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* from agricultural sources in a manner which safeguards the environment.

This standard does not preclude the addition of other off farm organic materials, pending approval by the appropriate regulatory authority.

III. Conditions Where Practice Applies

This standard applies to:

- waste storage impoundments or structures up to 30 million gallons in size;
- 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;
- facilities that are part of a planned agriculture waste management system intended to 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.

This standard does not apply to the storage of human waste or the unstacked waste that accumulates in animal housing units.

IV. Federal, Tribal, State and Local Laws

Waste storage facilities shall comply with all federal, tribal, 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, tribal, state, or local laws governing waste storage facilities.

V. Criteria

The following criteria establish **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, sand and manure solids separation methods, 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 land spreading or waste distribution strategies, stabilization of organic by-products, separation of sand bedding, reducing pollutant loads, nutrient concentration, waste consistencies, odor control, energy production, and volume reduction.

The management assessment shall address the following as appropriate to the system being designed:

a. Waste Characterization.

1) Sources, volumes and consistency of manure, contaminated runoff, manure processing derivatives, leachate,

[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.

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 from the waste source to the storage facility.

e. Facility waste removal methods.

f. Storage facility liner possibilities and preferences.

g. Access needs and limitations.

h. Safety needs, including those to address the hazards of manure gases.

i. Labor and equipment needs.

j. Potential odor concerns.

k. 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 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, springs, floodplains, surface waters, surface drains, drain tile, utilities, overhead lines, *cultural resources*, and wetlands.

b. Test pit or soil boring logs, soil test results, a soil survey photo, and a narrative describing the design parameters that have been derived from the soils data. 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 these criteria shall be located in the footprint or no more than 100 feet from the footprint. These test pits/soil borings shall extend to bedrock, a free water surface, or to a minimum depth to ensure subsurface saturation and bedrock separation distances required in this standard are achieved.

3) Soil layers shall be described with respect to thickness, texture using the Unified Soil Classification System (USCS), Munsell color, presence and color of redoximorphic features (soil mottling), *gleyed soil* and moisture condition.

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

5) The upper elevation of all saturated layers encountered.

c. Locations of *sinkholes* and other *karst* features and direct conduits to groundwater 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)), V.A.2.b.(3), and V.A.2.b.(4). Test pits for clay borrow source evaluation shall be completed on a maximum 100-foot grid.

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

3. Flood Prone Areas

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. Potential failures and environmental impacts identified in the site assessment shall be addressed in the design phase, the operation and maintenance plan, and/or the emergency action plan.

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 site-specific 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:

- Manure, bedding and other wastes.
- 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.
- Normal precipitation less evaporation on the surface of the facility.
- Runoff volumes from the drainage area for design storage duration.
- 25-year, 24-hour precipitation on the surface of the facility.
- 25-year, 24-hour runoff volume from the drainage area.

6. Maximum Operating Level

The maximum operating level for liquid or slurry 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. State or local codes may require additional markers.

A contingency plan shall be implemented when the maximum operating level is reached.

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. Separation from Subsurface 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.

The definition of subsurface saturation is not intended for application in any context other than to protect structures installed from hydrostatic loadings.

a. For the purposes of this standard, factors used to identify subsurface saturation shall include observed saturation, gleyed soil, gray mottles, and soil color in conjunction with nearby surface water features. The highest subsurface saturation elevation in a test pit/soil boring will be identified by any of the following soil properties.

   1) Free water or wet soil identified by glistening, due to the slow release of water.

2) Gleyed soil, that may extend uninterrupted from an observed free water surface.

3) The presence of distinct gray redoximorphic features with a chroma of 2 or less based on Munsell color charts.

4) Depleted matrices having a value of 4 or more and chroma 2 or less based on Munsell color charts. In some cases soil parent materials have a natural color of 2 chroma or less or gleyed color that is not due to saturation. In these cases other indicators may be used: landscape position, elevation or soils in relation to nearby water features.

b. In soils not conducive to mottling, such as sand, the subsurface saturation elevation shall be established by evaluating the soil morphology of the soil profile. Other indicators that may be considered in making the determination are the position of the soil in the landscape, topography, nearby wetlands and well construction logs.

c. Subsurface saturation, if encountered shall not be drained (or have water-bearing layers removed) except as described for *perched conditions*. Perched conditions may be drained or water-bearing materials removed to achieve separation distances in the tables and relieve hydrostatic loads on the facility. Documentation to demonstrate that subsurface saturation is perched and of drainable extent or its effects otherwise eliminated shall be included in the site assessment. All *drainage systems* shall drain by gravity. The effect of temporary tailwater on the structure or liner and the effects of outletting to perennial and intermittent waterways shall be evaluated. A drainage system shall be located around the outside perimeter of the facility footprint and drain to a surface outlet. A drainage system may also be located around the outside perimeter of an impoundment floor within the facility footprint if the drainage system outlets to a manhole that can be monitored for liquid level, and pumped if needed to remove liquids.

d. If the site assessment indicates artesian features, a hydrogeologic and geotechnical evaluation of the site shall be completed to determine the site suitability for an in-ground waste storage facility.

e. Excavation of bedrock is permitted to achieve the required separation distance as specified in the tables. Bedrock shall not be removed by blasting. The exposed bedrock surface shall be evaluated to ensure a structurally sound base for liner or other soil material. Fractures or voids shall be treated to prevent migration of soil material. The surface of excavated bedrock shall have a positive grade, minimum of 1 percent, under and away from the storage facility, as to prevent any significant ponding on the rock surface. If bedrock is excavated, the material placed between the liner and the bedrock shall have a minimum of 20% passing the #200 sieve.

