WASTE STORAGE FACILITY

(No.)
Code 313

Natural Resources Conservation Service
Conservation Practice Standard

I. Definition

A waste storage *impoundment*[1] made by constructing an embankment and/or excavating a pit or dugout, or by fabricating a *structure*.

II. Purpose

To temporarily store wastes such as manure, *manure processing derivatives*, *leachate, wastewater*, and *contaminated runoff* in a manner which safeguards the environment.

III. Conditions Where Practice Applies

This standard applies to:

- construction of a storage facility in areas where the soils, geography, and topography are suitable and where the construction, operation, and maintenance will protect the soil and water resources,
- areas that are part of a planned agriculture waste management system intended to reduce contaminated runoff and meet the facility management goals, regulatory requirements, or *nutrient management plans* by providing storage of waste,
- waste storage facilities utilizing embankments with a maximum *effective height* of 25 feet and where damage resulting from failure would be limited,
- temporary unconfined stacks of manure and derivatives outside the *animal production area*, and
- storage of milking center wastewater generated at the animal production area.

This standard does not apply to:

- facilities in which greater than 10% of the design storage volume or greater than 25,000 gallons is occupied by any combination of domestic waste, industrial wastewater generated offsite, or sludge. These types of facilities are defined and regulated under various codes administered by the Wisconsin Department of Natural Resources (WDNR).
- closure of waste storage facilities. For information related to closures refer to the criteria contained in Wisconsin NRCS Field Office Technical Guide (FOTG) Section IV, Standard 360, Closure of Waste Impoundments.

IV. Federal, State and Local Laws

Waste storage facilities shall comply with all federal, state, and local laws, rules or regulations. The operator is responsible for securing required permits. This standard does not contain the text of the federal, state, or local laws governing waste storage facilities.

V. Criteria

The following criteria establishes **minimum** allowable limits for design parameters, acceptable installation processes, or performance requirements.

A. General Criteria

The following general criteria apply to this practice.

1. Management Assessment

A management assessment shall be conducted, documented, and incorporated into the design. The assessment shall be performed with the owner/operator to explore options and to determine the purpose of storage components, available resources, manure disposal schemes, and waste characteristics.

When the intent of the owner/operator is to process and/or treat the various waste streams within the animal production area, the designer shall provide a narrative describing the system. The description will include the intent and purpose of the treatment or processing strategies relative to landspreading or waste distribution strategies, stabilization of organic by-products, reducing pollutant loads,

[1]Words in the standard that are shown in italics are described in VIII. Definitions. The words are italicized the first time they are used in the text.

nutrient concentration, waste consistencies, odor control, energy production, and volume reduction.

The management assessment shall address the following:

a. Waste Characterization.

(1) Sources, volumes and consistency of manure, contaminated runoff, manure processing derivatives, leachate, wastewater, and other inputs to the waste storage facility.

(2) Animal types.

(3) Bedding types and quantity.

b. Land base available for utilization of waste.

c. Planned storage period.

d. Waste handling and transfer methods.

e. Facility waste removal methods.

f. Storage liner possibilities and preferences.

g. Access needs and limitations.

h. Safety needs.

i. Labor and equipment needs.

j. Odor production concerns and control strategies – identify sources of odors and potential public contact.

k. Aesthetics and animal health.

l. Provisions for facility expansion.

2. Site Assessment

A site assessment shall be conducted, documented, and incorporated into the design. The assessment shall be performed to determine physical site characteristics that will influence the placement, construction, maintenance, and environmental integrity of a proposed waste storage facility, unconfined manure stacks, and transfer components. The assessment shall include input from the owner/operator. The site assessment shall include:

a. Locations and elevations of buildings, roads, lanes, soil test pits, property lines, setbacks, easements, wells, floodplains, surface waters, surface drains, drain tile, utilities, overhead lines, cultural resources, and wetlands.

b. Test pit or soil boring logs, soil test results, and a soil survey photo, if available. Test pit soil or boring criteria include:

(1) The number and distribution needed to characterize the subsurface (soils, saturation, and *bedrock*). Test pits or borings shall be added if there is inconsistency within or between test pits or borings.

(2) Based on the facility *footprint* there shall be a minimum of one test pit or boring per 15,000 square feet of footprint, with a minimum of two per facility. Test pits and borings used to meet this criteria shall be located in the footprint or no more than 100 feet from the footprint.

(3) For manure transfer systems, the number of test pits or soil borings shall be in accordance with NRCS FOTG Section IV, Standard 634, Manure Transfer.

(4) Soil layers shall be described with respect to texture using the Unified Soil Classification System (USCS).

(5) A minimum depth to ensure separation distances in Tables 1-6 and 9 of this standard and Table 1 in NRCS FOTG Section IV, Standard 634, Manure Transfer.

(6) The elevation of bedrock and bedrock type, if encountered, such as sandstone, limestone, dolomite, or granite.

(7) Saturation indicators, if encountered, such as seepage from sand and gravel lenses, lens thickness, estimated volume of flow, and elevation. Ground water maps and well construction logs shall be included when available and applicable.

c. Locations, dimensions and elevations of *sinkholes* and other *karst* features within 1,000 feet of the facility.

d. Locations, dimensions and elevations, soil volumes, soil samples, testing results, and reclamation plans of any borrow areas. Characterize borrow areas according to Section V.A.2.b.(1).

e. Identification of potential impacts from failure of the embankments, liners, or structures.

3. Floodplain

Waste storage facilities located in *flood prone areas* shall be protected from inundation, structural damage, and instability. These facilities shall be designed to accommodate any additional loading resulting from static water levels or saturated soils. The lowest point at which floodwater could enter the waste storage facility shall be 2 feet above the maximum elevation of flow resulting from a 100-year, 24-hour rainfall event.

4. Location

Waste storage facilities shall be located so the potential impacts from breach of embankment, accidental release, and liner failure are minimized. Consideration VI.N. contains information related to reducing the impacts.

5. Design Storage Volume

Design storage volumes shall be calculated with the procedures and default values found in the Wisconsin supplement to Chapter 10 of the NRCS Agricultural Waste Management Field Handbook (AWMFH) or estimates and measurements documented in the plan. The design storage duration and volume shall be consistent with the nutrient management plan and emptying schedule. Design volume shall include the sum of the following during the storage period:

a. Manure, bedding and other wastes.

b. The volume of wastewater from all sources that is anticipated to enter the storage facility. The wastewater volume shall be based on default values or estimates and measurements documented in the plan.

c. Normal precipitation less evaporation on the surface of the facility.

d. Runoff volumes from the drainage area for design storage duration.

e. 25-year, 24-hour precipitation on the surface of the facility.

f. 25-year, 24-hour runoff volume from the drainage area.

