Natural Resources Conservation Service

CONSERVATION PRACTICE STANDARD

POND SEALING OR LINING - GEOMEMBRANE OR GEOSYNTHETIC CLAY LINER

Code 521

(Square Feet)

DEFINITION

A liner for an impoundment constructed using a geomembrane or a geosynthetic clay material.

PURPOSE

This practice is applied to—

- Reduce seepage losses from an impoundment for water conservation.
- Protect soil and water from contaminants.

CONDITIONS WHERE PRACTICE APPLIES

This practice applies where in-place natural soils have excessive seepage rates.

CRITERIA

General Criteria Applicable to Purposes.

Design. The structure to be lined must meet all applicable NRCS standards. All inlets, outlets, ramps, and other appurtenances may be installed before, during, or after the liner placement, but must be done in a manner that does not damage or impair the proper operation of the liner.

Design and install the liner in accordance with manufacturer recommendations. The installer or manufacturer must certify that the liner installation meets the material and installation requirements of the plans and specifications.

Follow manufacturer's recommendations with regard to protection from weather and ultraviolet exposure.

Materials. Geomembrane and geosynthetic clay liner (GCL) materials must meet the requirements in table 1.

Table 1 – Liner Materials

Type	Name	Minimum Thickness	
		Wastewater (mil)	Clear Water (mil)
HDPE	High Density Polyethylene	60	30
LLDPE	Linear Low-Density Polyethylene	60	30
GCL	Geosynthetic Clay Liner	0.75 lbs./square foot	

Type	Name	Minimum Thickness	
		Wastewater (mil)	Clear Water (mil)

1 mil = 1/1000 inch
Geomembrane materials must meet the criteria in NRCS National Engineering Handbook (NEH), Part 642, Chapter 3, "Material Specification 594 – Geoembrane Liner." GCL materials must meet the criteria in NRCS NEH, Part 642, Chapter 3, "Material Specification 595 – Geosynthetic Clay Liner."

Safety. Include appropriate safety features in the design to minimize the hazards of the completed pond structure. Use warning signs, fences, ladders, ropes, bars, rails, and other devices, as appropriate, to ensure the safety of humans, wildlife, and livestock.

Underliner drainage and venting. Design the drainage and venting system beneath the geomembrane liner based on subsurface conditions such as soil type and groundwater levels. Liners used for waste storage require venting at the top of slope and a drainage system if the invert elevation of the pond is within 2 feet of the seasonal high water table. Hydrostatic pressures from fluctuating groundwater 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 gas to accumulate, resulting in bubbling of the liner. Incorporate a drainage and venting system when conditions exist that may result in floating of the geomembrane liner. Ponds with an underliner drainage system must have a bottom slope of at least 1 percent.

Groundwater and leakage detection. If a soil investigation indicates that the groundwater level may be near the invert elevation of the pond, install groundwater monitoring wells to verify the expected water table location. Use NRCS Conservation Practice Standard (CPS) Monitoring Well (Code 353). In some situations, monitoring wells may need to be installed for a year or more to determine the groundwater levels and gather enough information to properly determine the required flow capacity of the drainage system. If the monitoring wells indicate a seasonal high water table within 2 feet of the pond invert, install subsurface or other type of drainage to control the potential uplift pressures.

A liner used for waste storage must have a leak detection line to a free outlet or observation well. Sites with granular subbase material require a secondary liner across the bottom and around the leak detection line to assure leakage is detected. The maximum permeability rate of the secondary liner is 1×10^{-4} cm/sec. The system shall have a minimum of one perforated drain installed at least one foot underneath the liner. This drain shall be directed to a manhole or other structure that can be used to visually monitor the flow from the drain. A valve shall be installed at the outlet of this observation well so the flow can be turned off, in the event a leak is detected. If a leak is detected, the contaminated effluent will be pumped out of the observation well and properly disposed until the leak is found and repaired.

If a soils investigation determines there are seeps or the presence of a seasonal high water table, an independent perimeter drain shall be installed around the storage facility below the bottom elevation of the storage facility. The lateral distance to the perimeter drain shall be equal to the centerline of the berm. The perimeter drain shall outlet downstream of the leak detection observation well.

