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 35 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 shall be planned, designed, and constructed to comply with all federal, state and local laws, rules and regulations.

Location. Waste storage facilities shall be located outside of floodplains or protected from inundation or damage from a 100-year flood event.

Waste storage facilities shall not be constructed in the 100-year floodway unless permitted by the Indiana Department of Natural Resources (IDNR), Division of Water.

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.

Table 1. Setback Distances

Features (known and identifiable at the time of application)	Minimum Setback Distance (feet)
Public Water Supply and Surface Intake Structure	1000
Surface Waters of the State and Drainage Inlets (including Water and Sediment Control Basins)	300*
Sinkholes (measured from the Superficial opening or lowest point)	300*
Water Wells (offsite)	300*
Water Wells (onsite)	100
Property Lines and Public Roads	100

*If the facility is solids storage only, use a 100 foot setback distance.

Access to all waste storage facilities shall be constructed two feet above the 100-year flood elevation.

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.

Design Storage Volume. The design storage volume equal to the required storage volume, shall consist of the following as appropriate. See the Agricultural Waste Management Field Handbook (AWMFH) for guidance in computing volumes.

- Manure, bedding, wastewater, and other wastes accumulated during the storage period.
- Normal precipitation, less evaporation, on the surface area (at the design storage volume level) of the facility during the storage period.
- Normal runoff from the facility's drainage area during the storage period.
- 25-year, 24-hour runoff from the facility's drainage area.
- Residual solids after liquids have been removed. A minimum of 6 inches shall be provided for tanks or an additional 5 percent of the above totals to account for loss of storage due to incomplete removal of solids.
- Additional storage as may be required to meet management goals.
- For facilities exposed to rainfall, an additional two feet of freeboard over the above totals. If the facility is not exposed to rainfall, or if it is a dry stack/solid facility an additional six inches of freeboard over the above totals.

Soils. A geologic exploration shall be conducted for all manure storage facilities. The exploration shall be intensive enough to adequately characterize the site. A minimum of two holes shall be explored. Additional holes may be necessary based on the site size and complexity. The exploration shall extend 5 feet below the planned bottom elevation and ten feet below for soils in karst topography. The exploration shall document the presence or absence of a seasonal high water table. A soils log identifying the soils using the Unified Soil Classification System and showing the location of the seasonal high water table shall be shown on the plans. Soil sampling shall follow guidance in the National Engineering Manual (NEM) IN531-2.

All waste storage facilities shall be built above the seasonal high water table or provisions shall be made to lower the water table below the facility. The structure shall be designed to withstand the loads imposed by a high water table. When drainage is planned to lower the water table, drains shall be protected against waste entering the drainage system.

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 devices 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.

Accumulated Solids Removal. 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 configuration of ponds and type of seal, if any.

Staff Gauge. A staff gauge or similar device shall be permanently installed in liquid storage facilities exposed to rainfall and/or runoff. It shall identify the design full and 50 percent design full elevations. Design full is the design volume minus the 25-year, 24-hour storm runoff (if applicable) and 2 feet of freeboard.

Safety. The 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. Install a permanent exterior fence according to Natural Resources Conservation Service (NRCS) Field Office Technical Guide (FOTG) Standard (382) Fence.

Erosion Protection. Embankments and disturbed areas surrounding the facility shall be protected to control erosion.

Liners. Liners shall meet or exceed criteria in NRCS FOTG Standard (521A-E) Pond Sealing or Lining.

Seeding. Seeding shall meet or exceed the criteria in NRCS FOTG Standard (342) Critical Area Planting.

Additional Criteria for Waste Storage Ponds

Location. Waste storage ponds shall not be constructed on slopes greater than 12%. Waste storage ponds shall not be located in karst terrain or over mines without a detailed soil/geologic exploration and specific design criteria for these sites.

Soil and Foundation. The pond shall be located in soils with an acceptable permeability that meets all applicable regulations, 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.

The soil or foundation shall have a maximum specific discharge of 1/16 $in^3/in^2/day$ ($1.8x10^{-6}$ $cm^3/cm^2/sec$) or the pond shall be lined.

