NATURAL RESOURCES CONSERVATION SERVICE
CONSERVATION PRACTICE STANDARD

POND SEALING OR LINING – COMPACTED SOIL TREATMENT

CODE 520
(FT.^{2})

DEFINITION

A liner for an impoundment constructed using compacted soil with or without soil amendments.

PURPOSE

This practice is installed to reduce seepage losses from impoundments constructed for water conservation and environmental protection.

CONDITIONS WHERE PRACTICE APPLIES

This practice applies where:

- In-place natural soils have excessive seepage rates, and
- An adequate quantity and type of soil suitable for constructing a compacted soil liner without amendments is available, or
- An adequate quantity and type of soil suitable for treatment with a soil dispersant or bentonite amendment is available for an amended soil liner.

CRITERIA

General Criteria Applicable to All Soil Liners

Design Seepage Requirements. Design a compacted soil liner for a waste storage impoundment to reduce specific discharge (unit seepage) to rates specified in the National Engineering Handbook (NEH), Part 651, Agricultural Waste Management Field Handbook (AWMFH), Chapter 10, Appendix 10D, or rates mandated in State regulations, if more restrictive. Lower specific discharge rates must be used if required by regulatory authorities, and may be used at the discretion of the designer even if no such lower limit exists. Tables 1 and 2 of this standard achieve the specific discharge requirements referenced in the AWMFH.

Laboratory testing of compacted soil liner material for a waste storage impoundment is required to document the specific discharge to meet the design seepage threshold.

Design a compacted soil liner for a clean water pond to reduce seepage to a rate that will allow the pond to function as intended.

Liner filter compatibility. Design a compacted soil liner that is filter-compatible with the subgrade on to which it is placed to prevent loss of the liner soil into larger openings in the subgrade material. NEH, Part 633, Chapter 26, Gradation Design of Sand and Gravel Filters, provides criteria on filter compatibility.

Liner Thickness. The minimum thickness of the finished compacted liner must be the greater of:

- The liner thickness required to achieve a specific discharge (unit seepage) design value, or
- A liner thickness required by State regulations, or
- The minimum liner thickness as shown in Table 1 (manure storage) or Table 4 (clean water).

Liner Construction. Use methods described in the AWMFH, Appendix 10D, for liner construction. Properly seal all protrusions through the liner, such as pipes.

Liner Protection. Protect the soil liner against damage caused by the effects of waste or water surface fluctuations, desiccation and cracking, wave action, rainfall during periods when the liner is exposed, water falling onto the liner from pipe outlets, agitation equipment, solids and sludge removal activity, animal activity, penetrations through the liner, and any other activity capable of causing physical damage to the liner.

A protective soil cover may be used to protect the soil liner from desiccation or erosion. The soil cover will be of a soil type, thickness, and density that is resistant to erosion and desiccation. Under severe conditions, a protective soil cover may not adequately protect the liner from desiccation. For example during long periods, of hot, low-humidity condition, a soil cover constructed with very high plasticity soils may experience damage. Under severe conditions, additional design measures such as installation of a geomembrane in conjunction with the soil cover may be required. The side slope liner thickness listed in Table 2 includes an additional two feet to act as a protective soil cover for desiccation (no additional measure is required). Additional erosion or agitation protection may still be needed based on the management assessment performed for waste storage facilities.

Side Slopes. The side slopes of the impoundment should be 3H (horizontal) to 1V (vertical) or flatter to facilitate compaction of soil on the slopes when the "bathtub" method of construction is used, as described in AWMFH, Appendix 10D. Slopes as steep as 2H to 1V can be considered if the "stair-step" method of construction as described in appendix 10D of the AWMFH is used.

Foundation. Evaluate the foundation for conditions such as karstic bedrock, joints, and other discontinuities of the underlying bedrock to determine the appropriateness for a compacted soil liner.

Additional Criteria for Waste Storage Facilities (WI CPS 313).

Tables 1 and 2 summarize the liner and separation distance requirements for waste storage facilities.

Determine the plasticity index (PI) in accordance with ASTM D4318 and the percent fines in accordance with ASTM D1140. Permeability shall be determined by ASTM D5084 from undisturbed samples of the compacted liner. Additional soil testing requirements are found in WI FOTG Construction Specification 300, Clay Liner.