10. Safety Design

Safety design shall identify and minimize the hazards to animals and people. In particular, waste storage facility designs may create *confined spaces*, which may pose significant hazards in terms of the inhalation of poisonous gases, asphyxiation, or explosion. At a minimum, safety design shall include the following.

a. Warning signs, fences, ladders, ropes, rails, and other devices shall be provided, as appropriate. A fence is required unless the waste storage facility has vertical walls 5 feet above the ground surface or the waste storage facility has a cover that will support foot traffic. Fences shall discourage passage of livestock and people. The fence design needs to consider the production site conditions.

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

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

d. Confined spaces where human entry may occur shall be designed and operated in compliance with the provisions contained in ASABE EP470, Manure Storage Safety.

11. Engineering Design Documentation

Engineering design documentation shall be prepared in accordance with the criteria of this standard. The design documentation shall include:

- Management assessment,
- Site assessment,
- Operation and maintenance plan,
- Construction plan,
- Construction Quality Assurance Plan,
- Engineering computations, such as runoff, structural (unless using NRCS Standard Drawings), earthwork quantities, and volumetric computations for sizing of waste storage facility.

Documentation for siting temporary, unconfined stacks of manure and derivatives outside the animal production area shall include:

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

12. Construction Plans and Specifications

Construction plans and specifications for materials and installation shall be prepared to serve as a basis for construction of the practice. Construction plans and specifications shall include, as applicable:

- Plan view of system layout.
- Minimum of two cross sections, perpendicular to each other, for each waste storage facility.
- Structural details of components sufficient to clearly show the construction requirements.
- Details for joining different liner types or new liners to existing liners.
- Locations, sizes, and type of pipelines and appurtenances, including a profile of the waste transfer system.
- Requirements for foundation preparation and treatment, including bedrock treatment.
- References to components supplied by others (pumps, etc.).
- Vegetative requirements.
- Surface Drainage/Grading plan.
- Subsurface drainage details.
- Location of soil test pits within 100 feet of the facility footprint on the plan view, and a summary of soil logs plotted on the cross sections or profile.
- Identification of borrow source location(s)
- Safety features, roof covers, fencing, ladders, and safety signs.
- Construction site erosion control practices
- Approximate location of utilities and notification requirements.
- Specifications for materials and installation.
- Signature of the person responsible for the design, their engineering seal, NRCS Job Approval or WDATCP Agricultural Engineering Practitioner Certification level, the date, and a statement attesting the plans meet the requirements of the WI FOTG 313 Conservation Practice Standard.
- Other site-specific information necessary to construct the waste storage facility.

13. Construction Quality Assurance Plan

A construction quality assurance plan is required that describes the type and frequency of testing, items requiring observation, and the documentation required. The plan shall be implemented by a person with NRCS Job Approval, WDATCP Agricultural Engineering Practitioner Certification, a Wisconsin registered professional engineer, or staff under the direction and control of the person holding the aforementioned credentials. The construction quality assurance plan shall address all the following items:

- Contact information and responsibilities of key parties (including owner, designer, construction observer, and contractor).
- Pre-construction meeting agenda items (including quality assurance plan, construction plans and specifications,

design change procedures, and critical project-specific items).
- Observation and construction verification (including items to be verified, sequencing, layout/staking, notification requirements, and onsite materials testing documentation).
- Items to be noted on as-built plans, job diary, and other certification (attesting) documentation.

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. A narrative describing the purpose of the system or structure and how it is intended to operate. This narrative should include design criteria such as number and type of animals, type of waste, type of bedding, days of storage, method for emptying, vehicle sizes intended to operate within or near the system and other pertinent operational information.

b. A requirement that waste be removed and utilized in accordance with Wisconsin NRCS Field Office Technical Guide, Section IV (WI FOTG), Standard 590, Nutrient Management.

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

d. Requirements for monitoring the waste level relative to the permanent maximum operating level markers or indicators.

e. Requirements for inspecting and maintaining the structural components and mechanical systems.

f. A requirement to contact the appropriate regulatory authority for approval prior to storing any off-farm waste material in a waste storage facility that has been constructed using the criteria in this standard.

g. 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.

h. An emergency response plan to deal with failures, spills, or overflows at the animal production area to minimize environmental impacts.

i. Safety issues and procedures/requirements connected with waste storage facilities, including confined spaces.

15. Seeding and Mulching

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

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. 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 as a means of emptying the facility. Flow from an auxiliary spillway must discharge to secondary containment. Gravity flow between waste storage facilities is acceptable, however a secondary containment or additional storage capacity must be provided for the potential waste volume release. The following specific criteria apply to this practice:

1. Concrete Liners

Floors and slabs-used as a liner shall be designed for anticipated loads along with crack control and joint treatments stated below. Slabs on ground that will be subject to heavy truck or heavy equipment loads shall be designed in accordance with ACI 360, Guide to Design of Slabs-on-Ground and Concrete Floors on Ground, Chapter 5, Portland Cement Association (PCA).

a. Concrete with waterstop – The concrete shall contain distributed reinforcing steel, and all joints shall have embedded waterstop in accordance with Wisconsin FOTG Construction Specification 4, Concrete (Spec. 4).

A waterstop joint plan shall be included in the construction plans and contain the following: location of joints; cross-section details of joint(s); waterstop materials including factory fabricated corners, intersections, and transitions; installation specifications; and a quality assurance plan.

