NATURAL RESOURCES CONSERVATION SERVICE
CONSERVATION PRACTICE STANDARD
WASTE STORAGE FACILITY
CODE 313
(NO.)

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

The control of wastewater and feedlot runoff is bracketed into five levels of control with Level 1 being full runoff control. The primary Minnesota NRCS practice standards addressing the control of wastewater and feedlot runoff and their respective levels of control are:

- Waste Storage Facility (313),
  Level 1
- Waste Facility Cover (367),
  Level 1, Feedlot Roof Structure
- Vegetated Treatment Area (635),
  Levels 2 - 4

Wastewater and feedlot runoff from Concentrated Animal Feeding Operations (CAFO's) must be controlled using LEVEL 1 methods unless all necessary permits have been obtained from the MPCA.

This practice applies:

- To Level 1 – full runoff control of contaminated runoff from such areas as feedlots, barnyards, and other livestock holding areas
- 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 fabricate structures including tanks, stacking facilities, and pond appurtenances.

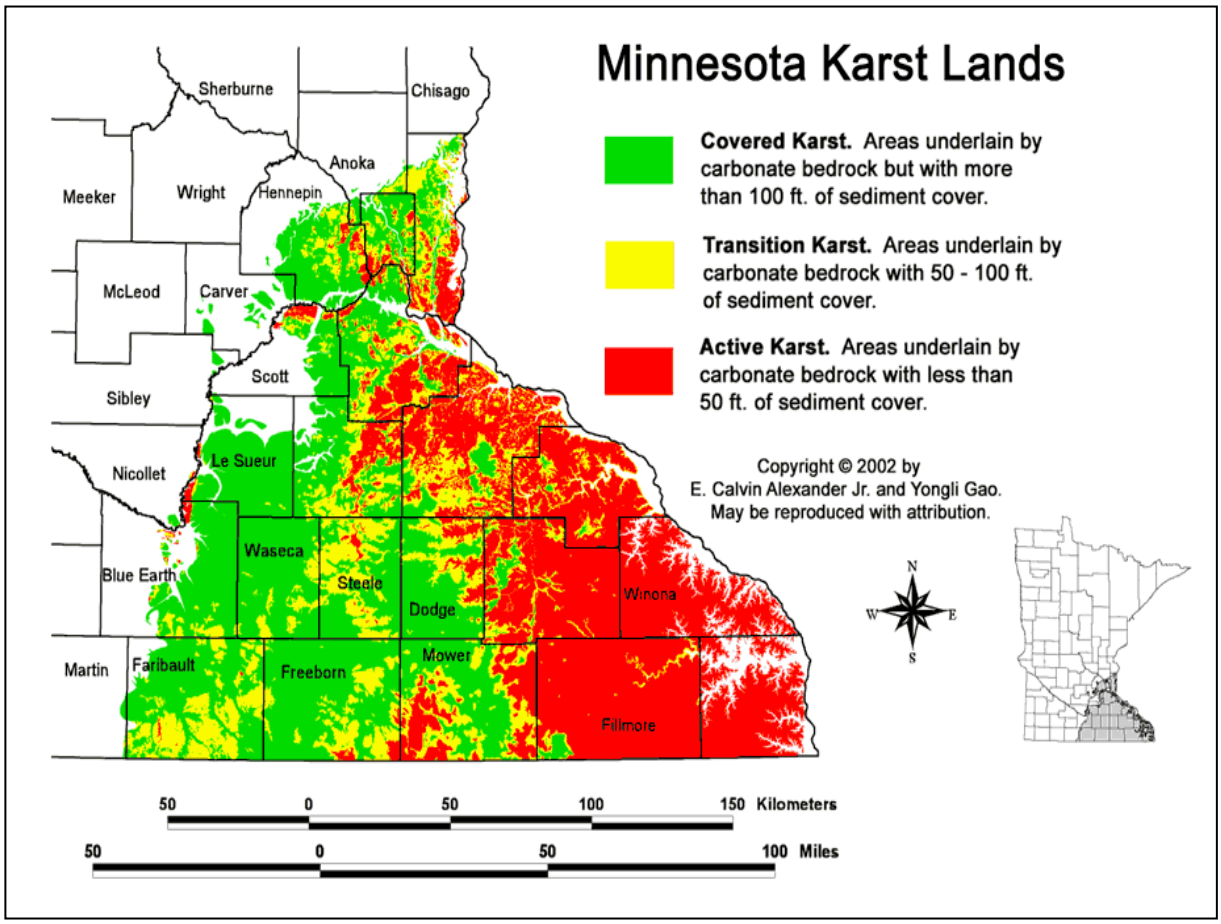
CRITERIA

General Criteria Applicable to All Waste Storage Facilities.

Laws and Regulations. Waste storage facilities must be planned, designed, and constructed to meet all Federal, State, and local laws and regulations.

Location. To minimize the potential for contamination of streams, waste storage facilities should be located outside of floodplains. However, if site restrictions require location within a floodplain, they shall be protected from inundation or damage from a 100-year flood event, or larger if required by laws, rules, and regulations. Waste storage facilities shall be located so: 1) the potential impacts from breach of embankment,

Figure 313-1. Approximate extent of Karst region in Minnesota



accidental release, and liner failure are minimized; and 2) separation distances are such that prevailing winds and landscape elements such as building arrangement, landforms, and vegetation minimize odors and protect aesthetic values.

Karst Area Restrictions. The type of storage facility and seepage control is restricted in areas susceptible to soil collapse or sinkhole formation. Refer to Minnesota Pollution Control Agency (MPCA) rules found in Minnesota Rules Chapter 7020 and MPCA guidelines for these criteria. Figure 313-1 may be used as an approximate guide to assist in identifying areas susceptible to soil collapse or sinkhole formation.

Soil and Foundation Investigation. Unified Soil Classification System designation, texture, depth to the regional water table, and depth to seasonal high water table shall be obtained and recorded at a minimum of

