WASTE STORAGE FACILITY

(no.)

CODE 313

Natural Resources Conservation Service
Conservation Practice Standard

I. Definition

A waste storage impoundment 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, waste water, and *contaminated runoff*[1] 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; and
- temporary unconfined manure stacks.

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, or sludge. These types of facilities are defined and regulated under various codes administered by the Wisconsin Department of Natural Resources (WDNR).

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 - 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 characterization. The management assessment shall address the following:

   a. Waste Characterization

      (1) Sources and volumes of manure and waste water
      (2) Animal types
      (3) Bedding types
      (4) Consistency: liquid manure; dilute (milkhouse, rinse, cleanup, runoff); solid (pack, bedded, stall, feed waste)

   b. Land base available for utilization of waste

   c. Planned storage period

   d. Waste handling and transfer methods

   e. Facility waste removal methods

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

f. Storage liner possibilities and preferences

g. Access needs

h. Safety needs

i. Labor and equipment needs

j. Odor, aesthetics, and animal health

k. Expansion needs

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 manure 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 drains, drain tile, utilities, overhead lines, cultural resources, and wetlands.

   b. Test pit logs, soil test results, and a soil survey photo, if available. Test pits or test holes shall include:

      (1) The number and distribution needed to characterize the subsurface with a minimum of three. Additional test pits shall be conducted if inconsistency within or between test pits is found in terms of the criteria in Tables 1-5.

      (2) A minimum of one per transfer system, unconfined manure stack area (Table 6), or storage facility less than 500 sq. ft. in area.

      (3) A minimum depth to ensure separation distances in Tables 1-5 of this standard and Table 1 in NRCS Field Office Technical Guide (FOTG) Section IV, Standard 634, Waste Transfer,

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

      (5) 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 and elevations of *sinkholes* and other *karst* features within 1,000 ft. of the facility.

   d. Locations and elevations, soil volumes, soil samples, and reclamation plans of any borrow areas.

   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 ft. above the maximum elevation of flow resulting from a 100-yr., 24-hr. rainfall event.

4. **Design Storage Volume** - Design storage volume shall be calculated with the procedures described in Chapter 10 of the NRCS Agricultural Waste Management Field Handbook (AWMFH). 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, waste-water, and other wastes.

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

c. 25-yr., 24-hr. precipitation on the surface of the facility.

d. Normal runoff volumes from the drainage area.

e. 25-yr., 24-hr. runoff volume from the drainage area.

5. ***Freeboard*** - A minimum of 1 ft. of depth shall be added to storage facility design.

6. **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 2 ft. shall be added to storage depth for facilities with side slopes and 1 ft. for vertical walled facilities. The additional storage depth can be reduced if a sump is installed.

7. **Embankment Requirements**

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

b. A core trench shall be required if the fill height at centerline is ≥ 10 ft. Minimum dimensions of the core trench shall be 8 ft. bottom width, 2 ft. depth, and 1:1 or flatter side slopes.

c. Top of embankment shall be ≥ 1ft. above the surrounding grade. Any diversion along the embankment shall have capacity for 25-yr., 24-hr. flow plus 0.5 ft. of freeboard.

d. Additional fill for settlement shall be 5% of the fill height.

e. Top width shall be a minimum of 8 ft. when the embankment height is 15 ft. or less. An additional 2 ft. of top width shall be added for every additional 5 ft. of embankment height.

f. Sum of interior and exterior side slopes shall be ≥ 5:1 with no slope steeper than 2:1, except as specified in Table 4.

g. Compaction shall be according to NRCS Wisconsin Construction Specification 204.

8. **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.

b. The following criteria apply to bedrock:

(1) Excavation of bedrock is permitted to achieve the required separation. Excavation of consolidated rock material is limited to 25% of the storage facility floor area.

(2) 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.

9. **Concrete Slabs** - Slabs for liners and structure floors shall be designed according to Table 5 footnotes.

Slabs for uses other than liners such as protection, scraping, and access shall be a minimum of 4 in. thick with control joint spacing and steel as required for anticipated

loads and usage (except for Table 3, footnote 3).

10. **Safety Design** - Safety design shall identify and minimize the hazards to animals and people. At a minimum, safety design shall include:

    a. Fences, gates, grates, or covers to restrict access of animals or people, and signs where access is possible.

    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 vertical walled structures to prevent accidental entry of machinery.

    d. Ramp slopes designed to be consistent with the equipment intended to be used, with curbs or safety bars installed on access ramps.

11. **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 in accordance with NRCS FOTG Section IV, Standard 590, Nutrient Management.

    b. Requirements for location and methods of pumping and agitation.

    c. A contingency plan to address unexpected volumes of wastewater, runoff, or spillage at loading sites that could cause the system to overflow before emptying occurs.

    d. Requirements for inspecting and maintaining the facility.

    e. Safety issues connected with waste storage facilities.