Construction quality assurance requirements for waterstop installation shall, at a minimum, include verification and documentation of the adequacy of the formwork, waterstop placement and welding prior to placement of the concrete, and continuous inspection during placement of concrete around embedded waterstop to ensure consolidation. The inspection shall be performed by a person under the direction and control of the individual responsible for approving the as-built construction plan. The person providing the inspection may not be an employee of the contractor or the owner.

A concrete mix in accordance with WI Spec. 4 shall be used.

Floors and slabs shall contain temperature and shrinkage reinforcing steel equal to or greater than shown in Table A. Steel shall be placed in the top ½ of the slab thickness with a minimum clear distance from the top of the slab of 1.5 inches.

Additional waterstop *control joints* shall be planned where stresses can be predicted to exceed the reinforcing steel's ability to restrain cracking and minimize leakage.

All waterstop joints in areas subject to equipment traffic shall be designed with a dowel system to transfer the load across the joint. Slab thickness changes at these joints shall be made with a minimum transition ratio of one inch of thickness change over ten inches of run (10:1).

Table A
Reinforcing Steel for Temperature and Shrinkage Control

Control Joint Spacing			
Concrete Thickness	**Rebar Size (grade 60) and Spacing**		
	≤ 100 ft.	≤ 150 ft.	≤ 175 ft.
≤ 5 "	#4 @ 18"	#4 @ 15"	#5 @ 18"
≤ 6 "	#4 @ 18"	#5 @ 18"	#5 @ 15"
≤ 7 "	#4 @ 15"	#5 @ 15"	#5 @ 12"
≤ 8 "	#5 @ 18"	#5 @ 15"	#5 @ 12"

b. Concrete soil composite – The concrete is in *intimate contact* with the soil and the concrete and soil work together to reduce seepage losses. Floors and slabs shall be a minimum of 5 inches thick with reinforcing consisting of #4 bars spaced at 18 inches on center each way. No control 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*. Drain tile and/or drain fill material shall be kept outside of the soil component of the composite liner.

2. Impoundment Design Criteria

Soil criteria in Tables 1 through 5 refer to mineral soils. Construction shall not occur on or with organic soils.

Table 1 contains the criteria for constructing waste impoundments into existing soils with recompaction of the upper 1 foot of soil. Tables 2 through 5 contain the criteria for impoundments with liners.

A combination of liners is acceptable. There shall not be more than two liner types used in any one facility. The sump liner does not apply as a liner type in this regard. The liners shall be joined so as to preserve the performance and integrity of all liner types.

Concrete walls used within 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, and resist agitation scouring.

a. Embankment Requirements

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

2) 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.

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

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

5) For liquid storage facilities with greater than one acre of surface area and where wave action is a concern, increase the embankment height to account for the calculated wave height, or provide other means to address the wave action concern.

6) 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

7) The sum of interior and exterior side slopes shall be ≥ 5:1 with no slope steeper than 2:1. All slopes must be stable. Additional embankment requirements are contained in the tables.

8) Compaction shall be according to WI FOTG Construction Specification 204, Earthfill for Waste Storage Facilities (Spec. 204).

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

1. Size			
Design Storage Volume		≤ 300,000 cu. ft.	> 300,000 cu. ft.
Manure Produced at Farm per Year		≤ 600,000 cu. ft.	> 600,000 cu. ft.
Waste Characteristics		≥ 4% manure solids in stored waste, ruminant animals only	All
2. Soils [Note 2]			
% Fines		≥ 40%	≥ 40%
Plasticity Index (PI)		≥ 7	≥ 12
Total Thickness, (measured perpendicular to storage surface, includes thickness of recompacted layer)		≥ 5 ft.	≥ 5 ft.
Thickness of Recompacted layer (upper 1' of soil)		≥ 1 ft.	≥ 1 ft.
Construction Specification (for recompacted 1' layer)		WI Spec 204[Note 4]	WI Spec 300[Note 5]
3. Separation Distances			
- Well Distance [Note 3]		≥ 250 ft.	≥ 250 ft.
- Sinkholes		≥ 800 ft.	≥ 400 ft.
- Subsurface Saturation (V.A.9)		≥ 6 ft.	≥ 6 ft.
- Bedrock		≥ 6 ft.	≥ 6ft.
4. Impoundment			
Inside Slope		2.5:1 or flatter	
Embankment		Shall be constructed with material meeting criteria in Table 1 from the inside surface to the embankment centerline, in accordance with the applicable compaction specification for the recompacted 1' layer.	
5. Other			
Scour Protection	Agitation and Pumping Locations	Minimum 20 ft. wide x 30 ft. long 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 the top of the facility.	
	Scraping and Other Mechanical Means of Removing Solids and Sand	Protect with hard surfacing designed for the expected conditions and loads, a minimum of 4 in. thick.	
Existing Field Drain Tile		Additional site investigation shall be completed to determine the presence of existing field drain tile within 100 ft. of the footprint of the facility. Any tile found must be abandoned or removed.	

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

Note 2 Soil tests shall be completed in a laboratory on representative samples of soil beneath the proposed liner grade at a rate of 1 test per 15,000 ft^2 of facility footprint, with a minimum of two tests. The PI shall be determined in accordance with ASTM D4318 and the percent fines in accordance with ASTM D1140.

Note 3 Community water system wells may require larger separation distances (see NR 811).

Note 4 WI FOTG Construction Specification 204, Earthfill for Waste Storage Facilities.