All waste storage facilities shall also meet the requirements of Wisconsin NRCS Conservation Practice Standard (WI NRCS CPS) Waste Storage Facility (Code 313).

Use WI NRCS CPS Waste Storage Facility (Code 313) criteria to determine subsurface saturation and bedrock depth.

Table 1. Clay Liner Criteria for Waste Storage Facility Impoundments [Note 1]

Clay Liner Requirements	
Thickness, Bottom	As specified in Table 2
Thickness, Sides [Note 2]	≥ 5 feet
% Fines	≥ 50%
Plasticity Index (PI)	≥ 12
Permeability, centimeters/second	≤ $1x10^{-7}$
WI FOTG Construction Specification	Spec 300, Clay Liner
Sub-Liner	**See Table 3**
Separation Distances	
Wells [Note 3]	≥ 250 feet
Sinkholes or other Karst Features	≥ 400 feet
Subsurface Saturation	As specified in Table 2
Bedrock	As specified in Table 2
Liner Protection Required	
Agitation and Pumping Locations	Minimum 20 feet wide x 30 feet long x 4 inches thick concrete pad or sump in bottom and 20 feet wide ramp or a 16 feet wide ramp with 12 inches 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 inches thick.

[Note 1] This liner may be used to meet the requirements of Wisconsin Administrative Code, Chapter NR 213 (NR 213), with additional restrictions (e.g. soils investigations, separation distances, liner properties, maintenance requirements). See NR 213 and WI AWMFH 313 companion documents.

[Note 2] Thickness measured perpendicular to slope.

[Note 3] Community water system wells may require larger separation distances (see Wisconsin Administrative Code, Chapter NR 811 (NR 811)).

Table 2. Clay Liner Thickness (Bottom) and Separations for Waste Storage Facility Impoundments [Note 1]

Impoundment Depth [Note 2]	Liner Thickness (feet)	Separation to Subsurface Saturation and Bedrock (feet)
0 – 13	≥ 3.0	≥ 5.0
13.1 – 14	≥ 3.2	≥ 5.2
14.1 – 16	≥ 3.6	≥ 5.6
16.1 – 18	≥ 4.1	≥ 6.1
18.1 – 20	≥ 4.5	≥ 6.5
20.1 – 22	≥ 5.0	≥ 7.0
22.1 – 24	≥ 5.4	≥ 7.4
24.1 - 25	≥ 5.7	≥ 7.7

[Note 1] Thickness is calculated based on a maximum permeability of $1x10^{-7}$ cm/sec.

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

Sub-Liner Soils. Sub-liner soil requirements are listed in Table 3. These soils can be placed or be in situ materials. There is no compaction requirement for in situ materials. Sub-liner soil is required under the footprint of all waste storage facilities. For structures, it must be wrapped around to the top of the footing to provide continuous protection.

Sub-liner soil thickness is in addition to any liner thickness requirement.

Table 3. Sub-Liner Soil Requirements for Waste Storage Facility Impoundments

	Minimum Soil Requirements			
% Fines	≥ 20%	≥ 20%	≥ 40%	Foundry Sand [Note 1]
Plasticity Index (PI)	≥ 7	—	≥ 12	—
Thickness (bottom and sides)	≥ 1.5 feet	≥ 2 feet	≥ 8 inches	≥ 1.5 feet
Compaction of Placed Material	WI Spec 204	WI Spec 204	WI Spec 300	WI Spec 204

[Note 1] 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 Wisconsin Administrative Code, Chapter NR 538 (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.

Additional Criteria for Compacted Soil Lined Clean Water Applications.

Table 4 lists required liner thickness for clean water applications.

Table 4. Minimum liner thickness for clean water

Design Storage Depth (feet)	Liner Thickness (inches)
≤16	12
16.1–24	18
24.1–30	24

Additional Criteria for Soil Dispersant Treatment

This liner treatment does not meet the requirements for a waste storage facility liner.

Dispersant Materials. The dispersant must be tetrasodium pyrophosphate (TSPP), sodium tripolyphosphate (STPP), or soda ash unless laboratory tests using other dispersant types are used in the design.