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.

B. Specific Criteria for Confined Impoundments - The following specific criteria apply to this practice:

1. **Waste Storage Facility Criteria** - Table 1 contains the criteria for constructing waste impoundments into existing soils with no additional liner. Tables 2-5 contain the criteria for liners. The portions of the waste storage facilities that do not meet Table 1 criteria shall be lined. A combination of liners is acceptable. For example, a facility may be constructed with clay lined side slopes and a concrete lined bottom. Liners and structures shall be designed to withstand all anticipated internal and external loads, hydrostatic uplift pressure, agitation scouring, and water pressure due to water table fluctuations. Soil criteria in Tables 1-5 refers to mineral soils; construction shall not occur on organic soils.

Table 1 - IN PLACE EARTH CRITERIA[1]

1. Well Distance	≥ 250'			≥ 150' (WDNR variance required)
2. Soils				
- *% Fines*	≥50%	≥40%	≥40%	≥50%
- *Plasticity Index* (PI)	–	≥ 12	–	–
- Thickness (bottom/sides)	3'	3'	3'	5'
- *Permeability2*	–	–	$5x10^{-7}$ cm/sec	5' $1x10^{-7}$ cm/sec
3. Topography/Geology				
- Sinkholes	≥ 400'			≥ 1,000'
- Saturation	≥ 3' separation			≥ 5' separation
- Bedrock	≥ 3' separation			≥ 5' separation
4. Waste Characteristics	No limitations			≥5% solids
5. Other				
- Scour Protection[3]				
- Agitation and pump access	20'x20' concrete pad or sump in bottom and 10' wide ramp to top of facility			
- Scraping	Protect with hard surfacing (see V.A.9.)			

[1] Embankment shall be constructed with material meeting criteria in Table 1 from the inside surface to the embankment centerline.
[2] Permeability measurement shall be of undisturbed soil.
[3] Not required if ≥ 5' of soil thickness meets the soils criteria in the table.

Table 2 - CLAY LINER CRITERIA

1. Well Distance	≥ 250'	
2a. Soils (directly below liner)		
- % Fines	–	≥ 20%
- Thickness	–	3' bottom, 2' sides
2b. Clay Liner Material		
- Thickness	3' bottom, 5' sides	2' bottom, 3' sides
- % Fines	≥ 50%	≥ 50%
- Plasticity Index (PI)	≥ 12	≥ 12
- Compaction	WI Spec. 204[1]	WI Spec. 204
3. Topography/Geology		
- Sinkholes	≥ 400'	≥ 400'
- Saturation	3' bottom separation, 5' side separation	3' separation bottom and sides
- Bedrock	3' separation	5' separation
4. Waste Characteristics	No sand bedding without liner protection	
5. Other		
- Required liner protection		
- Agitation and pump access	20'x20' concrete pad or sump in bottom and 10' wide ramp to top of facility	
- Scraping	Protect with hard surfacing (see V.A.9.)	

[1] NRCS Wisconsin Construction Specification 204 - Earthfill for Waste Storage Facilities.

Table 3 - POLYETHYLENE LINER CRITERIA[1]

	60 mil. liner with *intimate contact* to the soil below[2]	
1. Well Distance	≥ 250'	
2. Soils (directly below liner)		
- % Fines	≥ 20%	≥ 20%
- Plasticity Index (PI)	≥ 7	–
- Thickness	≥ 1.5'	≥ 3'
- Compaction of placed material	WI Spec 202	WI Spec 202
3. Topography/Geology		
- Sinkholes	≥ 400'	
- Saturation	3' separation	
- Bedrock	3' separation	
4. Waste Characteristics	No sand bedding without liner protection	
5. Other		
- Required liner protection[3]		
- Agitation and pump access	20'x20' concrete pad or sump in bottom and 10' wide ramp to top of facility	
- Scraping	Protect with hard surfacing	
- Gas release system	As needed	

[1] Includes high density polyethylene (HDPE) and very flexible polyethylene (VFPE) in accordance with NRCS Wisconsin Construction Specification 202 - Polyethylene Geomembrane Liner.

[2] Intimate contact does not exclude the use of a minimum area of drain fill material for gas venting or monitoring systems.

[3] The liner protection shall be a minimum of 5 in. of concrete, reinforced with #3 steel bars, spaced at 18 in. on center each way to prevent differential movement.