Note 5 WI FOTG Construction Specification 300, Clay Liner;

Table 2 - Clay Liner Criteria for Impoundments

1. Size		
Design Storage Volume	≤ 300,000 cu. ft.	> 300,000 cu. ft. Note 1
Manure Produced at Farm Per Year	≤ 600,000 cu. ft.	> 600,000 cu. ft.
2. Clay Liner Requirements		
Thickness, Bottom	≥ 3 ft.	As specified in Table 2A
Thickness, Sides	≥ 5 ft.	≥ 5 ft.
% Fines Note 2	≥ 50%	≥ 50%
Plasticity Index (PI) Note 2	≥ 12	≥ 12
Permeability, cm/sec. Note 3	—	≤ $1x10^{-7}$
Construction Specification	WI Spec 204 Note 4	WI Spec 300 Note 5
3. Separation Distances		
Wells Note 6	≥ 250 ft.	≥ 250 ft.
Sinkholes	≥ 400 ft.	≥ 400 ft.
Subsurface Saturation (V.A.9)	≥ 4 ft.	As specified in Table 2A
Bedrock	≥ 4 ft.	As specified in Table 2A
4. Other		
Liner Protection Required		
Agitation and Pumping Locations	Minimum 20 ft. wide x 30 ft. long 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 the top of the facility.	
Scraping and Other Mechanical Means of Removing Solids and Sand	Protect with hard surfacing designed for the expected conditions and loads, a minimum of 4 in. thick.	

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 The PI shall be determined in accordance with ASTM D4318 and the percent fines in accordance with ASTM D1140.

Note 3 Permeability shall be determined by ASTM D5084 from undisturbed samples of the compacted liner.

Note 4 WI FOTG Construction Specification 204, Earthfill for Waste Storage Facilities.

Note 5 WI FOTG Construction Specification 300, Clay Liner.

Note 6 Community water system wells may require larger separation distances (see NR 811).

Table 2A – Clay Liner Thickness Note 1 (Bottom) and Separations

Impoundment Depth Note 2 (feet)	Liner Thickness (feet)	Separation to Subsurface Saturation and Bedrock (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
20.1 – 22	≥ 5.0	≥ 6.0
22.1 – 24	≥ 5.4	≥ 6.4
24.1 - 25	≥ 5.7	≥ 6.7

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 Polyethylene (HDPE) or 60 mil Linear Low Density Polyethylene (LLDPE) or 60 mil Ethylene Propylene Diene Monomer (EPDM). The geomembrane shall be installed with intimate contact to the soil below [Note 1]	
2. Soils (Directly Below Liner)[Note 2]			
% Fines		≥ 40%	≥ 40%
Plasticity Index (PI)		≥ 7	—
Thickness		≥ 2 ft.	≥ 4 ft.
Compaction of Placed Material		WI Spec 204[Note 3]	WI Spec 204[Note 3]
Subgrade preparation requirements		WI Spec 202 or 205[Note 4]	WI Spec 202 or 205[Note 4]
3. Separation Distances			
Well Distance [Note 5]		≥ 250 ft.	≥ 250 ft.
Sinkholes		≥ 400 ft.	≥ 400 ft.
Subsurface Saturation (V.A.9)		≥ 4 ft.	≥ 6 ft.
Bedrock		≥ 4 ft.	≥ 6 ft.
4. Impoundment			
Inside Slope		2.5:1 or flatter.	
5. Other			
Liner Protection Required	Agitation and pumping locations[Note 6]	Minimum dimension of 20 ft. wide x 30 ft. long concrete pad or sump in bottom and 20 ft. wide ramp with 18 in. curb to the top of the facility with provisions for liner integrity. Ramps shall be located to be accessible to the agitation equipment used.	
	Scraping and other mechanical means of removing solids and sand [Note 7]	Protect with hard surfacing designed for the expected conditions and loads.	
Vent system		Required for all facilities. The system shall be designed in such a manner to vent gas from the system. Waste and runoff shall be prevented from entering the venting system. Liquid detection points may be installed as part of the 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. The PI shall be determined in accordance with ASTM D4318 and the percent fines in accordance with ASTM D1140.

Note 3 WI FOTG Construction Specification 204, Earthfill for Waste Storage Facilities.

Note 4 WI FOTG Construction Specification 202, Polyethylene Geomembrane Lining and 205, Ethyl Propylene Diene Monomer (EPDM) Geomembrane Lining.

Note 5 Community water system wells may require larger separation distances (see NR 811).

Note 6 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 ensure stability.

Note 7 Sand bedding may be used in conjunction with a geomembrane liner, but the design must include a method to remove sand from the waste stream before it enters the waste storage facility.

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

1a. Soils (Directly Below Liner)[Note 1]			
% Fines		≥ 20%	≥ 20%
Plasticity Index (PI)		≥ 7	—
Thickness (from bottom and sides)		≥ 2 ft.	≥ 3 ft.
Compaction of placed material		WI Spec 203[Note 2]	WI Spec 203[Note 2]
1b. Liner Cover Material Thickness			
Bottom		≥ 1 ft.	≥ 1 ft.
Side Slopes		≥ 2 ft.	≥ 2 ft.
Compaction of Placed Materials		WI Spec 203[Note 2]	WI Spec 203[Note 2]
2. Separation Distances			
Well Distance [Note 3]		≥ 250 ft.	≥ 250 ft.
Sinkholes		≥ 400 ft.	≥ 400 ft.
Subsurface Saturation (V.A.9)		≥ 4 ft.	≥ 5 ft.
Bedrock		≥ 4 ft.	≥ 5 ft.
3. Impoundment			
Inside Slope [Note 4]		3:1 or flatter	
4. Other			
Liner Protection	Agitation and Pumping Locations	Minimum dimension of 20 ft. wide x 30 ft. long x 4 in. thick concrete pad or sump in bottom and 20 ft. wide ramp or a 16 ft. wide ramp with 18 in. high curb to top of facility. GCL continues under the concrete pad or sump. Poured in place concrete slabs shall meet requirements of Section V.B.1.	
	- Scraping and Other Mechanical Means of Removing Solids and Sand	Sand bedding may be used in conjunction with a geosynthetic clay liner, but the design must include a method to remove sand from the waste stream before the waste is stored in the liner or the liner must be protected to allow mechanical removal of the sand. Poured in place concrete slabs shall meet requirements of Section V.B.1.	
GCL Material [Note 5]		Non-woven needle punched.	

