POND SEALING OR LINING - FLEXIBLE MEMBRANE

Code 521A

Natural Resources Conservation Service
Conservation Practice Standard

I. Definition

A manufactured hydraulic barrier consisting of a functionally continuous layer of synthetic or partially synthetic, flexible material.

II. Purpose

To restrict, impede, and control seepage of water and contaminants from water and waste impoundment structures for water conservation and environmental protection.

III. Conditions Where Practice Applies

On ponds and water storage structures that require treatment to control seepage rates within acceptable limits.

On earthen waste storage ponds or lagoons and other waste impoundment structures that require treatment to control seepage of contaminants from the storage structure.

IV Federal, Tribal, State, and Local Laws

Pond sealing or lining systems shall comply with all federal, tribal, state and local laws, rules or regulations governing pond sealing or lining systems or the structures that will be lined. The operator is responsible for securing required permits. This standard does not contain the text of the federal, tribal, state or local laws governing pond sealing or lining systems.

V. Criteria

A. General Criteria

1. Design

   Structures to be lined shall be constructed to meet all applicable Wisconsin NRCS Field Office Technical Guide, Section IV (WI FOTG), conservation practice standards.

   Liners for waste impoundments shall meet all additional criteria contained in WI FOTG Standard 313, Waste Storage Facility.

   All inlets, outlets, ramps, and other appurtenances may be installed before, during, or after the liner placement, but shall be done in a manner that does not damage or impair the proper operation of the liner.

   Design and installation of the flexible membrane shall be in accordance with manufacturer recommendations. All flexible membrane installations shall be certified by the installer or manufacturer as meeting the material and installation requirements of the plans and specifications.

   Manufacturer recommendations shall be followed with regard to protection from weather and exposure.

2. Liner Materials

   Flexible membrane liner materials shall meet the requirements of the specifications indicated in the following tables.

Table 1
Minimum Geomembrane Thickness Criteria

Type	Minimum Thickness	
	Wastewater	Clear Water
HDPE	60 mil	30 mil
LLDPE	60 mil	30 mil
LLDPE-R	60 mil	24 mil
PVC	Not Recommended	30 mil
EPDM	60 mil	45 mil
FPP	Not Recommended	30 mil
FPP-R	Not Recommended	24 mil
PE-R	Not Recommended	24 mil

1 mil = 1/1000 of an inch

HDPE – High Density Polyethylene Geomembrane
LLDPE – Linear Low Density Polyethylene Geomembrane
LLDPE-R – Reinforced Linear Low Density Polyethylene Geomembrane,
PVC – Polyvinyl Chloride Geomembrane
EPDM – Ethylene Propylene Diene Terpolymer Geomembrane

Table 2
Minimum Bentonite Content for Geosynthetic Clay Liners (GCL)

Type	Minimum Bentonite Content	
	Wastewater	Clear Water
GCL	0.75 lb/sq. ft.	

Table 3
Reference Specification for Liners

Type	Applicable Specification
HDPE LLDPE LLDPE-R	WI NRCS Specification 202, Polyethylene Geomembrane Lining
PVC	NRCS National Specification 594, Geomembrane Liner
EPDM	WI NRCS Specification 205, Ethyl Propylene Diene Monomer (EPDM) Geomembrane Lining
GCL	WI NRCS Specification 203, Geosynthetic Clay Liner

3. Cover Soil

PVC and GCL liners for water storage structures shall be covered with a minimum of 12 inches of soil measured perpendicular to the finished surface. GCL liners for waste storages shall be covered in accordance with WI FOTG Standard 313, Waste Storage Facility. Cover soil may be used on other liners but is not required unless essential for the proper performance, protection and durability of the installation. Cover soils shall not contain sharp, angular stones or any objects that could damage the liner. Maximum allowable particle size of soil cover material shall be ⅜ inch for geomembrane liners and ½ inch for geosynthetic clay liners, unless the liner is protected by a 10-oz/sq yd or heavier non-woven geotextile cushion material. Cover materials shall be stable against slippage down the slope under all operational and exposure conditions, such as rapid drawdown or saturation by precipitation or snowmelt.

Cover soil shall be placed within 24 hours after placement of the liner to minimize the potential for damage from various sources, including precipitation, wind, and ultra-violet exposure.

GCL liners shall have a uniform confinement pressure as recommended by the manufacturer, which shall not be compromised by the presence of a drainage layer or venting system under the liner.

GCL liners, wastewater and subgrade and cover soils should be analyzed to ensure that undesirable cation exchange (calcium and/or magnesium for sodium) will not occur in the GCL.