Table 4 - GEOSYNTHETIC CLAY LINER (GCL) CRITERIA

1. Well Distance	≥ 250'	
2a. Soils (directly below liner)		
- % Fines	≥ 20%	≥ 20%
- Plasticity Index (PI)	≥ 7	--
- Thickness (from bottom and sides)	≥ 1.5'	≥ 3'
- Compaction of placed material	WI Spec 203	WI Spec 203
2b. Liner Cover Material		
- Bottom	1'	
- Side Slopes	2'	
3. Topography/Geology		
- Sinkholes	≥ 400'	≥ 400'
- Saturation	3' separation	4' bottom sep., 5' side separation
- Bedrock	3' separation	5' separation
4. Waste Characteristics	No sand bedding without liner protection over cover material	
5. Embankment Requirements		
- Side Slopes	Sum of interior and exterior slopes ≥ 6:1.	
- Inside Slope[1]	3:1 or flatter	
6. Other		
- Required Liner Protection		
- Agitation and Pump Access	20'x20' concrete pad or sump in bottom and 10' wide ramp to top of facility	
- Scraping	Protect with hard surfacing (see V.A.9.)	
- GCL Material[2]	Non-woven needle punched	

[1] The GCL and soil cover shall be stable at the designed side slope.
[2] The liner shall be installed according to manufacturers specifications and NRCS Wisconsin Construction Specification 203 - Geosynthetic Clay Liner.

Table 5 - CONCRETE LINER AND STRUCTURE FLOOR CRITERIA

	Concrete with Waterstop[1]	Concrete Composite[2]	
1. Well Distance	≥ 100'		
2. Soils (adjacent to liner)			
- % Fines	–	≥ 20%	≥ 20%
- Plasticity Index (PI)	–	≥ 7	–
- Thickness (bottom and sides)	–	≥ 1.5'	≥ 3'
- Compaction of placed material	–	204	204
3. Topography/Geology			
- Sinkholes			
- Storage floor above ground	≥ 200'		≥ 200'
- Storage floor below ground	≥ 400'		≥ 400'
- Saturation (1' sep. for sump)	≥ 2' separation		≥3' separation
- Bedrock (1' sep. for sump)	≥ 2' separation		≥3' separation
4. Waste Characteristics	No limitations		

[1] The concrete liner or structure floor thickness shall be a minimum of 5 in. for uniform foundations, contain distributed reinforcing steel, and all joints shall have imbedded non-metallic waterstops in accordance with NRCS Wisconsin Construction Specification 4 - Concrete. The required area of reinforcing steel and spacing of 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 NRCS AWMFH. Reinforcing steel shall be deformed bars. There shall be 6" of compacted clean sand and gravel below the liner or structure floor.

[2] The concrete liner or structure floor thickness shall be a minimum of 5 in. and continuous reinforcement of #3 steel bars spaced at 18 in. on center each way. No control joints are required. The concrete shall be placed in intimate contact with the foundation soils. No granular base material is to be used. Steel shall be continuous through all construction joints.

2. **Structural Design Criteria** - The structural design shall include all items that will influence the performance of the structure, including loading assumptions, material properties, construction quality, 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.

   Liquid tight steel, reinforced concrete, or approved pre-cast concrete structures shall have concrete floors that meet the criteria contained in the Table 5 footnotes.

   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 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. Timber

used in contact with soil or manure shall contain a minimum of 0.6 lbs./cubic feet of CCA preservative or equivalent.

(3) Structural 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 A or another nationally recognized building code. In using presumptive bearing values, adequate detailing and articulation shall be provided to avoid movements that could stress the structure.

Table A
PRESUMPTIVE ALLOWABLE BEARING STRESS VALUES[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

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

c. **Structural Loading** - Fabricated 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 B shall be used.

Lateral earth pressures based upon equivalent fluid assumptions shall be assigned according to the structural stiffness or wall yielding as follows:

(1) Rigid frame or restrained wall. Use the values shown in Table B 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 B under the column "Freestanding 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 EP393.2, Manure Storage, 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 ASAE EP288.5, Agricultural Building Snow and Wind Loads. 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. The minimum loading used for Wisconsin shall be: Wind load, basic velocity pressure = 16 psf and Snow load = 24 psf.

d. **Wall Joints** - Waterstop joints for cast-in-place walls shall be continuous with floor waterstop joint locations. Joints for pre-cast and other pre-approved facilities shall demonstrate evidence of equivalent performance. Waterstops shall be imbedded non-metallic in accordance with NRCS Wisconsin Construction Specification 4.

C. Specific Criteria for Unconfined Manure Stacks - Unconfined manure stacks shall meet all General Criteria requirements in section V. A. of this standard and the following additional criteria. The criteria apply to the stacking of manure on the ground surface or on a constructed surface. Stacks shall not be placed in grassed waterways, drainageways, ditches, undrained areas, or areas of concentrated flow. Table 6 contains the specific criteria for unconfined manure stacks. Waste removed shall be utilized at locations, times, rates, and volumes in accordance with the NRCS, FOTG Section IV, Standard 590, Nutrient Management.