[Note 1] The liner is in intimate contact with the soil, and the two work together to reduce seepage losses. The PI shall be determined in accordance with ASTM D4318 and the percent fines in accordance with ASTM D1140.

[Note 2] WI FOTG Construction Specification 203, Geosynthetic Clay Liner.

[Note 3] Community water system wells may require larger separation distances (see NR 811).

[Note 4] The GCL and soil cover shall be stable at the designed side slope.

[Note 5] The liner shall be installed according to manufacturer's specifications and WI FOTG Construction Specification 203, Geosynthetic Clay Liner.

Table 5 - Concrete Liner Criteria for Impoundments

	Concrete with Waterstop [Note 1]	Concrete - Soil Composite [Note 2]			
1. Soils (Directly Below Liner) [Note 2]					
% Fines	—	≥ 20%	≥ 20%	≥ 40%	Foundry Sand [Note 5]
Plasticity Index (PI)	—	≥ 7	—	≥ 12	—
Thickness (bottom and sides)	—	≥ 1.5 ft.	≥ 3 ft.	≥ 8 Inches	≥ 1.5 ft.
Compaction of Placed Material	WI Spec 204	WI Spec 204	WI Spec 204	WI Spec 300	WI Spec 204
2. Separation Distances [Note 6]					
Sinkholes Well Distance [Notes 3 and 4]	≥ 400 ft. ≥ 100 ft.	≥ 400 ft. ≥ 100 ft.	≥ 400 ft. ≥ 100 ft.	≥ 400 ft. ≥ 100 ft.	≥ 400 ft. ≥ 100 ft.
Subsurface Saturation (V.A.9)	≥ 2 ft. (1 ft. for sump)	≥ 4 ft. (3 ft. for sump)	≥ 5 ft. (4 ft. for sump)	≥ 3 ft. (2 ft. for sump)	≥ 4 ft. (3 ft. for sump)
Bedrock	≥ 2 ft. (1 ft. for sump)	≥ 4 ft. (3 ft. for sump)	≥ 5 ft. (4 ft. for sump)	≥ 3 ft. (2 ft. for sump)	≥ 4 ft. (3 ft. for sump)
3. Impoundment					
Inside Side Slopes	2.5:1 or flatter	2:1 or flatter			

Note 1 Refer to section V.B.1.a. for design criteria specific to concrete with waterstop.

Note 2 Refer to section V.B.1.b. for design criteria specific to concrete composite liners. The PI shall be determined in accordance with ASTM D4318 and the percent fines in accordance with ASTM D1140.

Note 3 Community water system wells may require larger separation distances (see NR 811)

Note 4 For operations subject to NR 243, the private or non-community Well Separation Distance is 250 ft.

Note 5 The foundry sand must be ferrous foundry sand with only minimal concentrations of hazardous constituents, cores and other over-size materials crushed or removed, and at least 5% bentonite content. A site specific WDNR approval is required under NR 538 that may specify greater separation distances and parameters not addressed by this standard. An NR 538 Category I or II ferrous foundry sand may be appropriate.

Note 6 Lesser separation distances shown for sumps apply only when the total sump area is less than 15% of the floor footprint area of the waste storage facility.

3. 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.
Subsurface Saturation and Bedrock	See Table 5

Note 1 For operations subject to NR 243, the private or non-community well separation distances is 250 feet, community water system wells may require larger separation distances (see NR 811).

Structures 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 structures 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 design calculations shall use a minimum design compressive strength of 3,500 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.

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, frost or ice pressure, and load combinations in compliance with this standard and applicable local building codes.

If a dense ice cover can be expected the designer shall account for the additional point load associated with an ice sheet against a vertical wall.

Where the stored waste is not protected from precipitation, use 65 $lb/ft^2/ft$ of depth as the design internal lateral pressure. Use an internal lateral pressure of 72 $lb/ft^2/ft$ of depth for sand-laden manure. A value of 60 lb/ft^2 may be used where the stored waste is protected from precipitation and will not become saturated. Lesser values may be used if supported by measurement of actual pressures of the waste to be stored.

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.

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.

Structures 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 7-10, 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.

d. Concrete Joints

Wall Joints – Cast-in-place vertical walls shall have one control joint with embedded waterstop every 100 feet with a minimum of two control joints per four-sided structure. Vertical wall control joints are not required in structures with less than 100 feet of wall length.

Waterstop shall be embedded or expansive in accordance with WI Spec. 4. The type of waterstop is based on the joint movement criterion indicated below.

If there is no embedded waterstop at the wall base, the wall joint waterstop shall be cast 4 inches into the footing. If there is an embedded waterstop between the footing and the bottom of the wall, the wall joint waterstop shall be welded to a factory fabricated intersection at the base of the wall.

An embedded waterstop shall be installed at the wall to footing intersection if the joint is designed for movement. Either an expansive or embedded waterstop shall be installed at this joint if it is not designed for movement (fixed).

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

Floor Joints – Floor joints in vertical walled structures, if used, shall extend through the footing and continue to the top of the vertical wall. Joints shall meet the requirements of section V.B.1. of this standard.