two locations within the lateral boundaries of the proposed manure storage area for the first one-half acre of surface area. A minimum of one additional location is required for each additional one acre of surface area for the manure storage area. Sufficient soil records must be obtained to represent the range of soil conditions throughout the proposed manure storage area site.

Soil Investigations shall be made to a depth of 5 feet below the proposed manure storage volume (10 feet in areas susceptible to sinkhole formation) or to bedrock and to a depth that allows verification of MPCA separation to bedrock requirements in the Karst region.

Boreholes shall be sealed throughout their entire depth.

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. Facilities with greater than 1,000 animal units shall provide a storage period of not less than 9 months. The maximum design storage period is 14 months.

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

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

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

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

(d) 25-year, 24-hour precipitation on the surface of the facility.

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

(f) Residual solids after liquids have been removed. A minimum of 12 inches shall be provided for ponds. Six inches for tanks or for ponds with recessed agitation pads.

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

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.

Freeboard. For a storage area open to precipitation or receiving discharge of runoff into the storage area, a minimum freeboard of 1.0 foot is required.

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.

Safety. Design shall include appropriate safety features to minimize the hazards of the facility. Ramps used to provide vehicular equipment access to the pond bottom shall have a slope of 10:1 (horizontal:vertical) or flatter unless special traction surfaces are provided. Warning signs, fences, ladders, ropes, bars, rails, and other devices shall be provided, as appropriate, to ensure the safety of humans and livestock. Ventilation and warning signs must be provided for covered waste holding structures, as necessary, to prevent explosion, poisoning, or asphyxiation. Pipelines shall be provided with a water-sealed trap and vent, or similar device if there is a potential, based on design configuration, for gases to enter buildings or other confined spaces. Ponds and uncovered fabricated structures for liquid or slurry waste with walls less than 5 feet above ground surface shall be fenced and warning signs posted to prevent children and others from using them for other than their intended purpose.