If soil testing shows that *in situ* soils meet the maximum specific discharge criteria, the existing soils shall be over-excavated a minimum of six inches and recompacted to break up the existing macropore structure. If a clay liner is used, it shall have a maximum specific discharge of 1/16 $in^3/in^2/day$ ($1.8x10^{-6}$ $cm^3/cm^2/sec$). Clay liners shall be a minimum of one foot thick.

Outlet. No outlet shall automatically release storage from the required design volume except an outlet that releases effluent into another storage pond. Manually operated outlets shall be a permanent type designed to resist corrosion and plugging. Outlet pipes shall meet the requirements of NRCS FOTG Standard (634) Manure Transfer. Anti-seep collars shall be provided around all pipes.

Emergency spillways shall be provided for storage ponds where the contributing drainage area to the pond exceeds 50% of the surface area of the pond. Emergency spillways shall be constructed on undisturbed soils or the outlet shall be protected against erosion.

The emergency spillway flows shall be directed to a secondary containment area, other appropriate manure storage structure or a wastewater treatment strip. The wastewater treatment strip shall be designed according to NRCS FOTG Standard (635) Wastewater Treatment Strip. The spillway shall be located to maximize the distance to the nearest watercourse. The emergency spillway shall be designed for the 50-year, 24-hour storm event and the crest elevation shall be located at or above the freeboard elevation. The top of the bank shall be 1 foot above the crest of the emergency spillway.

Embankments. The embankment shall be constructed of compacted earthfill. A cutoff of impermeable soil shall be provided at or just upstream of the embankment centerline unless a liner is used. The cutoff should be deep enough to intercept shallow, pervious foundation strata, have a minimum bottom width of 8 feet, and have side slopes not steeper than 1.5:1. The minimum depth of the cutoff shall be 2 feet after stripping.

The minimum elevation of the top of the settled embankment shall be 2 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 not be less than 5 percent. The minimum top widths are shown in Table 2. 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.

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

Excavations. Unless supported by a soil investigation, excavated side slopes shall be no steeper than 2.5 horizontal to 1 vertical.

Emptying Facilities. For waste storage ponds where agitation is planned, anti-scour pads shall be installed to prevent erosion of the foundation and embankment. Normally, these will consist of unreinforced concrete slabs with a minimum thickness of 4 inches. These slabs should extend in all directions a minimum of 10 feet outward and/or up the side slopes from each point where the agitator pump is operated. For flexible membrane liners, reinforced liner sections shall be used to protect the membrane from pump activity. A sufficient number of agitation points shall be provided to thoroughly mix the waste to remove as many solids as possible.

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 shall 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 3 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 3 – Presumptive Allowing 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 practices 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, 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. The procedures for calculating lateral earth pressures can be obtained using Technical Release (TR)-74. If soil strength tests are not available, the presumptive lateral earth pressure values indicated in Table 4 shall be used.

TABLE 4 - 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/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] 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 4 under the column

"Frame tanks," which gives pressures comparable to the at-rest condition.

- **Flexible or Yielding Wall.** Use the values shown in Table 4 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 within 5 feet of the walls, a surcharge (horizontal pressure) of 100 lb/ft^2 on the walls 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 American Society of Agricultural Engineers (ASAE) Engineering Practice (EP) 378.3, 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 American Society of Civil Engineers (ASCE) ASCE-7, Minimum Design Loads for Buildings and Other Structures. 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.

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. All structures shall be designed to prevent leakage.

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.
- Concrete cover for reinforced steel shall be for the condition of the concrete exposed to weather or in contact with the ground. (ACI Code 318, Section 7.7)
- Plastic fiber reinforced concrete may be used, however, the fiber reinforcement shall not replace steel bars or welded wire reinforcement that would normally be required for strength or crack control.
- 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 the 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 and/or the slab is cast on granular backfill based on the subgrade drag theory as given in American Concrete Institute, ACI Code 360,"Design of Slabs-on-Grade". If steel

reinforcing bars are used, the minimum thickness of the slab shall be 5 inches.

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.

Waterstops. Control joints on floors of tanks and slabs that must restrict seepage shall be filled with a hydrophilic rubber waterstop.

Construction joints between the walls and the floor of the structure shall be sealed with hydrophilic rubber, vinyl, or a colloidal type waterstop. Colloidal waterstops shall be rapid-hydrating type and shall be hydrated with plain water before animal waste is stored in the structure. All other construction joints shall be sealed with a bulb-type vinyl waterstop. Pipes or other ports that are cast in the structure shall be sealed with a hydrophilic rubber waterstop or an expanding sealant.