Transitions from concrete wall footings to concrete slabs shall be made at a ratio of one inch of thickness change to one inch of run (1:1) or flatter.

Table 7 – Presumptive Allowable Bearing Stress Values Note 1

Class of Materials	Allowable Foundation Pressure (psf)
Crystalline Bedrock	12,000
Sedimentary and Foliated Rock	4,000
Sandy Gravel or Gravel (GW and GP)	3,000
Sand, Silty Sand, Clayey Sand, Silty Gravel, Clayey Gravel (SW, SP, SM, SC, GM and GC)	2,000
Clay, Sandy Clay, Silty Clay, Clayey Silt, Silt and Sandy Silt (CL, ML, MH and CH)	1,500

Note 1 International Building Code (IBC), 2006, International Code Council (ICC)

Table 8 - Lateral Earth Pressure Values Note 1

Soil		Equivalent Fluid Pressure (lbs./sq. ft./per ft. of depth)			
		Above Water Table		Below 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 D2488 and D653.

Note 3 Includes hydrostatic pressure from subsurface saturation.

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.

C. Specific Criteria for Permanent Stacking Facilities at the Animal Production Area

This criteria does not apply to the unstacked wastes that accumulate in animal housing units.

This criteria applies to stacking the following materials in a confined manner at the animal production area:

- Separated manure solids
- Compost
- Dewatered, recycled sand storage
- Poultry litter (turkey or broiler operations)
- Dry poultry layer manure
- Bedded manure (>50% solids)
- Waste feed (<50% moisture)

Facilities must be designed to prevent run-on and runoff, and operated to prevent ponding and significant hydrostatic head. Facilities may commonly be located near the ground surface, but may be above or below ground. Criteria for stacking facilities are shown in Table 9. **Solids stacking within the animal production area may also be done in an impoundment (Tables 1 through 5) or section V. B. 3.** Methods to ensure ongoing compliance with the criteria must be incorporated into the Operation and Maintenance Plan.

Table 9 – Liner Criteria for Permanent Solids Stacking Facilities at the Animal Production Area Note 1

	Roofed		**Not Roofed** Note 2	
	Work Surface Note 3	No Surface Note 4	Work Surface Note 3	No Surface Note 4
1. Soils In-Place Liner Note 4				
% Fines	≥ 30%	≥ 30%	≥ 40%	≥ 40%
Plasticity index (PI)	-	≥ 7	-	≥ 7
Thickness	≥ 2 ft.	≥ 2.5 ft.	≥ 3 ft.	≥ 5 ft.
2. Soils Compacted Liner Note 4				
% Fines	≥ 30%	≥ 40%	≥ 40%	≥ 40%
Plasticity index (PI)	≥ 5	≥ 7	≥ 7	≥ 7
Thickness	≥ 1.5 ft.	≥ 2 ft.	≥ 2 ft.	≥ 3 ft.
Compaction	WI Spec 204	WI Spec 204	WI Spec 204	WI Spec 204
3. Separation Distances				
Sinkholes	≥ 400 ft.	≥ 400 ft.	≥ 400 ft.	≥ 400 ft.
Well distance Note 5	≥ 100 ft.	≥ 100 ft.	≥ 100 ft.	≥ 100 ft.
Subsurface Saturation	≥ 3 ft.	≥ 3 ft.	≥ 5 ft.	≥ 5 ft.
Bedrock	≥ 3 ft.	≥ 3 ft.	≥ 5 ft.	≥ 5 ft.
4. Stacking Area	Stacking area not to exceed 7 acres for unroofed managed compost, 2 acres for sand, 2 acres for roofed facilities, or 1 acre for all other materials.			

Note 1 Solids and sand stacking facilities, treatment areas and other production area structures and systems may be subject to surface water setbacks and other requirements under state and local rules. MOL requirements do not apply to this Table.

Note 2 Facilities that are not roofed must have floors sloped to control surface drainage; and, unless used only for properly managed composting, all leachate and runoff (up to the 25-yr., 24-hr. storm) must be managed as follows:

Collect leachate and runoff in a facility suitable for liquid containment (Tables 1 through 6) or transfer receptacle (WI FOTG Standard 634), until land applied in accordance with WI FOTG Standard 590, or provide other acceptable treatment for runoff only. Acceptable treatment methods for runoff may only include those described in WI FOTG Standard 635 or WI FOTG Standard 629.

Note 3 The work surface may be constructed of any of the following: minimum 3 in. for asphalt; minimum 4 in. for concrete; or minimum 8 in. for macadam, and designed for anticipated equipment loads. Refer to industry standard design criteria for each work surface material. The purpose of the work surface is to protect the liner material.

Note 4 Facilities without a work surface must be operated to minimize rutting and removal of the soil liner. Ruts must be repaired and the soil liner thickness maintained after material handling. Stacking height is not to exceed 10 ft. The PI shall be determined in accordance with ASTM D4318 and the percent fines in accordance with ASTM D1140.

Note 5 Additional separation distances to wells may be necessary on WDNR regulated farms.

D. **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 10.

Conservation BMPs shall be used above stacking sites to divert overland flow, and below stacking sites to provide containment or buffering to downstream channels and lakes.

The maximum amount of manure that is stacked on any one field shall be limited to the nutrient needs of fields adjacent to the stacking site in accordance with a 590 nutrient management plan.