6. Maximum Operating Level

The maximum operating level for waste storage facilities shall be the storage level that provides for the design storage volume listed in Section V.A.5 less the volume of precipitation and runoff from the 25-year, 24-hour storm event. See Figure 1.

A permanent marker or indicator that does not compromise the integrity of the liner shall be installed at the maximum operating level. The stored waste shall be managed such that it remains below the maximum operating level during normal operating conditions.

A contingency plan shall be implemented when the maximum operating level is reached. See Section V.A.14.c for specific contents of the contingency plan.

7. Extra Depth for Safety

A minimum of one foot of depth shall be added to the design storage volume to reduce the risk of overtopping. This depth is not intended to add storage capacity. See Figure 1.

8. Remaining Waste and Sumps

An additional depth shall be added to the facility to accommodate the waste that cannot be routinely removed during emptying. A minimum of two feet shall be added to storage depth for facilities with side slopes and one foot for vertical walled facilities. The additional storage depth can be reduced if a sump is installed or other provisions to empty the facility have been made.

9. Embankment Requirements

a. The foundation area shall be stripped to remove vegetation and unsuitable materials.

b. A core trench shall be required whenever the settled embankment fill height at the

centerline is ≥ 10 feet. Minimum dimensions of the core trench shall be 8-foot bottom width, 2-foot depth, and 1:1 or flatter side slopes.

c. After settlement, the top of the embankment shall be ≥ 1 foot above the surrounding grade. Any diversion along the embankment shall have capacity for 25-year, 24-hour flow plus 0.5 feet of freeboard.

d. Additional fill for settlement shall be a minimum of 5% of the fill height measured at the centerline.

e. The minimum top width shall be according to the table below.

Settled Embankment Fill Height (feet)	Top Width (feet)
0 - 10	≥ 8
10.1 - 15	≥ 10
15.1 - 20	≥ 15
20.1 - 25	≥ 20

f. The sum of interior and exterior side slopes shall be ≥ 5:1 with no slope steeper than 2:1. Tables 1, 3, 4, and 5 contain specific embankment requirements.

g. Compaction shall be according to NRCS FOTG Section IV, Wisconsin Construction Specification 204, Earthfill for Waste Storage Facilities.

10. Separation from Saturation or Bedrock

The separation is determined to be the closest distance from any point on the inside surface (bottom and sides) of the storage facility to the feature from which separation is required.

a. The following criteria apply to saturation:

(1) *Regional High Water Table* - The regional high water table shall not be lowered to achieve the required separation.

(2) *Confined Lenses and Perched Water* may be drained. All *drainage systems* shall have a free outlet. The effect of temporary tailwater on the structure or liner and the effects of outletting to perennial and intermittent waterways shall be evaluated. At a minimum, drain tile and/or drain fill material shall be located outside the facility footprint.

b. The following criteria apply to bedrock. Excavation of bedrock is permitted to achieve the required separation distance as specified in the tables. Consolidated bedrock shall not be removed by blasting. The entire width of the surface of any excavated, consolidated rock material shall have a positive grade away from the storage facility with no ponding on the excavated surface. If bedrock is excavated, the material placed between the liner and the bedrock shall have a minimum of 20% fines.

11. Safety Design

Safety design shall identify and minimize the hazards to animals and people. At a minimum, safety design shall include the following.

a. Warning signs, fences, ladders, ropes, bars, rails, and other devices shall be provided, as appropriate, to ensure the safety of humans and livestock. Fences a minimum of 4 feet tall, that do not allow passage of animals or people, shall be installed to restrict access.

b. Ventilation for covered waste-holding structures to prevent the inhalation of poisonous gases, asphyxiation, or explosion.

c. Safety stops, gates, or both installed at push-off ramps and load-out areas of impoundments and structures to prevent accidental entry of machinery.

d. Equipment access ramps and embankment slopes shall be compatible with the equipment intended to be used.

12. Seeding and Mulching

Disturbed areas and embankments shall be seeded and mulched in accordance with NRCS FOTG Section IV, Standard 342, Critical Area Planting.

13. 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. A construction plan and inspection plan are required.

a. The plans, specifications, and documentation for the installation of waste storage impoundments and structures shall include:

- Management assessment,
- Site assessment,
- Safety design features,
- Operation and maintenance plan,
- Construction plan,
- Construction inspection plan, and
- Construction site erosion control plan (see NR 216).

b. Documentation for siting unconfined stacks of manure and derivatives in cropland outside the waste production area shall include:

- Management assessment,
- Site assessment, and
- Location maps, soils maps, and USGS quadrangle maps.

14. Operation and Maintenance

An operation and maintenance plan shall be developed that is consistent with the purposes of this practice, intended life of the components, safety requirements, and the criteria for the design. At a minimum, the plan shall include:

a. Operational requirements for emptying the storage facility. This shall require that waste be removed and utilized at locations, times, rates, and volumes detailed in a plan in accordance with NRCS FOTG Section IV, Standard 590, Nutrient Management.

b. Requirements for location and methods of waste removal in order to maintain liner integrity.

c. A contingency plan which shall be implemented when the maximum operating level is reached. The contingency plan shall include how to handle unexpected volumes of wastewater and/or runoff that could cause the system to overflow before scheduled emptying can occur. The contingency plan shall provide for the safe disposition of waste.

d. An emergency response plan to deal with spills or overflows at the animal production area.

e. Requirements for inspecting and maintaining the facility as well as monitoring the waste level relative to the permanent maximum operating level marker or indicator.

f. Safety issues and procedures/requirements connected with waste storage facilities.

B. Specific Criteria for Waste Storage Impoundments and Structures

Waste Storage impoundments and structures shall be designed to contain all wastes until emptied and utilized in accordance with the Operation and Maintenance Plan. This includes impoundments (Section 1, and Tables 1 through 5) and structures (Section 2, Table 6). The storage facilities may be used alone or in combination to contain the various waste streams. There shall be no gravity outlets from the waste storage facility.

