NATURAL RESOURCES CONSERVATION SERVICE

CONSERVATION PRACTICE STANDARD

WASTE STORAGE FACILITY

(Number)

CODE 313

DEFINITION

An agricultural waste storage impoundment or containment made by constructing an embankment, excavating a pit or dugout, or by fabricating a structure.

PURPOSE

To store manure, agricultural by-products, wastewater, and contaminated runoff to provide the agricultural operation management flexibility for waste utilization.

CONDITIONS WHERE PRACTICE APPLIES

Use where regular storage is needed for wastes generated by agricultural production or processing and where soils, geology, and topography are suitable for construction of the facility. For reception pits, use the IN FOTG Standard (634) Waste Transfer.

For liquid waste storage facilities implemented with an embankment, this practice applies only to low hazard structures as defined in the NRCS National Engineering Manual (NEM), Part 520.23.

This practice does not apply to the storage of human waste or animal carcasses.

CRITERIA

General Criteria Applicable to All Waste Storage Facilities.

Laws and Regulations. Waste storage facilities will be planned, designed, and constructed to comply with all federal, state and local laws, rules and regulations.

Location. Waste storage facilities will be constructed outside of the 100-year floodplain unless permitted by the Indiana Department of Natural Resources (IDNR), Division of Water and the Indiana Department of Environmental Management (IDEM).The waste storage facility must be protected from inundation or damage from a 100-year flood event.

Waste storage facilities will be located following the setbacks in Table 1 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.

Access to all waste storage facilities will 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 will be based on the timing required for environmentally safe waste utilization considering the climate, crops, soil, equipment, and local, state, and federal regulations.

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
Offsite Residential and Public Buildings	400
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.

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

Operational Volume

- Manure, bedding, wastewater, and other wastes accumulated during the storage period.
- For liquid or slurry storage facilities, include 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 (omit diverted roof runoff).
- Residual solids after liquids have been removed. A minimum of 6 inches will 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 is required unless a sump or other device allows for complete emptying.
- Additional storage as may be required to meet management goals or regulatory requirements.

Emergency Volume

- 25-year, 24-hour runoff from the facility's drainage area.

Freeboard Volume

- For facilities exposed to rainfall, an additional two feet of freeboard over the above totals (Includes 25-year, 24 hour precipitation on the surface of the liquid or slurry storage facility).
- If the facility is not exposed to rainfall, or if it is a dry stack/solid facility, an additional six inches of freeboard is required over the above totals.

Exclude non-polluted runoff from the structure to the fullest extent practical except where including the runoff is advantageous to the operation of the agricultural waste management system.

Soils. A geologic exploration will be conducted for all manure storage facilities. The exploration will be intensive enough to adequately characterize the site. A minimum of two holes will be explored. Additional holes may be necessary based on the site size and complexity. The exploration will extend 5 feet below the planned bottom of liner/floor or bottom elevation and ten feet below for soils in karst topography. The exploration will 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 will be shown on the plans. Soil sampling will follow the National Engineering Manual (NEM) IN531-2.

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

Inlet. Inlets will 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 will be provided with a water-sealed trap and vent or similar devices to control gas entry into the buildings or other confined spaces.

Waste Removal. Provide components for removing waste such as gates, pipes, docks, wet wells, pumping platforms, retaining walls, or ramps. Incorporate features to protect against erosion, tampering, and accidental release of stored waste as necessary. Design ramp slopes to accommodate anticipated equipment and traction available.

Use Indiana (IN) Field Office Technical Guide (FOTG) Standard (590) Nutrient Management for land application of stored material or follow other disposal options outlined in a Comprehensive Nutrient Management Plan (CNMP).

Accumulated Solids Removal. To preserve storage volume, make provision for periodic removal of accumulated solids. The anticipated method for solids removal must be accommodated in planning and design, particularly in determining the configuration of impoundments and the type of liner used.

Maximum Operating Level. The maximum operating level for liquid storage structures is the level that provides the operational volume.