Gas venting. All pond liners with anchor trenches require venting near the top of the side slopes. Design and install venting in accordance to the manufacturer's recommendations, with a spacing not to exceed 20 feet between vents. Investigate the need for additional venting beneath wastewater pond liners as part of the design. If the investigation determines the potential of gas buildup under the liner, the liner must be vented in accordance to the manufacturer's recommendations. Site conditions 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 groundwater levels may trap gases present in the soil. If site conditions are determined to be conducive to gas production, the bottom of the liner must include features to allow gas to flow along the bottom and up the side slopes to the liner vents in the crown.

Cushion. Place a cushion layer beneath the liner if the subgrade particles contain sharp angular stones that could damage the liner or if particles greater than 3/8 inch for geomembrane liners and 1/2 inch for GCLs are exposed on the surface. The cushion may be a 10-ounce-per-square-yard or heavier nonwoven geotextile or a layer at least 6 inches thick of soil meeting the particle size and shape requirements of the subgrade. Geotextile cushion material must meet the requirements of the Geosynthetic Research Institute (GRI) Test Method GT12(a). Follow the manufacturer's recommendations for any additional protective measures.

Subgrade preparation. Prepare the subgrade to conform to manufacturer's recommendations. The subgrade materials must be free from sharp, angular stones, and the surface free from oversized particles, or any objects that could damage the liner. If angular particles are present, treat the subgrade by placing a cushion layer between the subgrade and the liner. The subgrade surface must provide a smooth, flat, and unyielding foundation for the liner. No standing water, mud, vegetation, snow, frozen subgrade, or excessive moisture may be present at the time of liner placement. Unless otherwise specified by the manufacturer, the side slopes that will support the liner shall be 2.5 (horizontal) to 1 (vertical) or flatter.

Liner protection. Protect liners from mechanical damage from all sources, including equipment access points and agitation operations. If pond management plans indicate locations where agitation operations may result in abrasion or other mechanical damage to the liner, provide protective measures. Measures to ensure the integrity of the liner include increasing the liner thickness above the minimum values listed in table 1 or providing protective ramps and aprons at agitation locations. For GCL liners, analyze the wastewater, subgrade soil, and cover soil to ensure that undesirable cation exchange (calcium and magnesium for sodium) will not occur in the GCL.

Anchorage. Anchor the liner to prevent uplift due to wind or slippage down the side slope, in accordance with manufacturer's recommendations.

Seaming

The primary method of seaming shall be hot shoe double fusion weld. Fillet extrusion welding shall only be used in small areas for repairs, T-seams, and detail work. All double wedge fusions seams shall be air pressure tested and extrusion seams shall be vacuum box tested in accordance to Section 3 – Seam Testing in NRCS Construction Specification #97 – HDPE and LLDPE Liner. The results of all seam testing shall be documented by the contractor and submitted to NRCS upon completion of the liner.

Penetrations. Install penetrations through the liner in accordance with manufacturer's recommendations. Penetrations associated with waste storage must be watertight.

Cover soil. Cover PVC liners and GCLs with a minimum of 12 inches of soil measured perpendicular to the finished surface. Cover soil may be used on other liners but is not required unless essential for the proper performance, protection, and durability of the installation. Do not use cover soil that contains sharp, angular stones or any objects that could damage the liner. The maximum allowable particle size of soil cover material is 3/8 inch for geomembrane liners and 1/2 inch for GCLs. Use cover materials that are stable against slippage down the slope under all operational and exposure conditions, such as rapid drawdown or saturation by precipitation or snowmelt.

Place cover soil within 24 hours after placement of the liner to minimize the potential for damage from various sources, including precipitation, wind, and ultraviolet light exposure.

Cover soil for GCLs must provide uniform confinement pressure as recommended by the manufacturer. Do not install a drainage layer or venting system beneath a GCL, as they could compromise the liner.

CONSIDERATIONS

Designs for waste storage facilities should consider leakage through the liner due to liner damage. Giroud and Bonaparte (1989) recommends designing the drainage system based on a frequency of one hole (0.16 square-inch) per acre of surface area. Therefore, drainage and venting systems are strongly recommended for all waste storage facilities.

Minimize the number of penetrations through the liner for pond management appurtenances. Detail the trenching and backfilling of pipes to prevent charging of the underside of the liner with subsurface water.

For HDPE liners associated with waste water with penetrations over 2 inches in diameter, consider using concrete pads matching the slope with embedded channels to connect the liner, instead of manufactured boots.

PVC geomembranes are not recommended for aquatic production. The stabilizers in the PVC liner material leach out and may be harmful to aquatic species. Consult with manufacturers before selecting a geomembrane material used for aquatic production.