Table 10 – Temporary, Unconfined Stacks of Manure and Derivatives Outside the Animal Production Area

1. Waste Consistencies Note 1		
	> 32% Solids	16% to 32% Solids Note 2
2. Size & Stacking Period		
Stacking Period	8 months	8 months
Maximum Volume/Stack	≤ 40,000 cu ft.	≤ 15,000 cu ft.
Maximum Number of Stacks/40 acres Note 3	–	2
Frequency of Stacking Site Use	1 year out of 2	1 year out of 3
3. *Hydrologic Soil Groups*		
	B or C	B or C
4. Subsurface Separation Distance		
Subsurface Saturation	≥ 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.
Areas of Concentrated Flow	≥ 100 ft.	≥ 300 ft.
Land Slope Down Gradient of Stack	≤ 6%	≤ 3%
Floodplain	≥ 100 ft.	≥ 300 ft.
Tile lines	≥ 40 ft.	≥ 40 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 The separation distance between stacks shall be at least 100 feet.

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 large volumes of runoff. Factors such as downstream hazards and receiving waters should be evaluated in this consideration. Locate the auxiliary spillway to direct waste overflows away from receiving waters or sensitive areas. See Consideration N below for more ways to address environmental concerns.

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 EP379.4 Jan. 2007, Management 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:

- 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.)

P. As-Built Plans and other certification (attesting) documentation, a required element of a Construction Inspection Plan, is normally required to be submitted to the permitting or cost-sharing authorities prior to placing the waste storage facility in service.

Q. Consider designing a waste storage facility to contain more than the 25-year, 24-hour rainfall event if: due to site conditions, a rainfall event greater than the 25-year, 24-hour storm is likely to cause a significant discharge to surface water; or the operation will become a permitted CAFO and it houses swine, poultry or veal calves, and the waste storage facility will be uncovered.

R. Well construction logs within ½ mile of the proposed facility, available from the Wisconsin Geologic and Natural History Survey and/or the Wisconsin Department of Natural Resources may be included to promote understanding of water supply aquifers in the area along with area hydrogeology.

S. Consider increasing the horizontal reinforcement ratio beyond the minimum required in ACI 318 for vertical crack control in concrete walls.

T. A secondary liner directly below concrete joints with waterstops should be considered where the site assessment indicates the area is sensitive to leakage impacts.

VII. References

American Society of Civil Engineers (ASCE), Minimum Design Loads for Buildings and Other Structures, SEI/ASCE 7-10.

American Society of Agricultural and Biological Engineers (ASABE), Standards EP378.3, EP393.2, EP379.4, and EP470.

American Society of Testing Materials (ASTM) D1140, D4318, D5084, D2488, and D653.

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

Manual of Steel Construction, American Institute of Steel Construction.

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

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

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

USDA, NRCS, National Handbook of Conservation Practices.

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

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

Wisconsin Administrative Code, Department of Natural Resources, Chapters NR 141, NR 243 and NR 812.

VIII. Definitions

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

Animal Production Area (V.A.1.) – 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)) – The solid or consolidated rock formation typically underlying loose surficial material such as soil, alluvium or glacial drift. Bedrock includes but is not limited to limestone, dolomite, sandstone, shale and igneous and metamorphic rock.

Note: Although solid or consolidated bedrock can sometimes be removed with typical excavation equipment, these materials are included in the above definition.

Confined Space (V.A.10) – Confined Space is a space that 1) contains or has the potential to contain a hazardous atmosphere; 2) is large enough and so configured that a person can bodily enter; 3) has limited or restricted means for entry or exit; and 4) is not designed for continuous human occupancy.

Construction Joint (V.B.1.b.) – 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.

Control Joints (V.B.1.a.) – Control joints, often called contraction joints, are used to control the location of cracks caused by concrete shrinkage during setting and thermal changes. Steel reinforcement is interrupted in control joints with embedded waterstop.

Cultural Resources (V.A.2.a.) – Cultural resources are the traces of any past activities and accomplishments of people. They include tangible traces such as historic districts, sites, buildings, structures, historical documents and cemeteries. They also include traces of less tangible objects such as dance forms, aspects of folk-life, cultural or religious practices, and some landscapes and vistas.

Drainage System (V.A.9.c.) – 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 – (V.B.1.b.) – 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.

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.

Footprint (V.A.2.b.2)) – This is the horizontal area within the perimeter of a facility liner, or the perimeter of a work surface that may cover a liner. For a liquid or solids containment facility, the footprint is the maximum horizontal extent of containment. For a liquid impoundment facility or pond, the footprint is normally defined by the inside top of the embankment. For a solids storage facility, the footprint is normally defined by the edge of the pad, the curb on a pad, or the inside surface of bunker walls.

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)

Gleyed Soil (V.A.2.b.3)) – A soil condition resulting from prolonged soil saturation, which is manifested by the presence of bluish or greenish colors through the soil mass or in mottles (spots or streaks) among the colors. Gleying occurs under reducing conditions, by which iron is reduced predominantly to the ferrous state.

Hydrologic Soil Groups (Table 10) – 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 (V.B.1.b.) – 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.

Perched Conditions (V.A.9.c.) – Perched conditions describe a soil moisture regime where saturated soil is located above unsaturated soil.

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.

