


**COMMONWEALTH OF VIRGINIA**  
**Department of Environmental Quality**

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**Subject:** Land Protection and Revitalization Guidance Memo No. LPR-SW-2014-01  
**Clarification of Required Final Cover Designs and Acceptable Alternate Designs**

**To:** Regional Land Protection Program Managers, Regional Solid Waste Permit Writers, Kathryn Perszyk

**From:** Justin Williams   
Director, Office Waste Permitting & Compliance

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**Copies:** Regional Directors, James Golden

**Summary:**

This guidance supersedes the DEQ Office of Solid Waste Permits Memorandum dated May 18, 1993, to solid waste permit staff clarifying required final cover and acceptable alternate designs. This guidance provides additional clarification on acceptable alternate final cover designs in light of the new “pre-approved” alternate designs specified under 9 VAC 20-81-160.D.

**Electronic Copy:**

An electronic copy of this guidance is available on the Virginia Regulatory Town Hall website at: <http://townhall.virginia.gov/L/GDocs.cfm?boardid=119>

**Contact Information:**

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**Disclaimer:**

*This document is provided as guidance and, as such, sets forth standard operating procedures for the agency. However, it does not mandate any particular method nor does it prohibit any alternative method for the analysis of data, unless specifically required by the VSWMR. If alternative proposals are made, such proposals should be reviewed and accepted or denied based on their technical adequacy and compliance with appropriate laws and regulations.*



## Clarification of Required Final Cover Designs and Acceptable Alternate Designs

### I. Introduction

At closure, all solid waste management facilities shall install a final cover system that is designed to achieve the performance requirements of 9 VAC 20-81-160.D.2. The purpose of this guidance document is to provide clarification on the minimum required final cover and acceptable alternate designs specified under this section of the Virginia Solid Waste Management Regulations (VSWMR).

### II. Background

A memorandum was issued on May 18, 1993, to solid waste permit writers clarifying the required final cover and acceptable alternate designs based on the 1988 Solid Waste Management Regulations (VR 672-20-10). In those regulations, and the amendments since, allowances were included for facility owners or operators to request alternate final cover designs. Prior to Amendment 7 of the VSWMR, the 1993 memorandum has provided the basis for reviewing proposed alternate final cover designs. Amendment 7 to the VSWMR provided alternate final cover system designs for sanitary landfills and CDD or industrial landfills separately, thus setting the new standard for minimum alternate cover designs. Outside of these new alternate designs, owners or operators of solid waste disposal facilities have the option to petition for additional alternate final cover systems meeting the requirements of 9 VAC 20-81-160.D.2.f.

### III. Authority

The Virginia Waste Management Act (Va. Code § 10.1-1400 *et seq.*) authorizes the Virginia Waste Management Board to promulgate regulations necessary to carry out its powers and duties and the intent of the Act. Va. Code § 10.1-1410.1 requires submittal of final closure plans to the Department.

In accordance with 9 VAC 20-81-470.A.2., Closure Plans are a required submittal of the Part B solid waste management facility permit application. The required content of these plans is outlined at 9 VAC 20-81-160.B. and includes providing a description of the proposed final cover system. The proposed final cover system shall be designed to achieve the performance requirements of subsection D of this section, which specifies the current minimum required final cover design appropriate for solid waste disposal facilities and provides "pre-approved" alternate final cover designs and equivalency criteria for all other approvable alternate final cover designs.

### IV. Definitions

The definitions in § [10.1-1400](#) of the Code of Virginia and § [9 VAC 20-81-10](#) of the VSWMR apply to the implementation of these procedures and are not included in the list below.

"Bedding layer" means a foundation layer whose purpose is to provide grade control and a smooth surface for overlying layers, typically a flexible membrane liner. Adequate bedding

layers can consist of a 6 to 12 inches of soil that is free of rock, fractured stone, debris, cobbles, rubbish, and roots; geocomposite or geotextile bedding layers can also be used, and may need to be paired with a soil component depending on the condition of the intermediate cover layer. Additionally, depending on the make-up of the bedding layer, this layer can act as a landfill gas collection layer.