The following specific criteria apply to this practice:

1. Impoundment Design Criteria

Table 1 contains the criteria for constructing waste impoundments into existing soils with no additional liner. Tables 2 through 5 contain the criteria for impoundments with liners. The portions of the waste storage facilities that do not meet Table 1 criteria shall be lined. A combination of liners is acceptable. The liners shall be joined so as to preserve the performance and integrity of all liner types. Concrete walls used in impoundments shall maintain the integrity of any liner. Any penetration and overfall/outfalls of the liner shall be constructed to maintain the performance and integrity of the liner used. Liners shall be designed to withstand all anticipated internal and external loads, hydrostatic uplift pressure, and agitation scouring. Soil criteria in Tables 1 through 5 refers to mineral soils. Construction shall not occur on or with organic soils.

Table 1 - *In-Place Earth* Criteria for Impoundments 20 Feet Deep or Less[Note 1]

1. Size - Design Storage Volume - Manure Produced at Farm per year	 ≤ 300,000 cu. ft. ≤ 300,000 cu. ft.	 > 300,000 cu. ft.[Note 2] > 300,000 cu. ft.	 > 300,000 cu. ft.[Note 2] > 300,000 cu. ft.
2. Waste Characteristics - % Solids in Stored Waste	 ≥ 4	 ≥ 2[Note 3]	 ≥ 2[Note 3]
3. Soils - *% Fines* - Thickness, (measured perpendicular to storage surface) - *Plasticity Index (PI)*[Note 4]	 ≥ 50% ≥ 5 ft. —	 ≥ 50% ≥ 3 ft. (impoundment < 16 ft. deep)[Note 1] ≥ 4 ft. (impoundment ≥ 16 ft. deep) ≥ 7	 ≥ 40% ≥ 3 ft. (impoundment <16 ft. deep)[Note 1] ≥ 4 ft. (impoundment ≥ 16 ft. deep) ≥ 12
4. Separation Distances - Well Distance[Note 5] - Sinkholes - Saturation (V.A.10) - Bedrock	 ≥ 250 ft. ≥ 800 ft. ≥ 5 ft. ≥ 5 ft.	 ≥ 250 ft. ≥ 400 ft. ≥ 3 ft. (impoundment < 16 ft. deep) ≥ 4 ft. (impoundment ≥ 16 ft. deep) ≥ 5 ft.	 ≥ 250 ft. ≥ 400 ft. ≥ 3 ft. (impoundment < 16 ft. deep) ≥ 4 ft. (impoundment ≥ 16 ft. deep) ≥ 5 ft.
5. Embankment	Shall be constructed with material meeting criteria in Table 1 from the inside surface to the embankment centerline. If this material has a PI less than 7, then the sum of the embankment slopes shall be 6 or greater and the constructed embankment height shall be less than 10 feet.		
6. Other - Scour Protection • Agitation and Pumping Locations • Scraping and Other Mechanical Means of Removing Solids and Sand - Bottom Modification	 Not required if actual soil thickness is 3 feet greater than the minimum required in the table. 20 ft. x 20 ft. x 4 in. thick concrete pad or sump in bottom and 20 ft. wide ramp or a 16 ft. wide ramp with 12 in. high curbs to top of facility. Protect with hard surfacing designed for the expected conditions and loads, a minimum of 4 in. thick. If the bottom of the impoundment is less than three feet below the native soil surface, the bottom soil shall be reworked to a minimum depth of 6 in. and compacted in accordance with WI Spec 204[Note 6].		

Note 1 The depth is measured from the bottom of the impoundment to the maximum operating level.

Note 2 These two columns show the minimum criteria for larger storage facilities and farms, but can also be used for smaller facilities and farms.

Note 3 In Place Impoundments are not allowed if the waste has less than 2% solids.

Note 4 PI shall be determined by ASTM D-4318, Atterberg Limits.

Note 5 Community water system wells may require larger separation distances (see NR 812).

Note 6 NRCS FOTG Section IV, Wisconsin Construction Specification 204, Earthfill for Waste Storage Facilities.

Table 2 - Clay Liner Criteria for Impoundments

1. Size - Design Storage Volume - Manure Produced at Farm Per Year	 ≤ 300,000 cu ft. ≤ 300,000 cu ft.	 > 300,000 cu ft.[Note 1] > 300,000 cu ft.	 > 300,000 cu ft.[Note 1] > 300,000 cu ft.
2. Waste Characteristics - % Solids in Stored Waste	—	≥ 2	< 2
3. Clay Liner Material Requirements - Thickness, Bottom - Thickness, Sides - % Fines - Plasticity Index (PI)[Note 2] - *Permeability*, cm/sec.[Note 3]	 ≥ 3 ft. ≥ 5 ft. ≥ 50% ≥ 12 —	 ≥ 3 ft. ≥ 5 ft. ≥ 50% ≥ 12 $\leq 1x10^{-6}$	 As specified in Table 2A ≥ 5 ft. ≥ 50% ≥ 12 $\leq 1x10^{-7}$
4. Clay Liner Compaction Specification	WI Spec 204[Note 4]	WI Spec 300[Note 5]	WI Spec 300[Note 5]
5. Separation Distances - Wells[Note 6] - Sinkholes - Saturation (V.A.10) - Bedrock	 ≥ 250 ft. ≥ 400 ft. ≥ 4 ft. ≥ 3 ft.	 ≥ 250 ft. ≥ 400 ft. ≥ 4 ft. ≥ 3 ft.	 ≥ 250 ft. ≥ 400 ft. As specified in Table 2A Same as liner thickness
6. Other - Liner Protection Required	• If facility bottom is to be mechanically cleaned • At all agitation and pumping locations[Note 7]		

Note 1 These two columns show the minimum criteria for larger storage facilities and farms, but can also be used for smaller facilities and farms.

Note 2 PI shall be determined by ASTM D-4318, Atterberg Limits.

Note 3 Permeability shall be determined by ASTM D-5084 using a Shelby tube sample.

Note 4 NRCS FOTG Section IV, Wisconsin Construction Specification 204, Earthfill for Waste Storage Facilities.

Note 5 NRCS FOTG Section IV, Wisconsin Construction Specification 300, Clay Liner.

Note 6 Community water system wells may require larger separation distances (see NR 812).

Note 7 Minimum concrete agitation pad or sump to be 20 ft. x 20 ft. with a 20 ft. wide concrete ramp or 16 ft. wide concrete ramp with 12 in. high curbs in accordance with Table 5 criteria.