Staff Gauge. A staff gauge or similar device will be permanently installed in liquid storage facilities exposed to rainfall and/or runoff. It will clearly identify the following elevations:

- 50% of maximum operational volume;
- Maximum operating level (top of the operational volume);
- Emergency level (25-year, 24 hour storm runoff plus 2 feet of freeboard added to maximum operating level).

For storages where the contents are not visible and a staff gauge would not be visible, such as below a slatted floor, identify the method for the operator to measure the depth of accumulated waste in the Operation and Maintenance Plan.

Safety. Include appropriate safety features to minimize the hazards of the facility (refer to American Society of Agricultural and Biological Engineers (ASABE) Standard EP470, Manure Storage Safety for guidance, as needed).

Warning signs, fences, ladders, ropes, bars, rails, and other devices will 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.

Consider potential health threats associated with gypsum additives to manure storage, as high noxious gas releases can be life threatening during agitation of gypsum-treated facilities.

Pipelines will 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 or accumulate in buildings or other confined spaces.

Ponds and uncovered fabricated structures for liquid or slurry waste with walls less than 5 feet above ground surface will be fenced to prevent accidental entry by people or animals likely to be onsite. Install a permanent exterior fence according to IN FOTG Standard (382) Fence. Post universal warning signs to prevent children and others from entering liquid waste storage structures.

The design will include appropriate safety features to minimize the hazards of the facility. Ramps used to empty liquids will have a slope of 4 horizontal to 1 vertical or flatter. Those used to empty slurry, semi-solid, or solid waste will have a slope of 10 horizontal to 1 vertical or flatter unless special traction surfaces are provided.

Design covers and grating over openings such that livestock or humans cannot accidentally displace them and fall into the facility.

Roofs and Covers. Use IN FOTG Standard (367) Roofs and Covers for design of waste storage facility covers or roofs, as needed.

Treated Wood. Use criteria from IN FOTG Standard (367) Roof and Covers for treated wood and fasteners.

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

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

Additional Criteria for Liquid Waste Storage Impoundments

A liquid waste storage impoundment is a facility where the stored material does not consistently stack and is either a natural topographic depression, manmade excavation, or diked area formed primarily of earthen materials, such as soil (although the unit may be lined with manmade materials)

Location. Waste storage ponds will not be constructed on slopes greater than 12%. Waste storage ponds will 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 will be located in soils with an acceptable permeability that meets all applicable regulations, or the pond will be lined. Use liners which meet or exceed IN FOTG Standards (520) Pond Sealing or Lining, Compacted Soil Treatment, (521A) Pond Sealing or Lining, Flexible Membrane, or (522) Pond Sealing or Lining, Concrete. Information and guidance on controlling seepage from waste impoundments can be found in the Agricultural Waste Management Field Handbook (AWMFH), Appendix 10D.

Perform subsurface investigations for all waste storage impoundments in sufficient detail and analysis to support the design in accordance with NRCS NEM, Part 531, Geology. Describe the soil material encountered, location of any seeps, depth-to-high-water table, depth to bedrock, and presence of sink holes in karst topography.

For the design of a liner on a site located in a floodplain and other locations where there is potential for uplift, include an evaluation of all potential buoyant uplift forces on the liner. Limit projected uplift head under clay liners to a gradient of less than 0.5 ft/ft in the clay liner. The gradient is determined as the difference in total head between the top and the bottom of a clay liner when buoyant forces exist (such as when the floodplain is flooded) divided by the thickness of the clay liner.

Design Bottom Elevation. Locate the impoundment bottom elevation a minimum of 2 feet above the seasonal high water table unless special design features are incorporated that address buoyant forces, impoundment, 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 will have a maximum specific discharge of 1/16 in^3/in^2/day ($1.8x10^{-6}$ cm^3/cm^2/sec) or the pond will be lined.