D. Waste Storage Facility Closure Criteria - Waste storage facility closure will require a site-specific design and inspection during closure. Additional procedures may be required for remediation. The closure shall be in accordance with the criteria contained in NRCS FOTG Section IV, Standard 360, Closure of Waste Impoundments.

Table 6
UNCONFINED MANURE STACKS CRITERIA

1. Well Distance	≥ 250'
2. Soils	
- % Fines	≥ 20%
- Thickness from ground surface	≥ 3'
3. Topography/Geology	
- Saturation	≥ 3' separation
- Bedrock	≥ 3' separation
- Lake and Sinkholes	≥ 1000' upgradient
- Perennial or Intermittent[1] Streams, Quarries, Wetlands, or surface inlets that outlet to the above features	≥ 300' upgradient
- Other channelized flow (i.e. road ditches and waterways)	≥ 100' upgradient
- Land Slope	≤ 6%
4. Floodplain	Above 100 year flood elevation of perennial or intermittent stream[1]

[1] Perennial or intermittent streams as identified on USGS quadrangle maps

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:

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

2. Adding an emergency 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.

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

4. Separating solids and liquids from runoff or waste water entering waste storage facilities may minimize the frequency of accumulated solid removal and benefit the pumping and application of the stored waste.

5. Outletting drainage to locations that will not directly enter surface water.

6. Steel reinforcement on slabs that will be scraped may prevent vertical displacement at crack locations.

7. Gas venting channels beneath a geomembrane liner may reduce gas bubble formation when a geomembrane is installed over an abandoned waste storage pond or over soils with high organic content.

VII. 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.

VIII. References

United States Department of Agriculture - Natural Resources Conservation Service, Agriculture Waste Management Field Handbook, Part 651, 1992.

United States Department of Agriculture - Natural Resources Conservation Service, Wisconsin Field Office Technical Guide, Section IV.

IX. Definitions

% Fines (Tables 1-6, Table B) - Percentage of given sample of soil which passes through a #200 sieve. The analysis is done according to ASTM procedure C-117.

Bedrock (V.A.2.b.(4), V.A.8., V.A.8.b., V.A.8.b.(1), Tables 1-6, Table A) - 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.8.a.(2)) - 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.

Contaminated Runoff (II., III.) - Runoff that has come through or across a barnyard or animal lot. It includes the runoff and any manure, sediment, feed, or other material carried in the runoff.

Drainage System (V.A.8.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 ground, measured at the centerline.

Flood Prone Areas (V.A.3) - These include areas delineated as floodplains on Federal Emergency Management Agency maps, or local floodplain maps as well as areas along perennial streams shown on the United States Geologic Survey quadrangle sheets that may be subject to out of bank flows.

Freeboard (V.A.5., V.A.7.c.) - Additional storage depth that is added as a safety factor.

Intimate Contact (Table 3, Table 3 footnote 2, Table 5 footnote 2) - Direct contact between liner materials (concrete, GCL, and PE) and soil.

Karst (V.A.2.c., Sinkhole Definition) - 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 AWMFH for additional discussion of karst features.

Nutrient Management Plans (III., V.A.4.) - A planning document that outlines the requirements for managing the amount, form, placement, and timing of applications of plant nutrients.

Permeability (Table 1, Table 1 footnote 2) - The coefficient of permeability (k) is determined by ASTM D-5084. The coefficient of permeability is a measure of the rate of flow of liquid through the soil. It is used to compute the flow rate for specific conditions of soil thickness and fluid head.

Plasticity Index, PI (Tables 1-5) - A soil property indicating moldability. Measured by ASTM D-4318.

Regional High Water Table (V.A.8.a.(1), Table B, Confined and Perched Water Definition) - 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., Tables 1-6, Karst Definition) - 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.

Table B - LATERAL EARTH PRESSURE VALUES [1]

Soil		Equivalent Fluid Pressure (lbs./sq. ft./per ft. of depth)			
Description	Unified Classification[3]	Above Regional High Water Table		Below Regional High Water Table[2]	
		Free Standing Wall	Frame Tanks	Free Standing Wall	Frame Tanks
- Clean gravel, sand or sand-gravel mixtures (maximum 5% fines)[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)[5]	CH, MH	–	–	–	–

[1] For lightly compacted soils (85% to 95% maximum standard density). Includes compaction by use of typical farm equipn.
[2] Includes hydrostatic pressure.
[3] All definitions and procedures in accordance with ASTM D-2488 and D-653.
[4] Generally, only washed materials are in this category.
[5] Not recommended. Requires special design if used.