateral Earth Pressure Values[1]

		Equivalent Fluid Pressure (lb./ft.^{2}/ft. of depth)			
Soil		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/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] AII 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.

Concrete 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 minimum joint spacing of 10 feet. Joint spacing can be increased, if steel reinforcing for crack control is added based on subgrade drag theory.

For applications where liquid-thickness 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 as described in ACI 360 shall be used.

If the facility is to have a roof, wind and snow 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.

Storage Tank

Storage 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 holding tanks shall be designed to accommodate equipment for loading, agitating, and emptying, and shall have grills or secure covers for safety, odor, and vector control. Steel and other corrodible materials shall be adequately protected with concrete, paint, or other protective coatings to prevent corrosion.

All storage tanks shall be underlain by free-draining material.

Depending on the hazard to the environment involved, 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.

Storage 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.

A minimum of 6 inches of residual storage shall be provided for in the storage volume design.

Stacking Facilities

Stacking facilities shall meet all the criteria for fabricated structures.

Stacked manure behaves primarily as a solid and can be stored without flowing even during wet periods. Facilities that receive excreted manure without bedding or where there are no provisions for liquid separation shall not be designed as stacking facilities.

Stacking facilities may be uncovered or roofed. The anticipated stacking angle of the manure must be considered in determining the wall height.

If stacking facilities are unroofed, then the runoff shall be collected.

Seepage. Effluent seepage in amounts that would pollute surface or ground water shall be prevented by watertight 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.

Floor Slabs and Walls. Floors shall slope away from the entrance. Suggested grade of the floor is 0.2 or 0.3 percent.

Timber Walls. All posts and lumber in contact with wastes or exposed to moisture shall be pressure-treated in accordance with Federal Specification, Wood Preservation: Treating Practices, TT-W-571i. Posts shall have a minimum size of 4 inches by 6 inches (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.

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 cracks. 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.

Hoop Roofs

In addition to the requirements for fabricated structures, the following shall be met:

Foundation. The foundation shall be designed, approved, and sealed by a professional engineer licensed to practice engineering in Tennessee.

Wall. Pony walls 4 feet high shall be constructed along the sides for the purposes of fastening the trusses and supporting the manure and/or organic byproduct stored in the structure. The wall shall meet the manufacturer's design requirements.

Design. The design of hoop roof (truss arch shelter) shall be approved and sealed by a professional engineer licensed to practice engineering in the state of Tennessee.

Construction. The construction of the hoop roof structure shall be approved by a professional engineer licensed to practice engineering in the state of Tennessee.

Additional Criteria to Provide a Safe Environment for Storing and Handling Manure

Ramps used to empty liquids shall have a slope of 4 horizontal to 1 vertical or flatter. Ramps used to empty slurry, semi-solid, or solid shall have a slope of 10 horizontal to 1 vertical or flatter, unless special traction surfaces are provided.

Embankment or excavated storage ponds and fabricated structures with walls less than 5 feet above ground surface shall be fenced and warning signs posted to impede children and others from using the facility for reasons other than its intended purpose. Fencing shall be of the permanent type and accomplished in accordance with conservation practice standard Fence, Code 382.

Vertical push-off ramps shall include a tractor safety device. Warning signs, 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 storage facilities, as necessary, to prevent explosion, poisoning, or asphyxiation.

Pipelines from enclosed buildings shall be provided with a water-sealed trap and vent or similar devices to control gas entry into the buildings.

CONSIDERATIONS

Storage facilities should be located as close to the source of manure and polluted runoff as practical. Storage facilities should be located as far away from public or private use facilities as required in **Table 1**. 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.

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

A storage period of 180 days is recommended for most liquid storage structures.

Solid/liquid separation of runoff or wastewater entering pond facilities should be considered to minimize the frequency of accumulated solids removal, reduce odor, and to facilitate pumping and application of the stored manure.

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.

Development of an emergency action plan should be considered for ponds where there is a potential for significant impact from breach or accidental release. Where there is potential for significant impact, the plan shall include site specific emergency action plan provisions for minimizing the impact.

CONSIDERATIONS FOR MINIMIZING THE POTENTIAL FOR 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 6** might be affected.

Table 6 - Potential Impact Categories from Breach of Embankment or Accidental Release

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

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 6** may be affected:

1. An auxiliary (emergency) spillway.
2. Additional freeboard.
3. Storage of wet year rather than normal year precipitation.
4. Reinforced embankment (i.e., additional top width, flattened and/or armored downstream side slopes).
5. Secondary containment.

The following should be considered to minimize the potential for accidental release of gravity outlets from the required volume when one or more of the potential impact categories listed in **Table 6** may be 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 IMPACT OF ODORS

An anaerobic lagoon instead of a storage pond should be considered for sites located where odors are a concern. The recommended loading rate for anaerobic lagoons at sites where odors are to be minimized is one-half of the values given in AWMFH Figure 10-22.

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

1. Covered storage facilities.
2. Naturally aerated or mechanically aerated lagoons.
3. Solids separation and composting.
4. Methane digester and capture system.
5. Vegetative windbreaks.

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

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. Site survey of existing conditions and investigation pits shown.
b. Plan view of system layout.
c. Type and number of animals the structure is designed to serve.
d. Storage period.
e. Structural details of all components.
f. References to components supplied by others (pumps, etc.).

g. Special safety requirements.

h. Vegetative requirements.

i. Quantities.

j. Drainage/Grading plan, if one is needed.

k. 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 storage facility, 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 manure or other organic byproducts be removed from storage and utilized in accordance with conservation practice standards, Nutrient Management (Code 590) and/or Waste Utilization (Code 633).

A strategy will be developed for removing and utilizing manure as a result of unusual storm events that cause the storage facility to fill prematurely. The storage facility shall be operated so as to maintain the storage capacity for the 25-year, 24-hour storm.

If an emergency action plan is developed, it shall include site specific emergency action provisions for minimizing the impact from breach or accidental release.

The embankment and other vegetated areas shall be mowed and fertilized to maintain a protective vegetative cover.

The structure(s) should be inspected at least twice each year when the facility is empty.

Replace any wooden parts, hardware, or other replaceable parts that are damaged or show excessive wear or decay. Roof structures should be examined for structural integrity. Walls of composters and drystack may need replacing during the life of the structure.

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 5 to 7 feet, with litter to wood contact limited to 3 to 5 feet.

REFERENCES

- ACI 318, 360, 530.
- ASTM D-653, D-698, D-2488.
- ASAE Specifications: EP378.3; EP393.2; EP288.5; S288.
- Basic Building Code, 12th Edition.
- Federal Specification, Wood Preservation: Treating Practices, TT-W-571i.
- “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
  - Nutrient Management, Code 590
  - Pond, Code 378
  - Pond Sealing or Lining, Code 521
  - Waste Utilization, Code 633
- AWMFH, Appendix 10D.
- TR-74.