GEOSYNTHETIC CLAY LINERS
PRODUCT DATA

FOR MORE INFORMATION

Geosynthetics magazine has provided information on the geosynthetic clay liner specification charts for comparative purposes only. Designers should contact manufacturers for additional details and to discuss site-specific considerations.

Information on the use and specification of geosynthetic clay liners is also available from the Geosynthetic Materials Association (GMA).

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PUBLISHER’S NOTE

Geosynthetics magazine compiled all information included in the 2018 Geosynthetics Specifier’s Guide from information submitted by firms in the geosynthetic industry. Companies provided specifications voluntarily, and specification accuracy is the responsibility of the manufacturer. The appearance of a listing in this directory is not an endorsement of the company or product by Geosynthetics magazine or the Industrial Fabrics Association International (IFAI). The 2018 Geosynthetics Specifier’s Guide is intended as a guide, and Geosynthetics magazine and IFAI encourage readers to contact the companies listed for further information.

By bonding clay to geosynthetic materials, manufacturers created an economical, long-term solution for many applications.

Geosynthetic clay liners (GCLs) are hydraulic barriers made of clay bonded to a single geosynthetic layer or to multiple geosynthetic layers. Because of its low permeability, swelling capacity and relative abundance, natural sodium bentonite is the preferred clay component of GCLs. A wide range of materials, including geotextiles and geomembranes, are used to carry and encapsulate the clay. Also, they provide the product with structural support.

GCLs are used primarily as substitutes for compacted clay liners (CCLs), providing significant advantages in cost, ease of installation and performance. Primary applications include surface impoundment, secondary containment and landfill lining.

GCL use has grown steadily, and standards have been authored to address swell and fluid-loss index testing, determination of flux, manufacturing, sampling, installation and more.

Manufacturing process

GCLs are prefabricated sheets of processed bentonite clay available in multiple sizes. They are manufactured by encapsulating the clay between two or more layers of geotextile or by bonding the clay to one side of a geomembrane. The geotextile-supported products hold the clay in place by soluble adhesives, I-ties or barbed-needle punching that interlocks the geotextile fibers, or by periodic rows of heavy stitching through the clay and fabric.

The numbers

Companies that submitted product data chart lines were asked to provide data determined through industry-accepted testing methods. Companies signed a certificate of compliance verifying the accuracy of this data.
### Geosynthetic Clay Liners

**Companies were requested to provide minimum roll values (MARV). All claims are the responsibility of the manufacturer.**