"Composite liner" means a bottom liner system consisting of two components. In accordance with RCRA Subtitle D (40 CFR 258), the upper component must consist of a minimum 30-mil flexible membrane liner (60-mil if HDPE), and the lower component must consist of at least a two-foot layer of compacted soil with a hydraulic conductivity of no more than  $1 \times 10^{-7}$  cm/sec (9 VAC 20-81-130.J.1.a.). The FML/GCL alternate liner specified under 9 VAC 20-81-130.J.1.b., and all other two component liner systems meeting the minimum specifications under Subtitle D are considered a composite liner for purpose of this guidance.

"Drainage layer" means a layer consisting of a geocomposite drainage net (GDN) or alternate drainage material whose purpose is to drain the overlying erosion control/vegetative support layer, thereby reducing seepage forces above the infiltration layer.

"FML" means flexible membrane liner.

"GCL" means geosynthetic clay liner.

"Landfill Gas Collection Layer" means a granular or geosynthetic layer whose purpose is to allow for collection of landfill gas below the infiltration layer and convey the gas to a collection or venting point. In some instances, the bedding layer (defined above) can dually act as a landfill gas collection layer.

"Unlined landfill" means a sanitary landfill that is not underlain by a composite liner (a.k.a. HB1205 landfill) or a CDD or industrial landfill that is not underlain by one of the liner systems specified under 9 VAC 20-81-130.J.2.

## **V. Guidance Document**

The intent of this guidance is to provide solid waste permit writers and solid waste landfill owner/operators and their consultants clarification on the minimum required and acceptable alternate final cover designs based on the type of disposal facility (sanitary, CDD, or industrial landfill) and the facility's bottom liner system.

The regulations require that the permeability of the final cover system (or rate of surface water infiltration) be less than or equal to the permeability of the bottom liner system (or rate of leachate leakage). This requirement is intended to eliminate the "bathtub" effect where the containment system fills up with leachate once active operations are terminated. The table below outlines the minimum final cover design and acceptable alternate final cover designs for common liner systems. Facilities with a bottom liner system that does not fall within one of the three categories identified must still install a final cover design that meets the minimum requirements of 9 VAC 20-81-160.D.2. The following sections further relate each cover design to site-specific factors in order to meet the regulatory design requirements. The acceptable

Bottom Liner System	Final Cover System – <b>REQUIRED</b>	Final Cover System – <b>ACCEPTABLE ALTERNATE</b>
Unlined or Soil-only lined Landfill	Subtitle D: <ul style="list-style-type: none"> <li>• 6-inch vegetative support layer<sup>1</sup></li> <li>• 18-inch infiltration layer (<math>1 \times 10^{-5}</math> cm/sec or lower)</li> </ul>	Single GCL: <ul style="list-style-type: none"> <li>• 24-inch erosion control / vegetative support layer</li> <li>• Drainage layer<sup>2</sup></li> <li>• GCL</li> <li>• Landfill gas collection layer<sup>3</sup></li> </ul> Single FML: <ul style="list-style-type: none"> <li>• 24-inch erosion control / vegetative support layer</li> <li>• Drainage layer<sup>2</sup></li> <li>• FML (min 40-mil)</li> <li>• Bedding layer<sup>4</sup></li> </ul> FML/Soil or FML/GCL: <ul style="list-style-type: none"> <li>• 24-inch erosion control / vegetative support layer</li> <li>• Drainage layer<sup>2</sup></li> <li>• FML (min 40-mil)</li> <li>• 18-inch infiltration layer or GCL</li> <li>• Landfill gas collection layer<sup>3</sup></li> </ul>
Single synthetic-lined landfill	Composite Cap: <ul style="list-style-type: none"> <li>• 24-inch vegetative support layer</li> <li>• FML (min 40-mil)</li> <li>• 18-inch infiltration layer (<math>1 \times 10^{-5}</math> cm/sec or lower)</li> </ul>	Single FML: <ul style="list-style-type: none"> <li>• 24-inch erosion control / vegetative support layer</li> <li>• Drainage layer<sup>2</sup></li> <li>• FML (min 40-mil)</li> <li>• Bedding layer<sup>4</sup></li> </ul> FML/GCL alternate: <ul style="list-style-type: none"> <li>• 24-inch erosion control / vegetative support layer</li> <li>• Drainage layer<sup>2</sup></li> <li>• FML (min 40-mil)</li> <li>• GCL</li> <li>• Landfill gas collection layer<sup>3</sup></li> </ul>
Composite lined landfill	Composite Cap: <ul style="list-style-type: none"> <li>• 24-inch vegetative support layer</li> <li>• FML (min 40-mil)</li> <li>• 18-inch infiltration layer (<math>1 \times 10^{-5}</math> cm/sec or lower)</li> </ul>	FML/GCL alternate: <ul style="list-style-type: none"> <li>• 24-inch erosion control / vegetative support layer</li> <li>• Drainage layer<sup>2</sup></li> <li>• FML (min 40-mil)</li> <li>• GCL</li> <li>• Landfill gas collection layer<sup>3</sup></li> </ul>
<p><sup>1</sup> The regulation stipulates a minimum 6-inch vegetative support layer; however, a 24-inch layer is standard in most of Virginia in order to protect the infiltration layer from the effects of erosion, frost, and wind as stipulated in 9 VAC 20-81-160.D.2.c.(2)</p> <p><sup>2</sup> While not required by regulation, use of a drainage layer is recommended to prevent storm water infiltration and improve stability of the landfill cap.</p> <p><sup>3</sup> While not required by regulation, use of a landfill gas collection layer reduces pressure forces beneath the final cover system and allows for collection and removal of landfill gas.</p> <p><sup>4</sup> While not required by regulation, use of a bedding layer provides grade control and a smooth surface to prevent damage to the FML.</p>		