Application Rate. For waste storage impoundments, conduct laboratory permeability tests using a dispersant of the same quality and fineness as that proposed for use. To meet the liner design threshold, use the application rate and the number and thickness of compacted soil lifts specified in the geotechnical laboratory report.

For clean water ponds, in the absence of laboratory tests or field performance data on soils similar to those to be treated, apply dispersant at a rate equal to or greater than the amount lined in Table 5. Install the liner with a maximum 6-inch-lift thickness.

Table 5. Minimum Dispersant Application Rates for Clean Water Ponds

Dispersant Type	Minimum Application Rate per 6-inch lift thickness (pounds/100 square feet)
Polyphosphate (TSPP, STPP)	7.5
Soda Ash	15

Safety. During dispersant handling, application and mixing, personnel on site must wear masks and goggles for protection against dispersant dust.

Additional Criteria for Bentonite Treatment

This liner treatment does not meet the requirements for a waste storage facility liner.

Bentonite Material. The bentonite must be a sodium bentonite with a free swell of at least 22 milliliters as measured by ASTM Standard Test Method D5890, unless laboratory tests using other bentonite types are used for design.

Application Rate. For waste storage impoundments, conduct laboratory permeability tests using bentonite of the same quality and fineness as that proposed for use. To meet the liner design threshold,

use the application rate and number and thickness of compacted soil lifts specified in the geotechnical laboratory report.

For clean water ponds, in the absence of laboratory tests or field performance data on soils similar to those to be treated, apply the bentonite at a rate equal to or greater to the amount listed in Table 6. Install the liner with a maximum of 6-inch-lift thickness.

Table 6. Minimum Bentonite Application Rates for Clean Water Ponds

Pervious Soil Description	Minimum Application Rate (pounds/square foot) per 1-inch lift thickness
Silts (ML, CL-ML)	0.375
Silty Sands (SM, SC-SM, SP-SM)	0.5
Clean Sand (SP, SW)	0.625

Safety. During bentonite handling, application and mixing, personnel on site must wear masks and goggles for protection against bentonite dust.

CONSIDERATIONS

Consider maintenance access safety and slope stability when selecting inside side slopes for design.

Consider using a composite liner system, including a geomembrane and/or geosynthetic clay liner (GCL) for sites that have liquid depths greater than 24 feet.

Consider installing a 12-inch protective soil cover over the compacted soil liner.

In areas where the liner can potentially be damaged or scoured by agitation, pumping, or other equipment access, consider installing a concrete pad over the liner.

PLANS AND SPECIFICATIONS

Prepare plans and specifications for a compacted soil liner for a pond or a waste storage impoundment that describe the requirements for applying the practice to achieve its intended purpose. As a minimum, include:

- Soils investigation, including subgrade.
- Soil amendment requirements, as needed.
- Quantities of soil liner material and soil cover material, as needed.
- Quantity and gradation of filter material, as needed.
- Compaction requirements.
- Supplemental practices, such as geomembrane, as needed.
- Construction and material specifications.
- Safety requirements.
- Applicable Wisconsin Construction Specifications

OPERATION AND MAINTENANCE

Maintenance activities required for this practice consist of those operations necessary to prevent and/or repair damage to the compacted soil liner. This includes, but is not limited to:

- Excluding animals and equipment from the treated area.
- Repairing damage to the liner; restoring the liner to its original thickness and condition.
- Removing roots from trees and large shrubs at first appearance.

REFERENCES

USDA Natural Resources Conservation Service. 2012. Agricultural Waste Management Field Handbook (AWMFH). USDA-NRCS, Washington, D.C.

National Engineering Handbook, Part 633, Chapter 26 – Gradation Design of Sand and Gravel Filters.

DEFINITIONS

Bedrock – 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.

Clean Water – Water that has not been mixed with manure, wastewater or other contaminants.

Geomembrane – 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).

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

Karst features – Refers to areas of land underlain by carbonate bedrock (limestone or dolomite). Typical land features in karst areas include sinkholes, network of interconnected fissures, fractures, 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 – 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.

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

Permeability – 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 (e.g., $1x10^{-7}$ cm/s).

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

Sinkhole – 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 – A waste storage facility consisting of constructed surfaces, tanks, or walls for the purpose of storing waste above or below the ground surface.

Sub-Liner Soil – The soil directly below the bottom of the liner. This may be placed or in situ material.

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