#### GEOSYNTHETIC CLAY LINERS

**Flux** is defined as "Flow rate/unit area" which can be converted to permeability using the equation:

$$\text{Permeability} = \frac{\text{flux}}{\text{hydraulic gradient}}$$

**Report result at a maximum confining stress of 35 kPa (5 psi) and 14 kPa (2 psi) head pressure**

<table>
<thead>
<tr>
<th>Product Name</th>
<th>Bonding Method</th>
<th>Needlepunched Peel Strength ASTMD4569: N/m (lb/in)</th>
<th>Panel Size Roll Width/Length m/m (ft/ft)</th>
<th>Average Roll Weight kg (lb)</th>
<th>Bentonite Mass/Unit Area ASTM D5993 gm/m² (lb/ft²)</th>
<th>Flux ASTM D5887 [m³/m²-s]</th>
<th>Swell Index ASTM D5890 (ml/2g)</th>
<th>Fluid Loss ASTM D5891 ml</th>
<th>Upper Geosynthetic Type or Structure</th>
<th>Weight ASTM D5261 or Thickness ASTM D5199 g/m² or mm (oz/yd² or mil)</th>
<th>Lower Geosynthetic Type or Structure</th>
<th>Weight ASTM D5261 or Thickness ASTM D5199 g/m² or mm (oz/yd² or mil)</th>
<th>Manufacturer’s Suggested Applications [3]</th>
</tr>
</thead>
<tbody>
<tr>
<td>AGRU America</td>
<td><a href="http://www.agruamerica.com">www.agruamerica.com</a></td>
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<tr>
<td>Agru GeoClay® NN66</td>
<td>Needle Punch</td>
<td>6.1 (3.5)</td>
<td>4.7/45.7 (15.5/150)</td>
<td>1700 (3750)</td>
<td>3600 (0.75)</td>
<td>1x10⁻⁸</td>
<td>24</td>
<td>18</td>
<td>Nonwoven</td>
<td>200 (6.0)</td>
<td>Nonwoven</td>
<td>200 (6.0)</td>
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<td>Agru GeoClay® WN26</td>
<td>Needle Punch</td>
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<td>4.7/45.7 (15.5/150)</td>
<td>1590 (3500)</td>
<td>3600 (0.75)</td>
<td>1x10⁻⁸</td>
<td>24</td>
<td>18</td>
<td>Nonwoven</td>
<td>200 (6.0)</td>
<td>Woven</td>
<td>105 (3.1)</td>
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<td>CETCO</td>
<td><a href="http://www.cetco.com">www.cetco.com</a></td>
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<tr>
<td>BENTOMAT 600CL</td>
<td>needled punched laminated</td>
<td>175 (1.0)</td>
<td>4.6/45.7 (15/150)</td>
<td>1250 (2750)</td>
<td>3660 (0.75)</td>
<td>1 x 10⁻⁹</td>
<td>24</td>
<td>18</td>
<td>geotextile/geotextile composite</td>
<td>NP</td>
<td>wave</td>
<td>105 (3.2)</td>
<td>LL, LC, SIC, CL, SLL</td>
</tr>
<tr>
<td>BENTOMAT CL</td>
<td>needled punched laminated</td>
<td>610 (3.5)</td>
<td>4.6/45.7 (15/150)</td>
<td>1250 (2750)</td>
<td>3660 (0.75)</td>
<td>1 x 10⁻⁹</td>
<td>24</td>
<td>18</td>
<td>smooth FML/ geotextile composite</td>
<td>NP</td>
<td>wave</td>
<td>105 (3.2)</td>
<td>LL, LC, SIC, CL, SLL</td>
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<td>BENTOMAT CLT</td>
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<td>610 (3.5)</td>
<td>4.6/45.7 (15/150)</td>
<td>1340 (2950)</td>
<td>3660 (0.75)</td>
<td>1 x 10⁻⁹</td>
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<td>18</td>
<td>textured FML/ geotextile composite</td>
<td>NP</td>
<td>wave</td>
<td>105 (3.2)</td>
<td>LL, LC, SIC, CL, SLL</td>
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<td>BENTOMAT DN</td>
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<td>1220 (2700)</td>
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<td>1 x 10⁻⁸</td>
<td>24</td>
<td>18</td>
<td>nonwoven</td>
<td>200 (6.0)</td>
<td>nonwoven</td>
<td>200 (6.0)</td>
<td>LL, LC, SIC</td>
</tr>
<tr>
<td>BENTOMAT ST</td>
<td>needled punched</td>
<td>610 (3.5)</td>
<td>4.6/45.7 (15/150)</td>
<td>1200 (2650)</td>
<td>3660 (0.75)</td>
<td>1 x 10⁻⁸</td>
<td>24</td>
<td>18</td>
<td>nonwoven</td>
<td>200 (6.0)</td>
<td>wave</td>
<td>105 (3.2)</td>
<td>LL, LC, SIC</td>
</tr>
<tr>
<td>BENTOMAT 200R</td>
<td>needled punched</td>
<td>175 (1.0)</td>
<td>4.6/45.7 (15/150)</td>
<td>1200 (2650)</td>
<td>3660 (0.75)</td>
<td>1 x 10⁻⁸</td>
<td>24</td>
<td>18</td>
<td>nonwoven</td>
<td>105 (3.2)</td>
<td>wave</td>
<td>105 (3.2)</td>
<td>LL, LC, SIC</td>
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<tr>
<td>RESISTEX</td>
<td>needled punched Per Design</td>
<td>175 (1.0)</td>
<td>4.4/45.7 (14.5/150)</td>
<td>1300 (2870)</td>
<td>4400 (1.0)</td>
<td>4 x 10⁻⁹</td>
<td>NP</td>
<td>NP</td>
<td>Per Design</td>
<td>Per Design</td>
<td>Per Design</td>
<td>Per Design</td>
<td>LL, SIC*</td>
</tr>
</tbody>
</table>

[1] Flux is defined as "Flow rate/unit area" which can be converted to permeability using the equation:  
Permeability = \frac{\text{flux}}{\text{hydraulic gradient}}

[2] Report result at a maximum confining stress of 35 kPa (5 psi) and 14 kPa (2 psi) head pressure

[3] CL = Canal liner  
LL = Landfill liner  
SL = Surface impoundment cover  
LC = Landfill cover  
SIL = Surface impoundment liner  
NP = Not provided by manufacturer  
NA = Not applicable, per manufacturer

*RESISTEX*® geosynthetic clay liners were tested against various leachates including but not limited to samples from EPRI (Electric Power Research Institute) and other industrial leachates, and should be considered as guide only. CETCO offers site-specific compatibility testing to verify the suitability of CETCO products. Site-specific geotechnical properties will be per design and appropriate testing will be conducted to confirm expected performance criteria.

