

**RESPONSE 41**

**APPENDIX III-3G-4**

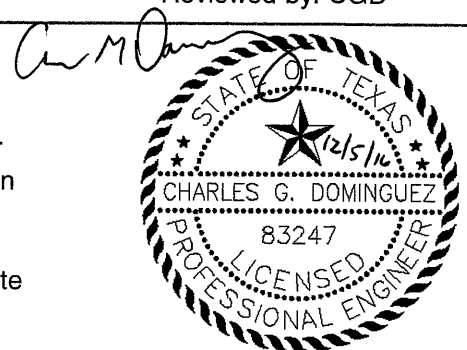
**LEACHATE COLLECTION SYSTEM OVERLINER DRAINAGE LAYOUT**

**LEACHATE COLLECTION SYSTEM  
 OVERLINER DRAINAGE LAYOUT**

Made By: VK  
 Checked by: JBF / MX  
 Reviewed by: CGD

**1.0 OBJECTIVE**

- I) Determine the required transmissivity of the overliner drainage layer (double-sided geocomposite) based on critical case conditions.
- II) Based on published data, determine the geocomposite drainage layer type that will meet the required transmissivity.



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**2.0 GIVEN**

The critical case overliner slope is a composite slope consisting of the following : (i) a 15% slope of length ( $L_{up}$  - upstream) = 270 ft.

and (ii) a 33% slope of length ( $L_{down}$  - downstream) = 85 ft.

The permeability of the protective cover,  $K_{prot} = 1.0E-05$  cm/s  
 (same as HELP model)

**3.0 METHOD**

Determine the required transmissivity of the overliner drainage layer after applying reduction factors and a factor of safety.

$$\theta_{\text{measured -req, downstream}} = FS \Pi(RF) q_h (L_{up} + L_{down}) / (\sin \beta_{down}) \text{ (Ref. 2)}$$

$$\theta_{\text{measured -req, upstream}} = FS \Pi(RF) q_h (L_{up}) / (\sin \beta_{up}) \text{ (Ref. 2)}$$

$\theta_{\text{measured -req}}$  = required transmissivity of geocomposite drainage layer measured in laboratory

- Test Conditions:  $i = 0.33$
- Normal Stress = 10,000 psf
- Boundary Cond'ns = steel plates
- Test Time = 15 minutes

FS = factor of safety (see Table 1)

RF = reduction factors (see Table 1)

$\Pi(RF)$  = product of all reduction factors

$q_h$  = rate of liquid supply expressed per unit surface area measured horizontally.

L = length of geocomposite in direction of flow

$\beta$  = slope angle

Based on the above equations and the given slopes of the upstream and downstream sections, the required transmissivity on the upstream slope will be higher. Hence, the upstream section represents the critical case.

The required transmissivity is calculated for the following conditions:

(i) exposed condition - consists of saturated protective cover overlying the drainage layer. Under this condition the gradient = 1.0 and  $q_h$  is equal to the hydraulic conductivity of the protective cover soil  $q_h = 1.0 \times 10^{-5}$  cm/sec = 0.340 in/day.

(ii) open condition

(iii) intermediate condition

(iv) final condition prior to final cover placement

(v) final condition with final cover



(Refer Appendix III-3E-1 for explanation of conditions ii-v)

#### 4.0 CALCULATION

**Table 1 Required Transmissivity for Overliner Upstream Slope Section (Critical Case)**

Condition	$q_h$ (in/day) <sup>(1)</sup>	$\theta_{design}$ (m <sup>2</sup> /sec)	RF <sub>cr</sub> <sup>(1)</sup>	RF <sub>cc</sub> <sup>(2)</sup>	RF <sub>bc</sub> <sup>(2)</sup>	RF <sub>in</sub> <sup>(2)</sup>	FS	$\theta_{required}$ (m <sup>2</sup> /sec)
Exposed	0.340	5.5E-05	1	1	1.1	1.1	1.5	1.19E-04
Open	0.278	4.5E-05	1	1.2	1.1	1.1	2	1.82E-04
Intermediate	0.152	2.4E-05	2	1.7	1.3	1.1	3	2.67E-04
Final - no cover	0.053	8.5E-06	2	2	2	1.2	4	3.27E-04
Final	1.1E-04	1.8E-08	2	2	2	1.2	4	6.79E-07

(1) All values except the exposed condition (explained in Section 3.0) are obtained from Appendix III-3E-1

(2) Reduction factors are based on Ref. 1

I) The required transmissivity ( $\theta_{required}$ ) (i.e. the transmissivity required during QC and conformance testing) was determined to be  **$3.7 \times 10^{-4}$  m<sup>2</sup>/sec.**

II) Typical transmissivity values for double-sided 200-mil geonet geocomposites are in the  $10^{-4}$  m<sup>2</sup>/sec range and are expected to meet the required transmissivity for the overliner system.