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

Outlet. No outlet will automatically release storage from the required design volume except an outlet that releases effluent into another storage pond. Manually operated outlets will be a permanent type designed to resist corrosion and plugging. Outlet pipes will meet the requirements of IN FOTG Standard (634) Waste Transfer. Anti-seep collars will be provided around all pipes. Provide a backflow prevention measure for an outlet that pumps wastewater to secondary storage located at a higher elevations.

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

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

Embankments. The embankment will be constructed of compacted earthfill. A cutoff of impermeable soil will 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 will be 2 feet after stripping.

The minimum elevation of the top of the settled embankment will be 2 foot above the waste storage pond's required volume. This height will be increased by the amount needed to ensure that the top elevation will be maintained after settlement. This increase will not be less than 5 percent.

The minimum top widths are shown in Table 2. The combined side slopes of the settled embankment will not be less than 5 horizontal to 1 vertical, and neither slope will be steeper than 2 horizontal to 1 vertical unless provisions are made to provide stability. The total embankment height (effective height) is the difference in elevation between the auxiliary (emergency) spillway crest or the settled top of the embankment if there is no auxiliary spillway and the lowest point in the cross section taken along the centerline of the embankment.

Table 2 – Minimum Top Widths

Total Embankment Height (feet)	Top Width (feet)
Less than 15	8
15-19.9	10
20-24.9	12
25-30	14
30-35	15

For an impoundment with greater than one acre of surface area and where wave action is a concern, increase the embankment height to account for calculated wave height.

Stabilize all embankments to prevent erosion or deterioration.

Spillway or Equivalent Protection. For a facility having a total embankment height greater than 20 feet, construct an auxiliary (emergency) spillway to handle another volume equivalent to the emergency volume or store this additional volume below the freeboard level.

Excavations. Design excavated side slopes to meet the requirements of the liner used, see IN FOTG Standards (520) Pond Sealing or Lining, Compacted Soil Treatment, (521A) Pond Sealing or Lining, Flexible Membrane or (522) Pond Sealing or Lining, Concrete.

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

Emptying Facilities. For waste storage ponds where agitation is planned, anti-scour pads will 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 will be used to protect the membrane from pump activity. A sufficient number of agitation points will be provided to thoroughly mix the waste to remove as many solids as possible.

<u>Additional Criteria for Fabricated Structures</u>

Foundation. Based on subsurface investigation, provide a foundation for fabricated waste storage structures to safely support all superimposed loads without excessive movement or settlement. Perform subsurface investigations for all fabricated structures sufficient in detail and analysis to support the design in accordance with NRCS NEM, Part 531, Geology. Describe the soil material encountered, location of any seeps, depth to high water table, depth to bedrock, and presence of sink holes in karst topography.

Where a non-uniform foundation cannot be avoided or applied loads may create highly variable foundation loads, settlement will 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 obtained from Table 3 or another nationally recognized building code. In using presumptive bearing values, adequate detailing and articulation will be provided to avoid distressing movements in the structure.

For bedrock foundations with joints, fractures, or solution channels, separate the floor slab and the bedrock by—

- A minimum of 1 foot of impermeable soil.
- A liner that meets or exceeds IN FOTG Standards (520, 521, or 522) Pond Sealing or Lining.
- Other appropriate method or alternative that achieves equal protection.

Table 3 – Presumptive Allowable Foundation and Lateral Pressure[1]

Class of materials	Allowable foundation pressure (psf)	Lateral bearing (psf/ft) below natural grade	Coefficient of friction	Cohesion (psf)
Crystalline bedrock	12,000	1,200	0.70	-
Sedimentary and foliated rock	4,000	400	0.35	-
Sandy gravel or gravel (GW and GP)	3,000	200	0.35	-
Sand, silty sand, clayey sand, silty gravel, clayey gravel (SW, SP, SM, SC, GM and GC)	2,000	150	0.25	-
Clay, sandy clay, silty clay, clayey silt, silt and sandy silt (CL, ML, MH and CH)	1,500	100	-	130

[1] International Building Code (IBC), 2015, International Code Council (ICC)

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

Structural Loadings. Design the waste storage structure to withstand all anticipated loads in accordance with the requirements in NRCS NEM, Part 536, Structural Design. Such loads should include internal and external loads, hydrostatic uplift pressure, concentrated surface and impact loads, and water pressure due to seasonal high water table, frost or ice.