alternate final cover designs also include recommendations for additional layers to enhance final cover performance based on common design features seen in submitted permit applications. Please note, these recommendations are not required design features when considering an alternate final cover design, but should be taken under consideration for site-specific suitability.

Please note, this guidance does not discuss the intermediate cover layer, which shall consist of at least one foot of compacted soil. The final cover system designs discussed in this guidance would be placed above the intermediate cover layer in accordance with the compaction and cover requirements of 9 VAC 20-81-140.B.1.d. (sanitary landfill), C.1.c. (CDD landfill), and D.1.d. (industrial landfill).

#### **V.A Final Covers Appropriate for Unlined and Soil-only Lined Landfills**

Unlined landfills and those constructed with a soil liner are required to install a final cover system meeting the minimum requirements outlined under 9 VAC 20-81-160.D.2.c. This requires a final cover system consisting of, at a minimum:

- (1) an infiltration layer constructed of at least 18 inches of earthen material that has a hydraulic conductivity less than or equal to the hydraulic conductivity of any bottom liner system or natural subsoils present, but no greater than  $1 \times 10^{-5}$  cm/sec; and
- (2) an erosion layer that contains a minimum of six inches of earthen material capable of sustaining native plant growth and protecting the infiltration layer from the effects of erosion, frost, and wind. Depending on the facility's location in Virginia, the typical depth of frost penetration and vegetative root penetration depths may require a thicker layer (upwards of 24 inches) to protect the infiltration layer.

One alternative to the soil infiltration layer specified above, the 18-inch layer can be replaced with a single geosynthetic clay liner (GCL), resulting in a final cover system consisting of, from top down a 24-inch erosion control / vegetative growth layer; and a GCL; over the intermediate cover layer. Inclusion of a drainage layer between the erosion control / vegetative growth layer and the GCL is also recommended to prevent storm water infiltration and improve stability of the landfill cap. Requests for this final cover system will need to be accompanied by additional information citing the long-term GCL performance and stability when exposed to seasonal wet/dry and hot/cold cycles. In addition, GCL cover soils should be investigated to determine ionic content and information provided on how cations present in the soil will interact with the GCL and impacts its hydraulic conductivity.

A second alternative to the soil infiltration layer specified above is to replace the 18-inch layer with a single flexible membrane liner (FML), resulting in a final cover system consisting of, from top down a 24-inch erosion control / vegetative growth layer; a 40-mil minimum FML; and a bedding layer over the intermediate cover layer. Inclusion of a drainage layer between the erosion control / vegetative growth layer and the FML is also recommended to prevent storm water infiltration and improve stability of the landfill cap.