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

Additional Criteria for Waste Storage Ponds

Soil and foundation. The pond shall be located in suitable soils to ensure a maximum seepage rate of 1/56 inch/day, 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.

Vertical Separation to Ground Water. The pond shall have a bottom elevation that is a minimum of 2 feet above the seasonal high water table. The seasonal water table may be lowered by use of perimeter drains, if feasible, to meet this requirement under the following guidelines:

1. A locally perched water table exists.
2. A seasonal high water table condition exists higher than 2 feet below the pond bottom and the permeability of the water bearing material is less than 6 inches per hour and has little potential to serve as a source for either domestic or commercial use.
3. Localized lenses of free-draining saturated materials occur within a unit consisting mainly of materials with permeability's of less than 6 inches per hour, i.e., sand lenses in glacial till.
4. The water table is not a regional water table.

On site soil permeability shall be considered in designing the drainage system. The effects of temporary tailwater on the structure or liner shall be considered.

When a tile system is installed, provisions shall be provided to allow monitoring of the drainage water.

Lining Waste Storage Ponds.

Waste storage ponds shall have the bottoms and side slopes lined unless a fabricated storage structure is used. Alternatives for lining are listed below. Additional requirements for facilities in the Karst region of Minnesota are found in Minnesota Rules Chapter 7020 and MPCA guidelines.

1. Compacted Cohesive Soil.

Compacted Cohesive Soil liners shall meet the requirements of Practice Standard 521D, Pond Sealing and Lining, Compacted Clay Treatment.

2. Concrete.

Concrete liners shall have a minimum thickness of 5 inches and all joints shall have non-metallic water stops. The concrete shall be reinforced according to the Fabricated Structure Criteria of this practice standard. Caution should be used when using concrete liners where uneven settlement may occur.

3. Flexible Membranes (Plastic).

Liners shall meet the requirements of Practice Standard 521A, Pond Sealing or Lining – Flexible Membrane. Consideration should be given toward using thicker material for exposed liners without cover soils.

The liner and any required soil cover shall be stable at the designed side slope.

Flexible membranes shall be installed following the manufacturer's recommendations and requirements. All manufacturers' warranty requirements shall be met.

4. Geosynthetic Clay Liners (GCL).

Liners shall meet the requirements of Practice Standard 521A, Pond Sealing or Lining – Flexible Membrane.

Scour Protection. Anti-scour protection is required at pump out and agitation points on all ponds except those lined with concrete. This protection shall consist of a concrete pad extending a minimum of 10 feet radially from the pump out or agitation point.

Consideration should be given to having more than one location for agitation. Gate openings, posts, or other methods shall be used to locate the anti-scour protection points.

Maximum Operating Level. The maximum operating level for waste storage ponds shall be the pond level that provides for the required Design Storage Volume, less the volume contribution of precipitation and runoff from the 25-year, 24-hour storm event. 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.

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

Embankments. The minimum elevation of the top of the settled embankment shall be 1 foot above the waste storage pond's required Design Storage Volume. This height shall be increased by the amount needed to ensure that the top elevation will be maintained after settlement. This increase shall be not less than 5 percent. The minimum top widths are shown in Table 1. The combined side slopes of the settled embankment shall not be less than 5:1, and neither slope shall be steeper than 2:1.

Table 1. 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

* Height at embankment centerline.

When fill heights exceed 12 feet, cutoff trenches shall be installed under those sections of the embankment. Cut off trenches should be considered on lower fill heights based on foundation conditions and for fills placed on slopes where the fill, foundation interface could act as a slope failure plane. Cut off trenches shall have a minimum depth of 4 feet, minimum bottom width of 4 feet and side slopes not steeper than 1:1.

Wave protection should be considered on pond slopes where the soil PI < 15 or the pond area exceeds ½ acre.