**CETCO** ® RESISTEX® geosynthetic clay liners are engineered to provide the highest level of chemical compatibility in extremely aggressive leachate environments such as coal combustion product storage facilities, mining operations, and industrial waste storage facilities.
### GEOSYNTHETIC CLAY LINERS

**Geosynthetics** recommends you contact the manufacturers before making any specifying/purchasing decisions.

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\]

**Report result** at a maximum confining stress of 35 kPa (5 psi) and 14 kPa (2 psi) head pressure.

<table>
<thead>
<tr>
<th>Product Name</th>
<th>Bonding Method</th>
<th>Non-dimples Patch strength</th>
<th>Panel Size Roll Width/Length</th>
<th>Average Roll Weight (lb)</th>
<th>Bentonite Mass/Unit Area ASTM D5993</th>
<th>Flux (m^3/m^2-s)</th>
<th>Fluid Loss ASTM D5891</th>
<th>Swell Index ASTM D5878 (ml/2g)</th>
<th>Manufacturers Suggested Applications</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>GSE Environmental</strong></td>
<td><a href="http://www.gseworld.com">www.gseworld.com</a></td>
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<tr>
<td>GSE BentoLiner CNSL</td>
<td>needlepunched, coated</td>
<td>610 (3.5)</td>
<td>4.7/46 (15.5/190)</td>
<td>1180 (2600)</td>
<td>3660 (0.75)</td>
<td>1 x 10^-9</td>
<td>24</td>
<td>18</td>
<td>nonwoven</td>
</tr>
<tr>
<td>GSE BentoLiner EC</td>
<td>needlepunched</td>
<td>175 (1.0)</td>
<td>4.7/46 (15.5/150)</td>
<td>1180 (2600)</td>
<td>3660 (0.75)</td>
<td>1 x 10^-8</td>
<td>24</td>
<td>18</td>
<td>nonwoven</td>
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<tr>
<td>GSE BentoLiner NSL</td>
<td>needlepunched</td>
<td>610 (3.5)</td>
<td>4.7/46 (15.5/190)</td>
<td>1180 (2600)</td>
<td>3660 (0.75)</td>
<td>1 x 10^-8</td>
<td>24</td>
<td>18</td>
<td>nonwoven</td>
</tr>
<tr>
<td>GSE BentoLiner NNL</td>
<td>needlepunched</td>
<td>610 (3.5)</td>
<td>4.7/46 (15.5/190)</td>
<td>1180 (2600)</td>
<td>3660 (0.75)</td>
<td>1 x 10^-8</td>
<td>24</td>
<td>18</td>
<td>nonwoven</td>
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<tr>
<td>GSE BentoLiner NNL 35</td>
<td>needlepunched</td>
<td>928 (5.3)</td>
<td>4.7/46 (15.5/190)</td>
<td>1180 (2600)</td>
<td>3660 (0.75)</td>
<td>1 x 10^-8</td>
<td>24</td>
<td>18</td>
<td>nonwoven</td>
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<tr>
<td>GSE BentoLiner NNL-60</td>
<td>needlepunched</td>
<td>2,100 (12.0)</td>
<td>4.7/46 (15.5/190)</td>
<td>1180 (2600)</td>
<td>3660 (0.75)</td>
<td>1 x 10^-8</td>
<td>24</td>
<td>18</td>
<td>nonwoven</td>
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<tr>
<td><strong>Terrafix Geosynthetics Inc./Terrafix Environmental Technology Inc.</strong></td>
<td><a href="http://www.terrafixgeo.com">www.terrafixgeo.com</a></td>
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<tr>
<td>Bentofix NSE</td>
<td>needlepunched/ enhanced/polymer bentonite</td>
<td>610 (3.5)</td>
<td>4.72 m x 60 m (15.5/196.86)</td>
<td>1400 (3200)</td>
<td>4330 (0.939)</td>
<td>5 x 10^-9</td>
<td>26</td>
<td>16</td>
<td>nonwoven</td>
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<tr>
<td>BentoFix SRNWE</td>
<td>needlepunched/ enhanced/polymer bentonite</td>
<td>610 (3.5)</td>
<td>4.72 m x 60 m (15.5/196.86)</td>
<td>1585 (3500)</td>
<td>4330 (0.939)</td>
<td>5 x 10^-9</td>
<td>26</td>
<td>16</td>
<td>nonwoven</td>
</tr>
<tr>
<td>BentoFix CNWE</td>
<td>needlepunched/ polymer coated/ enhanced/polymer bentonite</td>
<td>610 (3.5)</td>
<td>4.72 m x 60 m (15.5/196.86)</td>
<td>1630 (3600)</td>
<td>4330 (0.939)</td>
<td>1 x 10^-9</td>
<td>26</td>
<td>16</td>
<td>nonwoven</td>
</tr>
</tbody>
</table>

**Note:** Also available in coal ash and brine resistant formulas.

**Manufacturers’ Suggested Applications:**

- **LL, LC, SIL, coal ash resistant**
- **High head applications with low hydraulic conductivity**
- **Low loads and flat slopes**
- **Medium loads and slopes**
- **High loads and steep slopes**

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