Facilities closing unlined and soil-only lined landfills are encouraged to construct even lower permeability final covers than the required minimum. The primary goal of the final cover system is to prevent the infiltration of rain water. A low permeability ( $1 \times 10^{-5}$  cm/sec or  $1 \times 10^{-7}$  cm/sec) soil-only final cover system will continue to allow rainwater infiltration, which may be

exacerbated by the annual freeze-thaw cycles, settlement due to waste decomposition, soil erosion, deep rooted vegetation, and burrowing animals. Installation of a final cover system including geosynthetics (geomembranes, geosynthetic clay liners, geocomposites, etc.) can decrease the final cover's permeability and provide drainage of rainwater from the cap system. Final covers using geosynthetics should be considered for facilities undergoing corrective action for groundwater at the time of closure. Thus, a third alternative to the soil-only infiltration layer specified above is to create a composite cap. This can be accomplished by adding a FML to the soil infiltration layer, resulting in a final cover system consisting of, from top down, a 24-inch vegetative support layer, a FML (min 40-mil), and an 18-inch infiltration layer ( $1 \times 10^{-5}$  cm/sec or lower) or to replace the 18-inch layer with a FML/GCL combination, resulting in a final cover system consisting of, from top down, a 24-inch erosion control/vegetative growth layer; a 40-mil minimum FML; and a GCL. Both of these options are outlined under 9 VAC 20-81-160.D.2.d.

#### **V.B. Final Covers Appropriate for Synthetic-Lined and Composite-Lined Landfills**

The minimum final cover for a single synthetic-lined CDD or industrial landfill or a composite-lined sanitary landfill includes, from top down, an erosion control layer consisting of 24 inches of soil capable of sustaining native plant growth and protecting the infiltration layer from the effects of erosion, frost, and wind; a geomembrane (minimum 40-mil), and an infiltration layer consisting of 18 inches of earthen material with a hydraulic conductivity less than or equal to  $1 \times 10^{-5}$  cm/sec.

For single synthetic-lined CDD and industrial landfills, alternative to a composite cap, the infiltration layer can be omitted resulting in a final cover system consisting of, from top down, a 24-inch erosion control/vegetative support layer and a 40-mil FML. A bedding layer should be placed between the FML and intermediate cover to protect the FML. A second option is to replace the soil infiltration layer specified with a GCL, resulting in a final cover system consisting of, from top down, a 24-inch erosion control/vegetative support layer, a 40-mil FML, and a GCL. Depending on the types of wastes disposed, a landfill gas collection layer may also be appropriate under the GCL. The regulation, specifically 9 VAC 20-81-160.D.2.e., allows for CDD and industrial landfills to be closed with a barrier layer consisting of a GCL paired with the 24-inch erosion control/vegetative support layer; however, this final cover system is not appropriate when the bottom liner contains an FML.

For composite-lined sanitary landfills, the 18-inch soil component in the infiltration layer may be replaced with a GCL. This results in a final cover system consisting of, from top down, a 24-inch erosion control / vegetative support layer, a minimum 40-mil FML, and a GCL over the intermediate cover. Again, the use of a drainage layer is recommended between the erosion control/vegetative support layer and FML to prevent storm water infiltration and improve stability of the landfill cap.

#### **V.C. Other Alternate Final Covers**

The Director may approve other alternate final cover designs that include:

- (1) an infiltration layer that achieves an equivalent reduction in infiltration as 18 inches of soil with a hydraulic conductivity less than or equal to the hydraulic conductivity of the bottom liner system or natural subsoils (no greater than  $1 \times 10^{-5}$  cm/sec); and

- (2) a minimum 24-inch erosion layer that is capable of sustaining native plant growth and provide for protection of the infiltration layer from the effects of erosion, frost, and wind.

**1. The Infiltration Layer Demonstration**

The infiltration layer is the portion of the proposed final cover system composed of one or more sequentially-placed low permeability soil or geosynthetic layers. An adequate demonstration will provide HELP Model results and other relevant calculations showing the proposed infiltration layer meets or exceeds the above infiltration requirement. This demonstration should not solely rely on the use of a drainage layer placed above the infiltration layer in a final cover system. The purpose of a drainage layer is to facilitate the removal of rainwater from the final cover system, thus preventing infiltration and instability; thus, this layer is considered part of the erosion layer for purposes of this demonstration. The infiltration layer demonstration needs to show that the proposed alternate infiltration layer meets or exceeds the effectiveness of the infiltration layer otherwise required by regulation.