Where access is needed, consider installing concrete ramps with embedded channels to connect the liner. Pond corners are typically good locations for concrete ramps due to the flatter slopes. Consider placing the access ramp at a corner location.

If the entire waste storage pond is lined and access is needed on the bottom, consider placing concrete over the liner, bedded with geotextile.

Consider the use of a geosynthetic such as a geonet or geocomposite under the liner to facilitate collection, drainage of liquids, and venting of gas. If geocomposite materials are used for drainage and/or venting, use materials recommended by the manufacturer in the system design. Use GRI Standard GC8, “Standard Guide for the Allowable Flow Rate of a Drainage Geocomposite” to determine the allowable flow rate of the geocomposite. Slope the pond bottom 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. For large impoundments, the bottom may need to be sloped in multiple directions in order to decrease the required drainage and venting flow travel distances.

PLANS AND SPECIFICATIONS

Prepare plans and specifications for a geomembrane or GCL 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—

- Layout of the containment structure, collection points, waste transfer locations or pipelines, and topography of the site.
- Soils investigation and subgrade details, including tolerances on smoothness of the finished grade.
- Required properties of selected liner, geosynthetics, and cushion materials.
- Quantities of liner materials, cover soil, and geosynthetic materials as needed.
- Subsurface drainage and venting details.
- Construction and material specifications.
- Safety requirements for installed liner.
- Details of liner installation, seaming requirements, and requirements for attachments and appurtenances.
- Minimum qualifications of installers and quality control testing requirements.
- Warranty requirements, if desired.
- Fence and signage requirements, if required.

OPERATION AND MAINTENANCE

Prepare a plan for O&M of the liner and structure consistent with the purposes of the type of liner chosen, intended life, safety requirements, and design criteria. Include site-specific information regarding design capacity and liquid level of the structure and repair procedures for liner material. Maintenance activities required for this practice consist of those operations necessary to prevent and repair damage to the geomembrane or GCL. These include, but are not limited to—

- Excluding animals and equipment from the treated area.
- Repairing damage to the liner and restoring the liner and cover to its original thickness and condition.
- Removing roots from trees and large shrubs at first appearance.
- Monitoring leak-detection system.
- Protecting the liner during filling and agitation procedures.

Provide guidance on items to inspect periodically, including—

- 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.

REFERENCES

ASTM D 5887-09, Test Method for Measurement of Index Flux Through Saturated Geosynthetic Clay Liner Specimens Using a Flexible Wall Permeameter.

ASTM D 5890-11, Test Method for Swell Index of Clay Mineral Component of Geosynthetic Clay Liners.

ASTM D 5891-02(2016), Test Method for Fluid Loss of Clay Component of Geosynthetic Clay Liners.

ASTM D 5993-14, Test Method for Measuring of Mass Per Unit of Geosynthetic Clay Liners.

ASTM D 6102-15, Guide for Installation of Geosynthetic Clay Liners.

ASTM D 6214-98(2013), Test Method for Determining the Integrity of Field Seams Used in Joining Geomembranes by Chemical Fusion Methods.

ASTM D 6392-12, Test Method for Determining the Integrity of Nonreinforced Geomembrane Seams Produced Using Thermo-Fusion Methods.

ASTM D 6497-02(2015), Guide for Mechanical Attachment of Geomembrane to Penetrations or Structures.

ASTM D 7176-06 (2011), Specification for Non-Reinforced Polyvinyl Chloride (PVC) Geomembranes Used in Buried Applications.

ASTM D 7272-06 (2011), Test Method for Determining the Integrity of Seams Used in Joining Geomembranes by Pre-manufactured Taped Methods.

ASTM D 7408-12, Specification for Non Reinforced PVC (Polyvinyl Chloride) Geomembrane Seams.

ASTM D 7465-15, Specification for Ethylene Propylene Diene Terpolymer (EPDM) Sheet Used in Geomembrane Applications.

Daniel, D.E., and R.M. Koerner. 1993. Technical Guidance Document: Quality Assurance and Quality Control for Waste Containment Facilities. EPA/600/R-93/182 (NTIS PB94-159100).

Geosynthetic Research Institute, GRI Standard GC8, Standard Guide for 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 (fPP and fPP-R) Nonreinforced and Reinforced 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.

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

U.S. Department of Agriculture, Natural Resources Conservation Service. National Engineering Handbook, Part 642, Specifications for Construction Contracts.

U.S. Department of Agriculture, Natural Resources Conservation Service. Conservation Practice Standard Monitoring Well (Code 353).