Excavations. Unless supported by a soil investigation, excavated pond side slopes shall be no steeper than 2:1.

Additional Criteria for Fabricated Structures

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

Where a non-uniform foundation cannot be avoided or applied loads may create highly variable foundation loads, settlement should be calculated from site-specific soil test data. Index tests of site soil may allow correlation with similar soils for which test data is available. If no test data is available, presumptive bearing strength values for assessing actual bearing pressures may be obtained from Table 2 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 2. Presumptive Allowable Bearing Stress Values[1]

Foundation Description	**Allowable Stress**
Crystalline Bedrock	12000 psf
Sedimentary Rock	6000 psf
Sandy Gravel or Gravel	5000 psf
	3000 psf

Sand, Silty Sand, Clayey Sand, Silty Gravel, Clayey Gravel Clay, Sandy Clay, Silty Clay, Clayey Silt	2000 psf
[1] Basic Building Code, 12th Edition, 1993, Building Officials and Code Administrators, Inc. (BOCA)	

Liquid Tightness. Applications such as tanks that require liquid tightness shall be designed and constructed in accordance with standard engineering and industry practice appropriate for the construction materials used to achieve this objective. Such structures shall be designed and constructed to achieve a maximum seepage rate of not more than 1/560 inch per day throughout the design life of the structure.

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.

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-74. If soil strength tests are not available, the presumptive lateral earth pressure values indicated in Table 3 shall be used.

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

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

Internal lateral pressure used for design shall be 65 lb/ft^2 where the stored waste is not protected from precipitation. A value of 60 lb/ft^2 may be used where the stored waste is protected from precipitation and will not become saturated. Use a minimum internal lateral pressure of 72 lb/ft2/ft of depth for sand-laden manure storage if the percentage of sand exceeds 20%. Lesser values may be used if supported by measurement of actual pressures of the waste to be stored. If heavy equipment will be operated near the wall, an additional two feet of soil surcharge shall be considered in the wall analysis.

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.

TABLE 3. LATERAL EARTH PRESSURE VALUES[1]

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

[1] For lightly-compacted soils (85% to 90% maximum standard density). Includes compaction by use of typical farm equipment.

[2] Also below seasonal high water table if adequate drainage is provided.

[3] Includes hydrostatic pressure.

[4] All definitions and procedures in accordance with ASTM D 2488 and D 653.

[5] Generally, only washed materials are in this category

[6] Not recommended. Requires special design if used.

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

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

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

- Steel: "Manual of Steel Construction", American Institute of Steel Construction.
- Timber: "National Design Specifications for Wood Construction", American Forest and Paper Association.

  Timber used in contact with soil or manure shall contain a minimum of 0.6 lbs/cubic feet (foundation grade) of CCA or ACQ preservative or equivalent.
- Concrete: "Building Code Requirements for Reinforced Concrete, ACI 318", American Concrete Institute. Concrete structures designed to meet ACI 318 shall have as a minimum, temperature and shrinkage reinforcement.

  Concrete shall have a minimum compressive strength of 3500 psi.

  Concrete with reinforcing steel shall meet local electrical codes dealing with Concrete Embedded Elements, Equipotential Planes, and Voltage Gradients.
- Masonry: "Building Code Requirements for Masonry Structures, ACI 530", American Concrete Institute.

Slabs on Grade. Slab design shall consider the required performance and the critical applied loads along with both the subgrade material and material resistance of the concrete slab. Where applied point loads are minimal and liquid-tightness is not required, such as barnyard and feedlot slabs subject only to precipitation, and the subgrade is uniform and dense, the minimum slab thickness shall be 4 inches. Consideration should be given to including steel reinforcement for preventing vertical displacement at crack locations on slabs that will be scraped.

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". The minimum reinforcing steel area shall be 0.15 percent of the cross-sectional area of concrete. Reinforcing steel shall be supported in its intended location by appropriate chairs or wet cast concrete blocks with the same strength as the concrete to be placed. Maximum reinforcing bar spacing shall be 24 inches.