Calculate loading from lateral earth pressures using soil strength values determined from the results of appropriate soil tests and procedures described in Technical Release 210-74, Lateral Earth Pressures. Table 4 provides minimum lateral earth pressure values when soil strength tests are not available. If heavy equipment will operate near the wall, use an additional soil surcharge or an additional internal lateral pressure in the wall analysis as appropriate.

For the lateral load from stored waste not protected from precipitation, use a minimum 65 $lb/ft^2/ft$ of depth as the design internal lateral pressure. Use a minimum value of 60 $lb/ft^2/ft$ of depth for the lateral load from stored waste protected from precipitation and not likely to become saturated. Use a minimum internal lateral pressure of 72 $lb/ft^2/ft$ of depth for sand-laden manure storage if the percentage of sand exceeds 20%. Designers may use lesser values if supported by measurement of actual pressures of the waste to be stored.

Foundation walls and other walls in which horizontal movement is restricted at the top will be designed for at-rest pressure. Retaining walls free to move and rotate at the top will be permitted to be designed for active pressure.

Table 4. Minimum Lateral Earth Pressure Values[1]

Description of backfill material [c]	Unified soil classification	Design lateral soil load (lb/ft^2/ft of depth) [a]	
		Active pressure	At-rest pressure
Well-graded, clean gravels; gravel-sand mixes	GW	30	60
Poorly graded clean gravels; gravel-sand mixes	GP	30	60
Silty gravels, poorly graded gravel-sand mixes	GM	40	60
Clayey gravels, poorly graded gravel-sand mixes	GC	45	60
Well-graded, clean sands; gravely sand mixes	SW	30	60
Sand-silt clay mix with plastic fines	SP	30	60
Silty sands, poorly graded sand-silt mixes	SM	45	60
Sand-silt clay mix with plastic fines	SM-SC	45	100
Clayey sands, poorly graded sand-clay mixes	SC	60	100
Inorganic silts and clayey silts	ML	45	100
Mixture of inorganic silt and clay	CL-ML	60	100
Inorganic clays of low to medium plasticity	CL	60	100
Organic silts and silt clays, low plasticity	OL	Note [b]	Note [b]
Inorganic clayey silts, elastic silts	MH	Note [b]	Note [b]
Inorganic clays of high plasticity	CH	Note [b]	Note [b]
Organic clays and silty clays	OH	Note [b]	Note [b]

• [1] Table 1610.1, Lateral Soil Load, International Building Code (IBC), 2015, International Code Council (ICC).

[a] Design loads based on moist conditions for the specified soils at optimum density. Include the weight of the buoyant soil plus hydrostatic pressure for submerged or saturated soil.

[b] Unsuitable as backfill material.

Structural Design. Design structures with reinforced concrete, steel, wood, or masonry materials in accordance with NRCS-NEM, Part 536, Structural Engineering. Account for all items that will influence the performance of the structure, including loading assumptions, durability, serviceability, material properties and construction quality. Ensure that the material used for a fabricated structure is compatible with the waste product to be stored.

Tanks may be designed with or without a cover. Design openings in a covered tank to accommodate equipment for loading, agitating, and emptying. Equip these openings with fencing, grills or secure covers for safety, and for odor and vector control as necessary.

All structures will be underlain by free draining material or will have a footing located below the anticipated frost depth. All structures will be designed to prevent leakage.

Slabs on Grade. Slab design will 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 will 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 will be 5 inches.

For applications where liquid-tightness is required such as floor slabs of storage tanks, the minimum thickness for uniform foundations will be 5 inches and will contain distributed reinforcing steel. The required area of such reinforcing steel will 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 will be used.