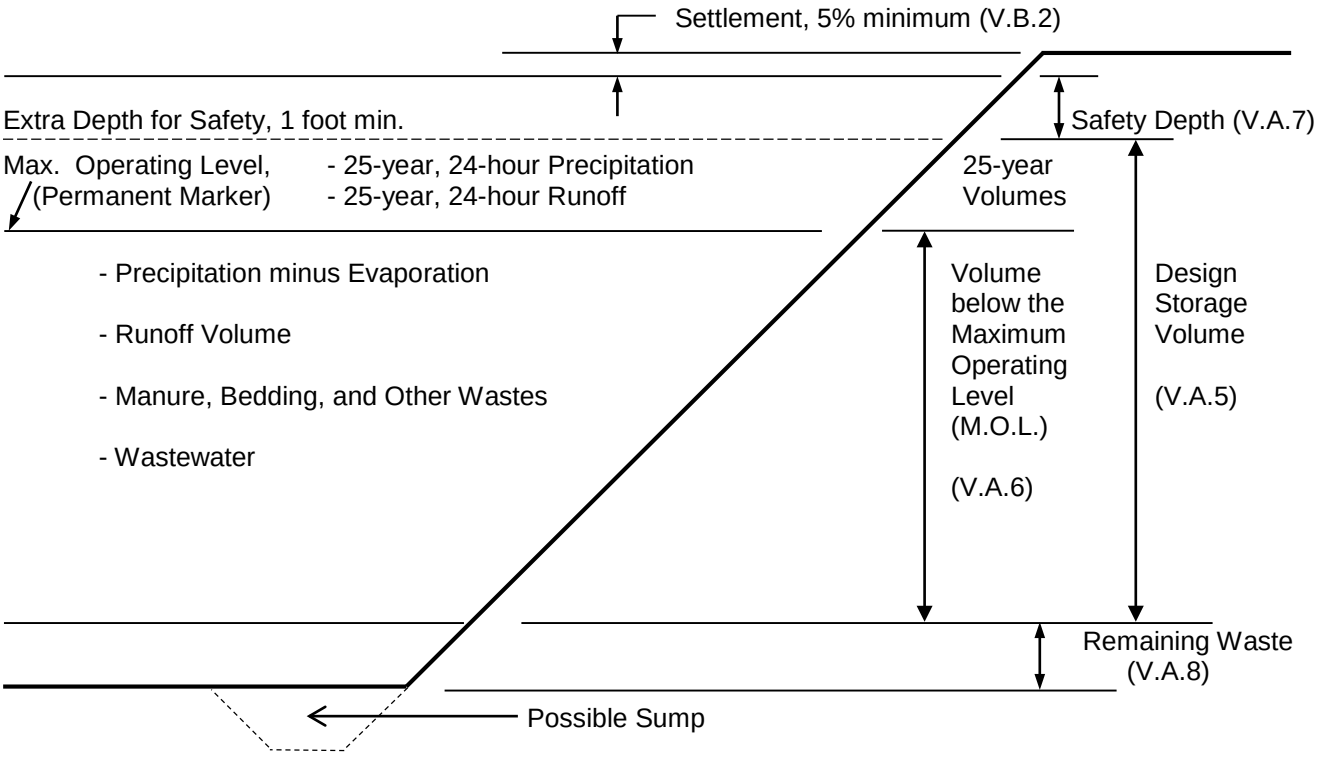
Plasticity Index, PI (Table 1) – A soil property indicating moldability. Measured by ASTM D4318.

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.

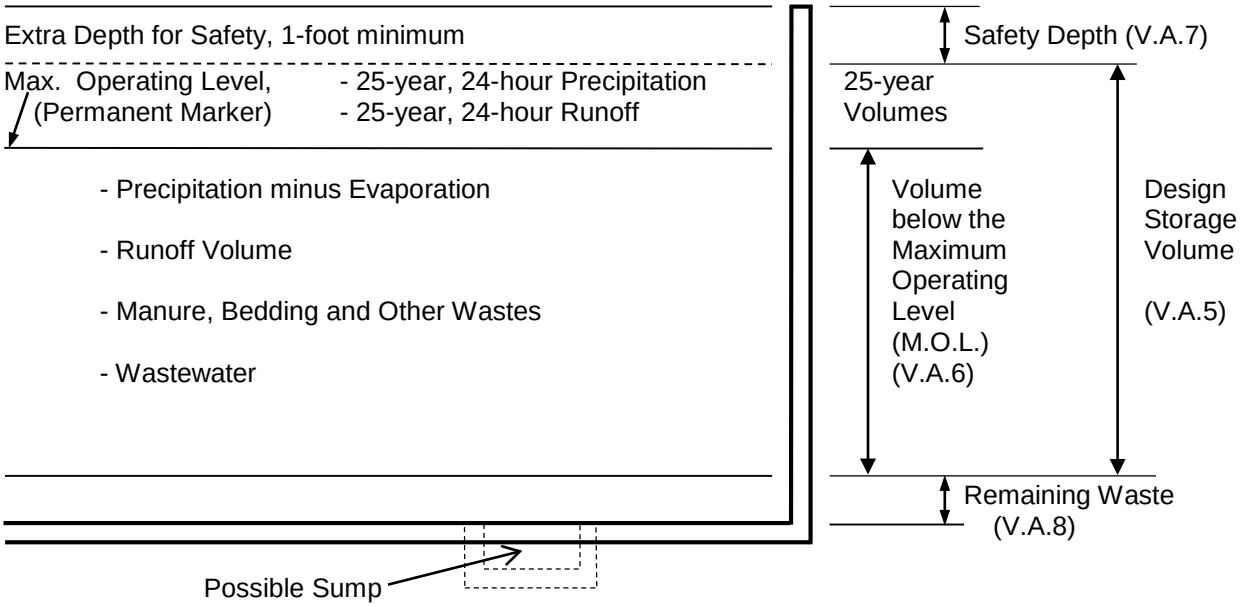
Structure (I) – A waste storage facility consisting of constructed surfaces, tanks, or walls for the purpose of storing waste above or below the ground surface. Structures may be constructed of concrete, steel, wood or other construction materials.

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