The use of welded wire fabric (WWF) is limited to 4 x 4 – W4 x W4 panels (rolls are not to be used). WWF shall be supported at its intended location by supports spaced no more than 26 inches center to center.

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.

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. When calculating the design storage volume, the amount of evaporation to be used should be selected considering the effects of crusting, shading, or covering of the effluent surface.

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 the stored waste.

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

Minnesota Department of Health (MDA) rules require a setback distance from wells of 50 feet to manure transfer pipelines, 20 feet to watertight sumps, and 100 feet to manure storage facilities. These distances are doubled for shallow wells as defined by MDH rules. Consult MDH rules for more information.

Wetlands. In some cases waste management systems can adversely affect wetlands. Minnesota NRCS policy regarding work affecting wetlands is found in the General Manual, Title 190, Part 410-Compliance with NEPA. Other federal, state or local permits or restrictions may apply to activities impacting wetlands. The Army Corps of Engineers administers Clean Water Act permits, the Local Government Unit administers State Wetland Conservation Act permits and the Minnesota Department of Natural Resources administers protected water permits.

Considerations for Minimizing the Potential for and Impacts of Sudden Breach of Embankment or Accidental Release from the Required Volume.

Features, safeguards, and/or management measures to minimize the risk of failure or accidental release, or to minimize or mitigate impact of this type of failure should be considered when any of the categories listed in Table 4 might be significantly affected.

The following should be considered either singly or in combination to minimize the potential of or the consequences of sudden breach of embankments when one or more of the potential impact categories listed in Table 4 may be significantly affected:

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

The following options should be considered to minimize the potential for accidental release from the required volume through gravity outlets when one or more of the potential impact categories listed in Table 4 may be significantly affected:

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

Table 4. Potential Impact Categories from Breach of Embankment or Accidental Release

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

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

In addition to MPCA requirements for the Karst region referred to on page 1 of this standard, sites with categories listed in Table 5 should be avoided unless no reasonable alternative exists. Under those circumstances, consideration should be given to providing an additional measure of safety from pond seepage when any of the potential impact categories listed in Table 5 may be significantly affected.

Table 5. Potential Impact Categories for Liner Failure

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

Considerations for Improving Air Quality

The need for odor control must be considered in selecting system components and location.

To reduce emissions of greenhouse gases, ammonia, volatile organic compounds, and odor, other practices such as Anaerobic Digester – Controlled Temperature (366), Waste Facility Cover (367), Biofilter (795) and Composting Facility (317) 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 Waste Utilization, 633).

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

SAFETY

Safety features and devices shall be included in waste management systems, as appropriate, to protect animals and humans from drowning, dangerous gases, and other hazards. Fencing shall be provided, as necessary, to discourage human entry and to prevent livestock from using facilities for other purposes. Warning signs are required for storage ponds, storage structures, confined spaces and other facilities that may present a hazard to humans.

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.

OPERATION AND MAINTENANCE

An operation and maintenance plan shall be developed that is consistent with the purposes of the practice, its intended life, safety requirements, and the criteria for its design. It should provide specific details concerning the operation of each component and shall include:

1. Safety warnings, particularly where there is danger of drowning or exposure to poisonous or explosive gases.
2. Requirements for removal of waste from 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 plans shall include a strategy for removal of wastes from unusual rainfall 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.
3. Maximum operation levels for impoundments. In addition, for ponds, the plan shall include an explanation of the permanent marker or recorder installed to indicate the maximum operating level.
4. Sediment removal recommendations.
5. Vegetation maintenance and harvesting suggestions.
6. Maintenance requirements for other components.
7. An emergency action plan should be considered for waste storage facilities where there is a potential for significant impact from breach or accidental release. The plan shall include site-specific provisions for emergency actions that will minimize these impacts.