Expanding sealant materials used in projects where new concrete is placed against existing concrete or for pipe penetrations through walls shall have been tested for expansion in the presence of manure. All expanding sealant materials shall be approved by the State Conservation Engineer prior to installation.

Buried Tanks. Fiberglass or plastic tanks shall have sufficient strength to withstand the design loads and be watertight. The tanks shall have a manufacturer's certificate to this effect. Tanks shall be anchored to prevent flotation if a high water table is present. Used tanks and steel tanks are not allowed.

CONSIDERATIONS

Waste storage facilities should be located as close to the source of waste and polluted runoff as practicable.

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.

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

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 Exhibit A 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 Exhibit A may be significantly affected:

- An auxiliary (emergency) spillway.
- Additional freeboard.
- Storage for wet year rather than normal year precipitation.
- Reinforced embankment – such as, additional top width, flattened and/or armored downstream side slopes.
- Secondary containment.

Exhibit A – Potential Impact Categories from Breach of Embankment or Accidental Release

- Surface water bodies – perennial streams, lakes, wetlands, and estuaries.
- Critical habitat for threatened and endangered species.

- Riparian areas.
- Farmstead, or other areas of habitation.
- Off-farm property.
- 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 Exhibit A may be significantly affected:

- Outlet gate locks or locked gate housing.
- Secondary containment.
- Alarm system.
- Another means of emptying the required volume.

Considerations for Minimizing the Potential of Waste Storage Pond Liner Failure.

Sites with categories listed in Exhibit B 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 Exhibit B may be significantly affected.

Exhibit B – Potential Impact Categories for Liner Failure

- Any underlying aquifer is at a shallow depth and not confined.
- The vadose zone is rock.(Area between the ground surface and water table.)
- The aquifer is a domestic water supply or ecologically vital water supply.
- The site is located in an area of solutionized bedrock such as limestone or gypsum.

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

- A clay liner designed in accordance with procedures of AWMFH Appendix 10D with a thickness and coefficient of permeability so that the specific discharge is less than 1.8 x 10^{-6} cm/sec.
- A flexible membrane liner over a clay liner.
- A geosynthetic clay liner (GCL) flexible membrane liner.
- A concrete liner designed in accordance with slabs on grade criteria for fabricated structures requiring water tightness.

Considerations for Improving Air Quality

To reduce emissions of greenhouse gases, ammonia, volatile organic compounds, and odor, other practices need to be added to the waste management system.

Consider adjusting the pH below 7. It may reduce ammonia emissions from the waste storage facility but may increase odor when waste is surface applied {see NRCS FOTG Standard (633) Waste Utilization}.

An anaerobic lagoon instead of a waste storage pond should be considered for sites located in areas where odors are a concern. Practices such as the following should be considered to reduce odor emissions:

1. Covering the storage facility with a suitable fabric or organic 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 in keeping with this standard and shall describe the requirements for applying this practice to achieve its intended purpose.

OPERATION AND MAINTENANCE

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

The waste utilization 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.

The plan shall include an explanation of the staff gauge 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.

An emergency action plan for waste storage facilities will be developed 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. The emergency action procedure shall be prominently displayed.

REFERENCES

USDA-NRCS, Agricultural Waste Management Field Handbook (AWMFH).

USDA-NRCS, National Engineering Handbook, Part 637, Chapter 2, Composting; Part 531, Geology.

University of Missouri-Columbia, 1994, Composting Dead Swine, Extension Publication, WQ 225.

American Concrete Institute, ACI-318, ACI-360, & ACI-530.

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

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

American Society of Civil Engineers (ASCE), ASCE-7, Minimum Design Loads for Buildings and Other Structures.

ASAE, EP 378.3 "Floor and Suspended Loads on Agricultural Structure Due to Use".

ASAE, EP 393.2 "Manure Storages".

American Society of Testing Materials (ASTM) D-2488 and D653.

IDEM, Office of Land Quality, "Confined Feeding Control Law".

Indiana Department of Natural Resources (IDNR), Division of Water, "Construction in a Floodway Permit".