**2. Exceptions to the 24-inch erosion layer**

The requirement to install a 24-inch thick erosion layer indicates that exposed geosynthetic final cover systems are not allowed under the VSWMR. Any requests for exposed geosynthetic covers (e.g. synthetic turf, solar geomembrane covers, etc.) will require submittal of a variance petition in accordance with 9 VAC 20-81-760 that demonstrates the requirements of 9 VAC 20-81-720 are met by the proposal.

Variances for use of EGCs in lieu of installing the required 24-inch erosion layer need to address the longevity of EGCs, stormwater run-off management, anchoring of EGCs against wind uplift, and how repairs will be made from damage due to animals, material degradation, and weather events. The postclosure cost estimate and related Financial Assurance mechanism shall account for the costs associated with removal of the alternate final cover and closure of the landfill with a final cover system meeting the requirements of 9 VAC 20-81-160.D.2. Evaluations of the effectiveness of the EGC will be made during the postclosure care period. At a request for termination of Post-Closure Care, if the EGC remains, the Department will evaluate the performance of the EGC and its viability as an alternate final cover, particularly focusing on the impact of no continued maintenance. This may require a longer post-closure care period, alterations to the alternate final cover, or other actions before the Department will terminate Post-Closure Care.

**3. RDD Plans for testing of the construction and infiltration performance of alternative final cover systems**

Alternate final or interim covers can also be applied for under the Research, Development and Demonstration Plan program for sanitary landfills. Covers under these plans would allow testing of the construction and infiltration performance of alternate final cover systems, such as phytocovers or evapotranspirative/water balance covers. Information regarding the applicability and major permit modification for such an alternate final or interim cover are provided in [Guidance Memo 05-2009: Research, Development and Demonstration Plans](#).

## **V.D. Administrative Procedures**

### **1. Staff Review of the Application**

The facility shall submit revised closure plans at least 180 days prior to the date closure activities are expected to begin. The regulation requires that the Department approve or disapprove of the submitted plan within 90 days of receipt. If the revised closure plan includes changes to the design of final closure cover, the revised closure plan shall be submitted with a major permit modification request. The Department will have 90 days to review the closure plan and indicate whether approval or denial is appropriate in accordance with 9 VAC 20-81-160.B.3. If the decision is to approve the plan (i.e. the plan is administratively complete and technically adequate), the facility shall be notified within the 90 day period of the DEQ's intention to draft a permit and move forward with the major permit modification.

### **2. Permit Modifications**

**Minor Modifications:** Revised closure plans that do not affect the final closure cover design require a minor permit modification to incorporate the revised plan into the facility's permit. Once the decision to approve the plan has been determined, the regional office solid waste permit writer staff will prepare the minor modification approval letter and provide to the regional land protection manager or appropriate authority for signature. For minor modifications, the goal should be for the minor modification approval letter to be issued within the 90 day review period.

**Major Modifications:** Revised closure plans requiring a major permit modification require public notification of the draft permit availability with a minimum 30-day public comment period. Once the decision to approve the plan has been determined, the regional office solid waste permit writer will prepare the draft permit and public notification package. The facility will be responsible for placing the prepared public notice in a local newspaper, while staff will ensure the notice is posted on the DEQ website. If a public hearing is requested during the public comment period, the hearing shall be held in the locality of the facility. Public hearings are typically held Tuesday, Wednesday, or Thursday evenings at 7pm in the board of supervisors meeting room at the County Courthouse, other administrative building, or public libraries.

At the end of the public comment period, the Department will review all comments received and determine whether changes to the draft permit are warranted. A final decision on the draft permit will be made within 90 days of the close of the public comment period.

## **V. Collaboration Process**

No project team was formed to develop this guidance; however, DEQ Central Office and Regional staff were given opportunity to comment during development. Additionally, comments from interested parties were solicited and considered in the final version.



## **VI. Other Applicable Information**

The following guidance documents also pertain to landfill closure:

[Submission Instruction No. 6: Closure and Post-closure Care Plans for Solid Waste Disposal and Management Facilities](#)

[OWPC Memo 2009-04: Final Cap System Hydraulic Conductivity Testing – Infiltration Layer](#)  
[link is to DEQNet]

[Guidance Memo 05-2009: Research, Development and Demonstration Plans](#)