Table 2A – Clay Liner Thickness (Bottom) and Separation to Saturation[Note 1]

Impoundment Depth[Note 2] (feet)	Liner Thickness (feet)	Separation to Saturation (feet)
0 – 13	≥ 3.0	≥ 4.0
13.1 – 14	≥ 3.2	≥ 4.2
14.1 – 16	≥ 3.6	≥ 4.6
16.1 – 18	≥ 4.1	≥ 5.1
18.1 – 20	≥ 4.5	≥ 5.5

Note 1 Thickness is calculated based on a maximum permeability of $1x10^{-7}$ cm/sec and a specific discharge limit of 500 gallons/acre/day using Darcy's Law.

Note 2 Depth is the distance from the bottom of the impoundment up to the maximum operating level (M.O.L.).

Table 3 - *Geomembrane* Liner Criteria for Impoundments

1. Liner Material	60 mil High Density Polyethlene (HDPE) or 60 mil Linear Low Density Polyethylene (LLDPE). The geomembrane shall be installed with *intimate contact* to the soil below[Note 1]	
2. Soils (Directly Below Liner)[Note 2] - % Fines - Plasticity Index (PI) - Thickness - Compaction of Placed Material	 ≥ 20% ≥ 7 ≥ 1.5 ft. WI Spec 202	 ≥ 20% — ≥ 3 ft. WI Spec 202
3. Separation Distances - Well Distance[Note 3] - Sinkholes - Saturation (V.A.10) - Bedrock	 ≥ 250 ft. ≥ 400 ft. ≥ 3 ft. (1.5 ft. sep. for sump) ≥ 3 ft. (1.5 ft. sep. for sump)	 ≥ 250 ft. ≥ 400 ft. ≥ 4 ft. (3 ft. sep. for sump) ≥ 3 ft.
4. Waste Characteristics	No limitations	
5. Embankment Requirements - Inside Slope	2.5:1 or flatter.	
6. Other - Liner Protection Required	• At all agitation and pumping locations[Note 4 and 5] • If facility bottom is to be mechanically cleaned[Note5]	
- Gas release system	Required for all facilities. The system shall be designed in such a manner to prevent waste and runoff from entry into the gas release system.[Note 1]	
- Liner Installation	• Continuous Inspection Required • All geomembrane placement, seaming, seam testing, and repair and concrete placement for liner protection shall be completed under the continuous observation of a qualified third-party quality assurance inspector under the direction of a Professional Engineer. This inspector shall not be an employee of the contractor, owner, or geomembrane supplier.	

[Note 1] Intimate contact does not exclude the use of gravel trenches for gas venting or monitoring systems.

[Note 2] The liner is in intimate contact with the soil, and the two work together to reduce seepage losses.

[Note 3] Community water system wells may require larger separation distances (see NR 812).

[Note 4] Minimum dimension of 20 ft. x 20 ft. concrete pad or sump in bottom and 20 ft. wide ramp with 12 in. curb to top of facility with provisions for liner integrity.

[Note 5] Poured-in-place concrete slabs shall meet requirements of Table 5, Note 2 if the geomembrane will be joined to the liquid-tight concrete. All connections between the geomembrane and concrete shall be liquid tight and structurally sound. If the liner protection is placed on top of the geomembrane, it shall be structurally sound, but liquid-tightness is not required. Liner protection poured on top of the geomembrane shall be separated from the geomembrane by a sacrificial layer of the same weight geomembrane and a cushioning layer of 12 oz/sy non-woven geotextile. The sacrificial layer shall not be welded to the geomembrane liner. Liner protection installation over the geomembrane shall be completed by methods that will maintain the integrity and performance of the liner. Liner protection placed on slopes shall be designed with provisions to insure stability.

Table 4 - *Geosynthetic Clay Liner (GCL)* Criteria for Impoundments

1a. Soils (Directly Below Liner)[Note 1] - % Fines - Plasticity Index (PI) - Thickness (from bottom and sides) - Compaction of placed material	 ≥ 20% ≥ 7 ≥ 1.5 ft. WI Spec 203	 ≥ 20% — ≥ 3 ft. WI Spec 203
1b. Liner Cover Material Thickness - Bottom - Side Slopes - Compaction of Placed Materials	 ≥ 1 ft. ≥ 2 ft. WI Spec 203	 ≥ 1 ft. ≥ 2 ft. WI Spec 203
2. Separation Distances - Well Distance[Note 2] - Sinkholes - Saturation (V.A.10) - Bedrock	 ≥ 250 ft. ≥ 400 ft. ≥ 4 ft. ≥ 3 ft.	 ≥ 250 ft. ≥ 400 ft. ≥ 5 ft. ≥ 4 ft.
3. Waste Characteristics	No limitations	
4. Embankment Requirements - Inside Slope[Note 3]	3:1 or flatter	
5. Other - Required Liner Protection - Scraping and Other Mechanical Means of Removing Solids and Sand - GCL Material[Note 5]	 • If facility bottom is to be mechanically cleaned • At all agitation and pumping locations[Note 4] Protect with hard surfacing designed for the expected conditions and loads, a minimum of 4 in. thick. Non-woven needle punched.	

Note 1 The liner is in intimate contact with the soil, and the two work together to reduce seepage losses.

Note 2 Community water system wells may require larger separation distances (see NR 812).

Note 3 The GCL and soil cover shall be stable at the designed side slope.

Note 4 Minimum dimension of 20 ft. x 20 ft. x 4 in. thick concrete pad or sump in bottom and 20 ft. wide ramp or a 16 ft. wide ramp with 12 in. high curb to top of facility. GCL continues under the concrete pad or sump.

Note 5 The liner shall be installed according to manufacturer's specifications and NRCS FOTG Section IV, Wisconsin Construction Specification 203, Geosynthetic Clay Liner.

Table 5 - Concrete Liner Criteria for Impoundments[Note 1]

	Concrete[Note 2]	**Concrete - Soil Composite**[Note 3]	
1. Soils (Directly Below Liner)[Note 3]			
- % Fines	—	≥ 20%	≥ 20%
- Plasticity Index (PI)	—	≥ 7	—
- Thickness (bottom and sides)	—	≥ 1.5 ft.	≥ 3 ft.
- Compaction of Placed Material	—	WI Spec 204	WI Spec 204
2. Separation Distances			
- Sinkholes	≥ 400 ft.	≥ 400 ft.	≥ 400 ft.
- Well Distance[Note 4]	≥ 100 ft.	≥ 100 ft.	≥ 100 ft.
- Saturation (V.A.10)	≥ 2 ft. (1 ft. sep. for sump)	≥ 3 ft.	≥ 4 ft.
- Bedrock	≥ 2 ft. (1 ft. sep. for sump)	≥ 3 ft.	≥ 3 ft.
3. Waste Characteristics	No limitations		
4. Embankment Requirements			
- Side Slopes	In accordance with WI Spec 4		

Note 1 Slabs for uses other than liners such as protection, scraping, and access shall be a minimum of 4 inches thick with steel as required for anticipated loads and usage.