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

Construction joints between the walls and the floor of the structure will be sealed with hydrophilic rubber, vinyl, or a colloidal type waterstop. Colloidal waterstops will be rapid-hydrating type and will be hydrated with plain water before animal waste is stored in the structure. All other construction joints will be sealed with a bulb-type vinyl waterstop. Pipes or other ports that are cast in the structure will 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 will have been tested for expansion in the presence of manure. All expanding sealant materials will be approved by the State Conservation Engineer prior to installation.

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

Sensitive Environmental Settings. Where liquid storage is to be provided in sensitive environmental settings (i.e., tanks, in areas with shallow wells in surface aquifers, high-risk karst topography, or other site-specific concerns), design the storage structure as a reinforced concrete hydraulic or environmental structure according to NRCS NEM, Part 536, Structural Design. Alternatively, use a flexible liner membrane, designed and constructed in accordance with standard engineering and industry practice, to provide secondary liquid containment for structures constructed with other methods described in NRCS NEM, Part 536, Structural Design.

Additional Criteria - Stacking Facilities

A stacking facility may be open, covered, or roofed and is used for wastes which behave primarily as solid. Determine the wall height using the anticipated stacking angle of the waste material and any clearance height needed for containment of the stacked material during operation and use. Construct a stacking facility of durable materials such as reinforced concrete, reinforced concrete block, or treated lumber. Design the stacking facility 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.

Seepage. Prevent leachate in amounts that would pollute surface or groundwater with collection and disposal of liquids in a safe manner as necessary. Prevent influent seepage in amounts that would infringe on designed storage capacity or on the stackable consistency of the waste being stored. Seepage control may not be necessary on sites that have a roof, waste material with little seepage potential or in certain climates.

Internal Drainage. Make provisions for drainage of leachate, including rainfall from the stacking area (especially those without a roof). Collect leachate in a tank or waste storage impoundment, or properly treat in a lagoon or vegetated treatment area.

Poultry Litter Stacking Facility. To reduce the potential for spontaneous combustion damage to wood walled facilities, design the height of the litter stack not to exceed 7 feet, with litter to wood contact limited to 5 feet.

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.

For exposed liners utilizing HDPE or similar materials that are slippery when wet, consider the use of textured liners or addition of features such as tire ladders that would allow for escape from the waste storage structure.

Consider solid/liquid separation of runoff or wastewater entering impoundments to minimize the frequency of accumulated solids removal and to facilitate pumping and application of the stored waste.

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

Since the economics and risks associated with waste storage facilities are quite high, consider providing the operator with the cost to close the facility. Cost should include removal of the planned sludge accumulation volume and the waste stored at the maximum operating volume.

Considerations for Siting

Consider the following factors in selecting a site for waste storage facilities:

- Proximity of the waste storage facility to the source of waste.
- Access to other facilities.
- Ease of loading and unloading waste.
- Compatibility with the existing landforms and vegetation, including building arrangement, to minimize odors and adverse impacts on visual resources.
- Adequate maneuvering space for operating, loading, and unloading equipment.

Considerations for Minimizing the Potential for and Impacts of Sudden Breach of Embankment or Accidental Release from the Waste Storage Facility.

Consider 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 when any of the categories listed below might be significantly affected.

Potential impact categories from breach of embankment or accidental release include:

- 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 archaeological sites or structures that meet the eligibility criteria for listing in the National Register of Historical Places.

Consider the following either singly or in combination to minimize the potential of or the consequences of sudden breach of embankments:

- 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.
- Double liners.

Options to consider to minimize the potential for accidental release from the waste storage facility through gravity outlets include—

- Outlet gate locks or locked gate housing.
- Secondary containment.
- Alarm system.
- Another nongravity means of emptying the waste storage facility.

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

Avoid sites with categories listed below unless no reasonable alternative exists.

Potential impact categories for liner failure are:

- 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 water soluble bedrock such as limestone or gypsum.

For a site with one or more of these site conditions, consider providing a leak detection system in conjunction with the planned liner to provide an additional measure of safety.

Should any of the potential impact categories listed above 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 Stacking Facilities

Internal seepage collection within a stacking facility can be 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. Use the design criteria for timber walls.