4. Subgrade Preparation

Subgrade preparation shall conform to manufacturer recommendations and applicable Wisconsin NRCS construction specifications. Subgrade materials shall not contain sharp, angular stones or any objects that could damage the liner or adversely affect its function unless a cushion layer is used.

5. Cusion

A cushion for clear water storages shall be placed beneath the liner if the subgrade particles contain sharp angular stones that could damage the liner or particles greater than ⅜ inch for geomembrane liners and ½ inch for GCLs. The cushion may be a 10-oz/sq yd or heavier non-woven geotextile or a layer at least 6 inches thick of soil meeting the particle size and shape requirements of the subgrade. Geotextile cushion material shall meet the requirements of GRI Test Method GT12(a). Follow the manufacturer's recommendations for any additional protective measures.

A cushion for waste storage lines shall be in accordance with applicable Wisconsin NRCS construction specifications.

6. Anchorage

Liners shall be anchored to prevent uplift due to wind or slippage down the side slope.

7. Safety

Design shall include appropriate safety features to minimize the hazards of the structure. Warning signs, fences, ladders, ropes, bars, rails, and other devices shall be provided, as appropriate, to ensure the safety of humans and livestock.

B. Underliner Drainage and Venting

Subsurface conditions such as soil type and soil water levels will dictate the direction and scope of the design of the drainage and venting system beneath the geomembrane liner. An inadequate drainage and venting system may result in floating of the geomembrane liner. Hydrostatic pressures from fluctuating soil water levels or leakage through the liner may cause the liner to float. Gas production and buildup beneath the liner due to the presence of organic material in the soil or leachate leakage through the liner may cause "whales" or bubbling of the liner.

1. Soil Water and Leakage Drainage

   If the soil water level may be near the invert elevation of the pond, soil water monitoring should be conducted during the site investigation to verify the expected water location. In some situations, it may be necessary to install soil water monitoring wells for a year or more to determine the water levels and gather enough information to properly determine the required flow capacity of the drainage system. If high water levels could adversely affect the proper functioning of the structure, interceptor or relief-type drainage systems should be included to control uplift pressures. Leakage through the liner due to liner damage should also be considered. Giroud and Bonaparte (1989) recommend designing the drainage system based on a frequency of one hole (0.16 in^2) per acre of surface area.

2. Gas Venting

   The need for venting for wastewater pond liners shall be investigated as part of the design. Site conditions which may be conducive to gas production include sites which have been subject to long-term seepage of animal waste into the foundation soil, sites with naturally occurring organics in the soil, or fine grained foundation soils where fluctuating soil water levels may trap gases present in the soil.

3. Drainage and Venting System Design

   The use of a geosynthetic such as a geonet or geocomposite under the liner for water storages to facilitate collection, drainage of liquids and venting of gas should be evaluated during design. If drainage and/or venting is needed, the geocomposite manufacturer's recommendations shall be followed in the system design. The allowable flow rate of the geocomposite shall be determined in accordance with GRI Standard GC8. The pond bottom should be sloped, typically a minimum of 1 percent, to permit positive flow of the liquids or gases. In most cases, the geocomposite will serve both purposes of drainage and venting. In large impoundments, the bottom may need to be sloped in multiple directions in order to decrease the required drainage and venting flow travel distances.

VI. Considerations

Considerations include additional design recommendations that are not required criteria, but may be used to enhance or avoid problems with the design and function of this practice.

A. Consider minimizing the number of penetrations through the liner. Trenching and backfilling of fill pipes should be detailed such that charging of the underside of the liner with subsurface water is prevented.

B. Consider a leak detection system beneath all liners, especially geomembranes.

C. If agitation operations may result in abrasion or other mechanical damage to the liner, consider additional protective measures needed to ensure the integrity of the liner. Consider increasing the liner thickness above the minimum values indicated or providing more extensive protective ramps and aprons at agitation locations.

VII. Plans and Specifications

Plans and specifications shall be prepared for specific field sites in accordance with this standard and shall describe the requirements for applying the practice to achieve its intended uses.

As a minimum, the plans and specifications shall provide the following.

- Layout of the containment structure, collection points, waste transfer locations or pipelines, and topography of the site.
- Required liner properties, cushion materials, and pipeline materials.
- Subgrade details, including tolerances on smoothness of the finished grade.

- Details of liner installation, seaming requirements, and requirements for attachments and appurtenances.
- Minimum qualification of installers.
- Warranty requirements, if desired.
- Quality control testing requirements.
- Fence and signage requirement , if required.