Note 2 The concrete liner thickness shall be a minimum of 5 in., contain distributed reinforcing steel, and all *contraction* or *expansion joints* shall have imbedded non-metallic waterstops in accordance with NRCS FOTG Section IV, Wisconsin Construction Specification 4, Concrete. The required size and spacing of reinforcing steel and spacing of liquid tight expansion or contraction joints shall be based on subgrade drag theory as discussed in industry guidelines such as American Concrete Institute, ACI 360, "Design of Slabs-on-Grade," or the WI Supplement to Chapter 10 of the NRCS AWMFH. Steel shall be continuous through all *construction joints.*

Note 3 The concrete is in intimate contact with the soil, and the two work together to reduce seepage losses. The concrete liner thickness shall be a minimum of 5 inches and continuous reinforcement of #3 steel bars spaced at 18 inches on center each way. No contraction or expansion joints are required. The concrete shall be placed in intimate contact with the foundation soils. If construction joints are required, steel shall be continuous through all construction joints and no waterstop is required. If the soil material below the floor meets Table 1 criteria, intimate contact is not required.

Note 4 Community water system wells may require larger separation distances (see NR 812).

2. Structure Design Criteria

The structure design shall include all items that will influence the performance of the structure, including loading assumptions, material properties, construction quality, waterstops, pipe penetrations, anchor plates, or other attachments to walls such as fence posts. Design assumptions and construction requirements shall be indicated on the construction plans. Waste storage structure separation criteria shall be as shown in Table 6. Any penetration of the structure shall be constructed to maintain the performance and integrity of the structure.

Table 6 - Waste Storage Structure Separation Distances

Well Distance[Note 1]	≥ 100 ft.
Sinkholes	
Storage floor above ground	≥ 200 ft.
Storage floor below ground	≥ 400 ft.
Saturation (V.A.10)	≥ 2 ft.
(1 ft. sep. for sump)	
Bedrock (1 ft. sep. for sump)	≥ 2 ft.

Note 1 Community water system wells may require larger separation distances (see NR 812).

Tanks may be designed with or without covers. Covers, beams, or braces that are integral to structural performance shall be designed accordingly and 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.

a. Fabricated Structures - Fabricated structures shall be designed according to the following criteria:

(1) Steel. "Manual of Steel Construction," American Institute of Steel Construction.

(2) Timber. "National Design Specifications for Wood Construction," American Forest and Paper Association.

(3) Concrete. "Building Code Requirements for Reinforced Concrete, ACI 318," American Concrete Institute. Concrete shall have a minimum compressive strength of 3500 psi.

b. Foundations - 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 7 or another nationally recognized building code. In using presumptive bearing values, adequate detailing and articulation shall be provided to avoid distressing movements in the structure.

Table 7 - Presumptive Allowable Bearing Stress Values[Note 1]

Foundation Description	Allowable Stress
- Crystalline Bedrock	12,000 psf
- Sedimentary Rock	6,000 psf
- Sandy Gravel or Gravel	5,000 psf
- Sand, Silt Sand, Clayey Sand, Silty Gravel, Clayey Gravel	3,000 psf
- Clay, Sandy Clay, Silty Clay, Clayey Silt	2,000 psf

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

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

The lateral earth pressures should be calculated from soil strength values determined from the results of appropriate soil tests. Lateral earth pressures can be calculated using the procedures in NRCS Technical Release - 74, Lateral Earth

Pressures. If soil strength tests are not available, the presumptive lateral earth pressure values indicated in Table 8 shall be used.

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

(1) Rigid frame or restrained wall. Use the values shown in Table 8 under the column "Frame Tanks," which gives pressures comparable to the at-rest condition.

(2) Flexible or yielding wall. Use the values shown in Table 8 under the column "Free Standing Wall," which gives pressures comparable to the active condition. Walls in this category are designed on the basis of gravity for stability or are designed as a cantilever having a base wall thickness to height of backfill ratio not more than 0.085.

Internal lateral pressure used for design shall be 65 psf.

If heavy equipment will be operated near the wall, an additional surcharge equivalent to two feet of soil shall be applied in the wall analysis.

Tank covers shall be designed to withstand both dead and live loads. The live load values for covers contained in ASAE EP378.3, Floor and Suspended Loads on Agricultural Structure Due to Use, and in ASAE EP393.3, 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 ASCE SEI/ASCE 7-02, 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.

Table 8 - Lateral Earth Pressure Values[Note 1]

Soil		Equivalent Fluid Pressure (lbs./sq. ft./per ft. of depth)			
		Above Regional High Water Table		Below Regional High Water Table[Note 3]	
Description	Unified Classification[Note 2]	Free Standing Wall	Frame Tanks	Free Standing Wall	Frame Tanks
- Clean gravel, sand or sand-gravel mixtures (maximum 5% fines)[Note 4]	GP, GW, SP, SW	30	50	80	90
- Gravel, sand, silt and clay mixtures (< 50% fines) - Coarse sands with silt and/or clay (<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% fines - Fine sands with silt and/or clay (< 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% fines)	CL, ML, CL-ML	65	85	95	110
- High plasticity silts and clays (liquid limit more than 50)[Note 5]	CH, MH	–	–	–	–

Note 1 For lightly compacted soils (85% to 95% maximum standard density). Includes compaction by use of typical farm equipment.

Note 2 All definitions and procedures in accordance with ASTM D-2488 and D-653.

Note 3 Includes hydrostatic pressure.

Note 4 Generally, only washed materials are in this category.

Note 5 Not recommended. Requires special design if used, see the companion documents in Chapter 10 AWMFH.

d. Floors - Concrete floors shall be designed according to one of the following options.