For any facility that is an organic producer or that sells manure to organic producers, consider using rot-resistant or treated lumber that meets the requirements for organic production. The producer should consult with the organic certifier as to the use and acceptability of treated lumber for waste storage.

Considerations for Improving Air Quality

Liquid manure storage may result in emissions of volatile organic compounds, ammonia, hydrogen sulfide, methane, nitrous oxide, and carbon dioxide. Solid manure storage may result in emissions of particulate matter, volatile organic compounds, ammonia, carbon dioxide, and nitrous oxide.

To reduce emissions of greenhouse gases, ammonia, volatile organic compounds, particulate matter and odor, other IN FOTG Standards such as (366) Anaerobic Digester, (367) Roofs and Covers, (629) Waste Treatment, (591) Amendments for Treatment of Agricultural Waste, (317) Composting Facility, and (371) Air Filtration and Scrubbing can be added to the waste management system.

Adjusting pH below 7 may reduce ammonia emissions from the waste storage facility but may increase odor when waste is surface applied—see IN FOTG Standard (590) Nutrient Management.

Some fabric and organic covers have been shown to be effective in reducing odors.

Maintain appropriate manure moisture content for solid manure storage facilities. Excessive moisture will increase the potential for air emissions of volatile organic compounds, ammonia, and nitrous oxide, and may lead to anaerobic conditions, which will increase the potential for emissions of methane and hydrogen sulfide. Too little moisture will increase the potential for particulate matter emissions.

PLANS AND SPECIFICATIONS

Prepare plans and specifications that describe the requirements for applying the practice to achieve its intended use. As a minimum, include the following in the engineering plans and specifications:

- Location Map with legal description
- Plan view of system layout with relevant benchmark elevations and descriptions.
- Structural details of all components, including reinforcing steel, type of materials, thickness, anchorage requirements, lift thickness.
- Locations, sizes, and type of pipelines and appurtenances.
- Construction and Material specifications
- Requirements for foundation and preparation and treatment.
- Vegetative requirements.
- Quantities.
- Approximate location of utilities and notification requirements.

OPERATION AND MAINTENANCE

Develop an operation and maintenance plan that is consistent with the purposes of the practice, its intended life, safety requirements, and the criteria for its design. The operation and maintenance plan will document the animal type, animal units, design capacity, and storage period for which the storage facility was designed. Changes such as increased manure inputs, application frequency, etc. will be evaluated and determined appropriate in an updated waste management plan. At a minimum, the plan will contain where appropriate:

Include the operational requirements for emptying the storage facility and the expected storage period. Begin removal of the liquid storage facility as soon as practical after the maximum operating level has been reached. Also include the requirement that waste be removed from storage and utilized at locations, times, rates, and volume in accordance with the overall waste management system plan.

For impoundments and other liquid storages include an explanation of the staff gauge or other permanent marker to indicate the maximum operating level. For storages where the contents are not visible and a staff gauge would not be visible, such as below a slatted floor, identify the method for the operator to measure the depth of accumulated waste.

Include a provision for emergency removal and disposition of liquid waste in the event of an unusual storm event that may cause the waste storage structure to fill to capacity prematurely.

Include instructions as needed for ventilating confined spaces according to ASABE standard S607, Venting Manure Storages to Reduce Entry Risk.

Consider potential health threats associated with gypsum additives to manure storage, as high noxious gas releases can be life threatening during agitation of gypsum-treated facilities.

Develop an emergency action plan for waste storage facilities where there is a potential for significant impact from breach or accidental release. Include site-specific provisions for emergency actions that will minimize these impacts. The emergency action plan will be prominently displayed.

Include a description of the routine maintenance needed for each component of the facility. Also include provisions for maintenance that may be needed as a result of waste removal or material deterioration.

Include a provision for monitoring accumulated solids. A maximum depth of accumulated solids should be estimated by determining the minimum storage time for the structure. Operation and maintenance plan needs to include information on proper removal of these solids at the appropriate time.

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