## 5.0 CONCLUSION

A standard 200-mil, double-sided geocomposite drainage layer will have flow capacity adequate to prevent the development of hydrostatic pressure below the protective cover on the overliner slopes. As per the Liner Quality Control Plan (Appendix III-3F), construction performance testing will be performed to verify that the geocomposite selected for construction has adequate transmissivity to meet the design requirement.

## 6.0 REFERENCES

1. Giroud, J.P, Zornberg, J.G., and Zhao, A., "Hydraulic Design of Geosynthetic and Granular Liquid Collection Layers", Geosynthetics International, Vol. 7, Nos. 4-6, 2000.
2. Giroud, J.P, Zornberg, J.G., and Zhao, A., "Hydraulic Design of Geosynthetic and Granular Liquid Collection Layers Comprising Two Different Slopes", Geosynthetics International, Vol. 7, Nos. 4-6, 2000.

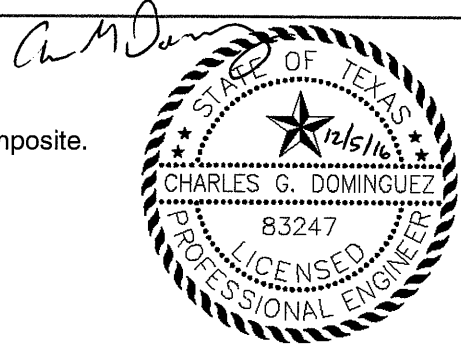
**APPENDIX III-3F-3C  
UNDERDRAIN GEOCOMPOSITE CALCULATION**

**UNDERDRAIN GEOCOMPOSITE  
 CALCULATION**

Made By: JBF  
 Checked by: MX  
 Reviewed by: CGD

**1.0 OBJECTIVE**

Determine the required transmissivity of the sideslope underdrain geocomposite.



**2.0 GIVEN**

Maximum groundwater flow  
 along entire sideslope = 6.11E-08 ft<sup>3</sup>/sec per unit width (maximum  
 total flow along slope - See  
 Appendix III-3F-3a)

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**3.0 METHOD**

Determine the required transmissivity of the sideslope underdrain geocomposite layer after applying  
 reduction factors and a factor of safety.

$$\theta_{\text{measured -req}} = FS\Pi(RF)q_h L / (\sin\beta) \quad (\text{Ref. 1})$$

$\theta_{\text{measured -req}}$  = required transmissivity of geosynthetic drainage layer measured in laboratory

Test Conditions:  $i = 0.33$

Normal Stress = 10,000 psf

Boundary Cond'ns = steel plates

Test Time = 15 minutes

FS = factor of safety = 1.5 (short-term cond'ns)

RF = reduction factors (see below) -- (short-term cond'ns)

$\Pi(RF)$  = product of all reduction factors

$q_h$  = rate of liquid supply per unit area (m<sup>3</sup>/s/m<sup>2</sup> or m/s)

L = length of geocomposite in direction of flow (m)

$q_h L = 6.11E-08 \text{ ft}^3/\text{sec}$  (this value represents the total flow along the entire sideslop, which is  
 computed in SEEP/W, IN App. III-3F-3a)

$\beta$  = slope angle

Reduction Factor	Description	Value (Ref. 1)
$RF_{in}$	Reduction Factor for intrusion of geotextile into geonet	1.2
$RF_{cr}$	Reduction Factor for creep	1.0
$RF_{cc}$	Reduction Factor for chemical clogging of geotextile and/or geonet	1.1
$RF_{bc}$	Reduction Factor for biological clogging of geotextile and/or geonet	1.1
$\Pi(RF) =$		1.5

#### 4.0 CALCULATION

I) Transmissivity for maximum flow

$$\theta_{\text{measured-req}} = 3.9\text{E-}07 \text{ ft}^3/\text{s-ft} = 3.6\text{E-}08 \text{ m}^3/\text{s-m}$$

II) Typical transmissivity values for double-sided 200-mil geonet geocomposites under low normal loads are in the  $10^{-4} \text{ m}^3/\text{s-m}$  range; roughly 3 orders of magnitude greater than required.

#### 5.0 CONCLUSION

A standard 200-mil, double-sided geocomposite underdrain layer will have flow capacity adequate to prevent the development of hydrostatic pressure below the clay liner on the sideslopes.

#### 6.0 REFERENCES

1. Giroud, J.P, Zornberg, J.G., and Zhao, A., "Hydraulic Design of Geosynthetic and Granular Liquid Collection Layers", Geosynthetics International, Vol. 7, Nos. 4-6, 2000.