VII. Operation and Maintenance

A plan for operation and maintenance (O&M) of the liner and structure shall be prepared. The plan shall be consistent with the purposes of the type of liner chosen, intended life, safety requirements, and design criteria. The plan shall contain requirements including but not limited to:

- Design capacity and liquid level of the structure.
- A description of the normal operation, safety concerns, and maintenance requirements.
- Monitoring procedures for leak detection systems, including alarm level leakage rates and actions to be taken if these rates are exceeded.
- Repair procedures.
- Periodic inspection of the following:
    - Visible portions of the liner for tears punctures, or other damage;
    - Liner interface with inlets, outlets, ramps, or other appurtenances for damage;
    - Liquid level in the structure;
    - Ballooning of the liner indicating presence of gas beneath the liner.

IX. References

USDA, Natural Resources Conservation Service, Wisconsin Field Office Technical Guide, Section IV, Practice Standards and Specifications.

ASTM D 5887, Test Method for Measurement of Index Flux Through Saturated Geosynthetic Clay Liner Specimens Using a Flexible Wall Permeameter.

ASTM D 5890, Test Method for Swell Index of Clay Mineral Component of Geosynthetic Clay Liners.

ASTM D 5891, Test Method for Fluid Loss of Clay Component of Geosynthetic Clay Liners.

ASTM D 5993, Test Method for Measuring of Mass Per Unit of Geosynthetic Clay Liners.

ASTM D 6102, Guide for Installation of Geosynthetic Clay Liners.

ASTM D 6214, Test Method for Determining the Integrity of Field Seams Used in Joining Geomembranes by Chemical Fusion Methods.

ASTM D 6392, Test Method for Determining the Integrity of Nonreinforced Geomembrane Seams Produced Using Thermo-Fusion Methods.

ASTM D 6497, Guide for Mechanical Attachment of Geomembrane to Penetrations or Structures.

ASTM D 7176, Specification for Non-Reinforced Polyvinyl Chloride (PVC) Geomembranes Used in Buried Applications.

ASTM D 7272, Test Method for Determining the Integrity of Seams Used in Joining Geomembranes by Pre-manufactured Taped Methods.

ASTM D 7408, Specification for Non Reinforced PVC (Polyvinyl Chloride) Geomembrane Seams.

ASTM D 7465, Specification for Ethylene Propylene Diene Terpolymer (EPDM) Sheet Used in Geomembrane Applications.

Koerner, R.M. 2005. Designing with Geosynthetics, 5th ed. Pearson Prentice Hall, Upper Saddle River, NJ.

Geosynthetic Research Institute, GRI Standard GC8, Standard Specification for Determination of the Allowable Flow Rate of a Drainage Geocomposite.

Geosynthetic Research Institute, GRI Test Method GT12(a) – ASTM Version, Test Methods and Properties for Nonwoven Geotextiles Used as Protection (or Cushioning) Materials.

Geosynthetic Research Institute, GRI Test Method GM13, Standard Specification for Test Methods, Test Properties and Testing Frequency for High Density Polyethylene (HDPE) Smooth and Textured Geomembranes.

Geosynthetic Research Institute, GRI Test Method GM17, Standard Specification for Test Methods, Test Properties and Testing Frequency for Linear Low Density Polyethylene (LLDPE) Smooth and Textured Geomembranes.

Geosynthetic Research Institute, GRI Standard GM18, Standard Specification for Test Methods, Test Properties and Testing Frequencies for Flexible Polypropylene Nonreinforced (fPP) and Reinforced (fPP-R) Geomembranes.

Geosynthetic Research Institute, GRI Test Method GM19, Standard Specification for Seam Strength and Related Properties of Thermally Bonded Polyolefin Geomembranes.

Geosynthetic Research Institute, GRI Test Method GM21, Standard Specification for Test Methods, Properties, and Frequencies for Ethylene Propylene Diene Terpolymer (EPDM) Nonreinforced and Scrim Reinforced Geomembranes.

Geosynthetic Research Institute, GRI Test Method GM25, Standard Specification for Test Methods, Test Properties and Testing Frequency for Reinforced Linear Low Density Polyethylene (LLDPE-R) Geomembranes.

Giroud, J.P., and R. Bonaparte. 1989. Leakage through liners constructed with geomembranes – Part 1. Geomembrane Liners. In Geotextiles and Geomembranes, Vol. 8, pgs. 27-67.

Quality Assurance and Quality Control for Waste Containment Facilities, EPA/600/R-93/182, September 1993.

USDA-Natural Resources Conservation Service, National Engineering Handbook, Part 642, Specifications for Construction Contracts.