(1) The concrete floor thickness shall be a minimum of 5 inches for uniform foundations, contain distributed reinforcing steel, and all contraction or expansion joints shall have imbedded non-metallic waterstops in accordance with NRCS FOTG Section IV, Wisconsin Construction Specification 4 - Concrete. The required area of reinforcing steel and spacing of liquid tight contraction or expansion joints shall be based on subgrade drag theory as discussed in industry guidelines such as American Concrete Institute, ACI 360, "Design of Slabs-on-Grade," or the WI Supplement to Chapter 10 of the NRCS AWMFH. The steel shall be continuous through all construction joints.

(2) If the soil material below the floor slab has 20% minimum fines and is at least 3 feet thick or has a minimum of 20% fines, is at least 1.5 feet thick, and has a PI of > 7, the reinforcing may be #3 bars spaced at 18 inches on center each way. No contraction or expansion joints are required. The concrete shall be placed in intimate contact with the foundation soil. The reinforcing steel shall be continuous through all construction joints. If the soil material below the floor

meets Table 1 criteria, intimate contact is not required. Drain tile and/or drain fill material shall be kept outside of the soil component of the composite liner. Refer to the companion documents contained in Chapter 10 of the AWMFH for further guidance.

e. Wall Joints - Waterstop joints for cast-in-place walls shall be located at the floor waterstop joint locations and shall be continuous with the floor waterstop. Waterstops shall be imbedded non-metallic in accordance with NRCS FOTG Section IV, Wisconsin Construction Specification 4, Concrete.

Joints for pre-cast walls shall demonstrate evidence of equivalent performance to waterstop joints as determined by the NRCS State Conservation Engineer.

C. Specific Criteria For Temporary, Unconfined Stacks of Manure and Derivatives Outside the Animal Production Area

This includes solid type manure and derivatives that are deposited for subsequent loading and spreading. Waste material having less than 16% solids shall not be stacked in the field. Storage of these materials shall be in facilities meeting the criteria in section V.B.1 and 2. Criteria for unconfined waste stacks are shown in Table 9.

Table 9 – Temporary, Unconfined Stacks of Manure and Derivatives Outside the Animal Production Area

1. Waste Consistencies[Note 1]	> 32% Solids	16% to 32% Solids [2]
2. Size & Stacking Period		
- Stacking Period	8 months	8 months
- Maximum Volume/Stack	≤ 40,000 cu ft	≤ 15,000 cu ft
- Frequency of Stacking Site Use	1 year out of 2	1 year out of 3
- Conservation BMPs above and below site[Note 3]	Yes	Yes
3. *Hydrologic Soil Groups*	B or C	B or C
4. Subsurface Separation Distance		
- Saturation (V.A.10)	≥ 3 ft.	≥ 3 ft.
- Bedrock	≥ 3 ft.	≥ 5 ft.
5. Surface Separation Distance		
- Wells[Note 4]	≥ 250 ft.	≥ 250 ft.
- Lakes	≥ 1,000 ft.	≥ 1,000 ft.
- Sinkholes, or other Karst Features	≥ 1,000 ft.	≥ 1,000 ft.
- Quarries	≥ 1,000 ft.	≥ 1,000 ft.
- Streams	≥ 300 ft.	≥ 500 ft.
- Wetlands and Surface Inlets	≥ 300 ft.	≥ 500 ft.
- Other Concentrated Flow	≥ 100 ft.	≥ 300 ft.
- Land Slope Down Gradient of Stack	≤ 6%	≤ 3%
- Floodplain	≥ 100 ft.	≥ 300 ft.

Note 1 Refer to AWMFH, Figure 9-1 for consistency values and Chapter 4 for % solids, for specific livestock types.

Note 2 16% to 32% solids represents waste at near saturation conditions where additions of free water from runoff, rain, or snowmelt can result in liquid flow conditions.

Note 3 Stacking sites shall employ conservation BMPs to divert overland flow, and provide buffering to downstream channels and lakes.

Note 4 Community water system wells may require larger separation distances (see NR 812).

VI. Considerations

Additional recommendations relating to design which may enhance the use of, or avoid problems with, this practice, but are not required to ensure its basic conservation function are as follows:

A. Consider using the companion documents located in Chapter 10 of the NRCS, Agriculture Waste Management Field Handbook (AWMFH).

B. Consider using the Waste Storage Design spreadsheet located in Chapter 10 of the NRCS AWMFH for design storage volume, liner thicknesses, and other calculations described in this standard.

C. Implementing erosion control methods on the top half of the inside slopes of earthen impoundments may reduce erosion.

D. Adding an auxiliary spillway, additional embankment height, or both may be needed to help protect the embankment, particularly for systems that store runoff. Factors such as downstream hazards and receiving waters should be evaluated in this consideration.

E. Non-polluted runoff should be excluded except where its storage is advantageous.

F. Separating solids from waste entering waste storage facilities may minimize the frequency of accumulated solid removal and benefit the pumping and application of the stored waste, however this may increase odors.

G. Consider outletting drainage systems to locations that will not directly enter surface water.

H. Adding or including steel reinforcement in slabs that will be scraped may prevent vertical displacement at crack locations.

I. Consider placing a permanent marker at the level one-foot below the top of the storage facility and a marker to designate the empty level. This consideration is particularly important for operations considering future herd expansion to WPDES permit size.

J. Monitoring and leakage collection systems should be considered for larger waste storage facilities, especially where the site assessment indicates the area is sensitive for groundwater impacts. This is particularly important for operations considering future expansion to WPDES permit size. Components of a designed system may include secondary containment (soil or synthetic), leachate collection, leachate recirculation, monitoring sumps, and/or monitoring wells. See NR 141 for regulations concerning monitoring wells.

K. Composting should be done in accordance with guidance from books such as "On-Farm Composting Handbook," NRAES-54, or equivalent.

L. Avoid locating facilities in areas where negative impacts to water resources may occur, particularly near streams or in floodplains.

M. Consider incorporating the following practices into the waste management system to reduce emissions of greenhouse gases, ammonia, volatile organic compounds, and odor:

- National Handbook of Conservation Practices (NHCP), Standards 366, Anaerobic Digestion-Controlled Temperature; 367, Waste Storage Cover; and 317, Composting Facility,
- Siting of livestock housing or feedlots, manure storage, and land application,
- Biofilters,
- Feed ration additives and adjustments,
- Manure additives, disinfectants, or aeration,
- Incorporation of manure when land-applied,
- Moisture and dust control within livestock housing areas, and
- Dead animal disposal plans.

For additional information on odor abatement see: ASAE EP379.2 Feb. 2003 Control of Manure Odors.

N. The following should be considered either singly or in combination to minimize the potential of or the consequences of sudden breach of embankments:

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

O. When designing impoundment embankments, consider using flatter slopes on the outside embankment slope. This would provide better

operation access and easier maintenance of the impoundment (i.e., pumping equipment access, mowing, and removal of woody vegetation.)

VII. References

USDA, NRCS, Agricultural Waste Management Field Handbook, Part 651, 1992.

USDA, NRCS Wisconsin Field Office Technical Guide (FOTG), Section IV, Practice Standards and Specifications.

Wisconsin Administrative Code, Department of Natural Resources, Chapters NR 141 and NR 812.

American Society of Testing Materials (ASTM) D-4318, D-5084, D-2488, and D-653.

American Concrete Institute (ACI) 318, 360, and 3630.

Manual of Steel Construction, American Institute of Steel Construction.

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

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

USDA, NRCS, Technical Release 74, Lateral Earth Pressures.

American Society of Agricultural Engineers (ASAE), EP378.3, EP393.2, and EP379.2.

American Society of Civil Engineers (ASCE), Minimum Design Loads for Buildings and Other Structures, SEI/ASCE 7-02.

Northeast Regional Agricultural Engineering Service, NRAES-54, On-Farm Composting Handbook, June 1992.

USDA, NRCS, National Handbook of Conservation Practices.

VIII. Definitions

% Fines (Table 1) – Percentage of given sample of soil which passes through a #200 sieve.

Animal Production Area (III) – Means any part of the livestock operation that is used for the feeding and housing of livestock. This includes the entire animal confinement and feeding area, and any adjacent manure storage areas, raw materials storage areas, and waste containment areas. This does not include pasture and cropland.

Bedrock (V.A.2.b.(1)) – Consolidated rock material and weathered in-place material with > 50%, by volume, larger than 2 mm in size.

Confined Lenses and Perched Water (V.A.10.a.(2)) – Confined lenses are water bearing deposits of stratified lacustrine material or material laid down by glaciers between deposits of less permeable till. Perched water is saturation found above and separated from the regional high water table.

Construction Joint (Table 5, Note 2) – These joints are used where a fresh pour of concrete abuts an existing recent pour. Construction joints where the steel is continuous through the joint are considered to be monolithic and liquid tight, if constructed properly.

Contaminated Runoff (II) – Runoff that has come through or across a barnyard or animal lot or feed storage area. It generally includes the runoff and any manure, sediment, feed, or other material carried in the runoff. It contains lower concentrations of contaminants than leachate from feed or manure.

Contraction Joints (Table 5, Note 2) – Contraction joints, often called control joints, are used to control the location of cracks caused by concrete shrinkage during setting and thermal changes.

Drainage System (V.A.10.a.(2)) – Water conveyance measures of specified capacity, location, and material that insure the removal of water to a free outlet.

Effective Height (III) – Height from the settled top of the embankment to the lowest point of the existing ground surface, measured at the centerline.

Expansion Joints – (Table 5, Note 2) – These joints are used to prevent crushing of abutting concrete or other structural units due to compressive forces developed during expansion caused by high temperature.

Footprint (V.A.2.b.(2)) – This is the area defined by the outside edge of the top surface of the waste when the facility is completely full. This is the top edge of the waste in a pond or the inside wall surface of a vertical walled structure.

Flood Prone Areas (V.A.3) – These include areas delineated as floodplains on Federal Emergency Management Agency (FEMA) maps, or local floodplain maps as well as areas along perennial streams (blue lines) shown on the United States

Geologic Survey quadrangle sheets that may be subject to out of bank flows.

Geosynthetic Clay Liner, GCL (Table 4) – A manufactured hydraulic barrier consisting of clay bonded to a layer or layers of geosynthetic materials.

Geomembrane (Table 3) – Very low permeability synthetic membrane liner or barrier used with any geotechnical engineering related material so as to control fluid migration in a man-made project, structure or system. (ASTM D 4439)

Hydrologic Soil Groups (Table 9) – Hydrologic Groups (HSG) are assigned for all soils mapped by USDA soil scientists. The hydrologic soil group, designated A, B, C, or D, indicates, in general, the amount of runoff to be expected from the soil after prolonged wetting. Soils in Group A yield very little runoff because they are rapidly permeable. Soils in Hydrologic Group D take water very slowly and yield large amounts of runoff. See Section II of the NRCS Wisconsin Field Office Technical Guide for HSG designations.

Impoundment (I) – A waste storage facility constructed of earthen embankments and/or excavations for the purpose of storing waste. An impoundment may be lined or unlined.

In-Place Earth (Table 1) – The entire surface of the bottom of the impoundment is excavated a minimum depth of one foot into the native soil.

Intimate Contact (Table 3) – Direct contact between liner materials (concrete, GCL, and geomembrane) and soil.

Karst (V.A.2.c.) – Refers to areas of land underlain by carbonate bedrock (limestone or dolomite). Typical land features in karst areas include sinkholes, disappearing streams, closed depressions, blind valleys, caves, and springs. See the companion document in Chapter 10 of the AWMFH for additional discussion of karst features.

Leachate (II) – Concentrated liquid waste which has percolated through or drained by gravity from a pile of manure, manure processing derivative, or animal feed. It contains much higher concentrations of contaminants than Contaminated Runoff.

Manure Processing Derivatives (II) – The by-products and waste components that are produced as a result of treatment and processing practices. These include, but are not limited to, the following waste components: separated sand, separated manure solids, precipitated manure sludges, supernatants, digested liquids, composted biosolids, process waters.

Nutrient Management Plans (III) – A planning document that outlines the requirements for managing the amount, form, placement, and timing of applications of plant nutrients to cropland.

Permeability (Table 2) – The coefficient of permeability (K) is a measure of the ability of soil to transmit liquids. It is used to compute the flow rate of liquid through a soil liner for specific conditions of soil thickness and fluid head.

Plasticity Index, PI (Table 1) – A soil property indicating moldability. Measured by ASTM D-4318.

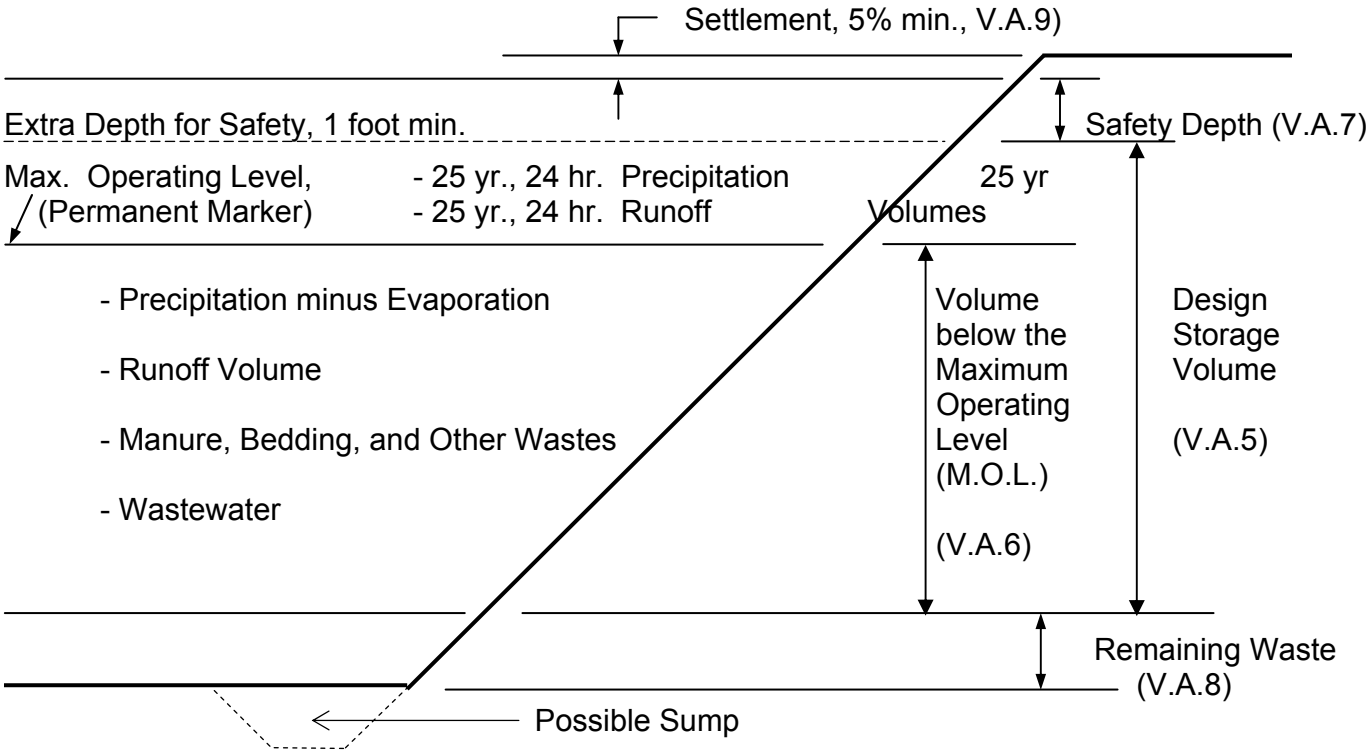
Regional High Water Table (V.A.10.a(1)) – The seasonal high free water surface of a large body of groundwater covering a region. All soil below the regional water table is saturated. Soil mottling (redoximorphic features) is not necessarily an indicator of the regional high water table, but is an indication of soil saturation.

Sinkholes (V.A.2.c) – Closed, usually circular depressions which form in karst areas. Sinkholes are formed by the downward migration of unconsolidated deposits into solutionally enlarged openings in the top of bedrock.

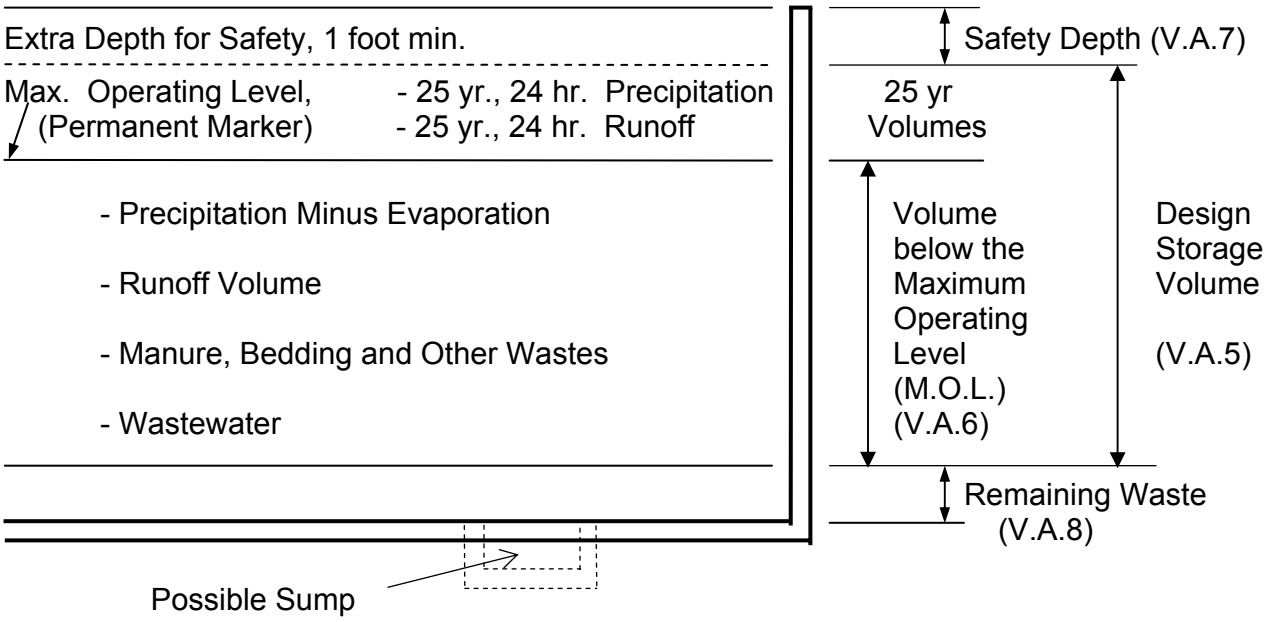
Structure (I) – A waste storage facility consisting of constructed surfaces, tanks, or walls for the purpose of storing waste above or below the ground surface. Structures may be constructed of concrete, steel, wood or other construction materials.

Wastewater (II) – Milking center waste, flush water, leachate from feed holding areas, and similar waste materials generated at the animal production area.

Figure 1 Design Storage Volume



IMPOUNDMENT



STRUCTURE