



# 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 *Geosynthetics 2021 Specifier's Guide* from information submitted by firms in the geosynthetics 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 *Geosynthetics 2021 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.

**G**eosynthetic 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.

GCLs 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 needlepunching 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

Product Name	Bonding Method	Needle-punched Peel Strength ASTM D6496, N/m (lb/in)	GCL Dimensional Properties			GCL Hydraulic Properties	Base Bentonite Properties		GCL Structural Components				Manufacturer's Suggested Applications [3]
			Panel Size Roll Width/ Length m/m (ft/ft)	Average Roll Weight kg (lb)	Bentonite Mass/Unit Area ASTM D5993 gm/m <sup>2</sup> (lb/ft <sup>2</sup> )	Flux [1] ASTM D 5887 [2] m <sup>3</sup> /m <sup>2</sup> ·s	Swell Index ASTM D 5890 (min) ml/2g	Fluid Loss ASTM D 5891 ml	Upper Geosynthetic		Lower Geosynthetic		
									Type or structure	Weight ASTM D5261 or Thickness ASTM D5199 g/m <sup>2</sup> or mm (oz/yd <sup>2</sup> or mil)	Type or structure	Weight ASTM D5261 or Thickness ASTM D5199 g/m <sup>2</sup> or mm (oz/yd <sup>2</sup> or mil)	
<b>AGRU America</b>   <a href="http://www.agruamerica.com">www.agruamerica.com</a>													
<b>Agru GeoClay® NN66</b>	Needle punch	6.1 (3.5)	4.7/45.7 (15.5/150)	1700 (3750)	3600 (0.75)	1x10 <sup>-8</sup>	24	18	Nonwoven	200 (6.0)	Nonwoven	200 (6.0)	
<b>Agru GeoClay® WN36</b>	Needle punch	6.1 (3.5)	4.7/45.7 (15.5/150)	1590 (3500)	3600 (0.75)	1x10 <sup>-8</sup>	24	18	Nonwoven	200 (6.0)	Woven	105 (3.1)	
<b>CETCO</b>   <a href="http://www.cetco.com">www.cetco.com</a>													
<b>BENTOMAT 600CL</b>	Needle-punched laminated	175 (1.0)	4.6/45.7 (15/150)	1250 (2750)	3660 (0.75)	1 x 10 <sup>-9</sup>	24	18	Geofilm/geotextile composite	NP	Woven	105 (3.2)	LL, LC, SIC, CL, SIL
<b>BENTOMAT CL</b>	Needle-punched laminated	610 (3.5)	4.6/45.7 (15/150)	1270 (2800)	3660 (0.75)	1 x 10 <sup>-9</sup>	24	18	Smooth FML/geotextile composite	NP	Woven	105 (3.2)	LL, LC, SIC, CL, SIL
<b>BENTOMAT CLT</b>	Needle-punched laminated	610 (3.5)	4.6/45.7 (15/150)	1360 (3000)	3660 (0.75)	1 x 10 <sup>-9</sup>	24	18	Textured FML/geotextile composite	NP	Woven	105 (3.2)	LL, LC, SIC, CL, SIL
<b>BENTOMAT FLW</b>	Needle-punched	610 (3.5)	4.4/45.7 (14.5/150)	1220 (2700)	3660 (0.75)	1 x 10 <sup>-8</sup>	24	18	Nonwoven	200 (6.0)	Scrim reinforced nonwoven	200 (6.0)	LL, LC, SIC
<b>BENTOMAT DN</b>	Needle-punched	610 (3.5)	4.4/45.7 (14.5/150)	1220 (2700)	3660 (0.75)	1 x 10 <sup>-8</sup>	24	18	Nonwoven	200 (6.0)	Nonwoven	200 (6.0)	LL, LC, SIC
<b>BENTOMAT ST</b>	Needle-punched	610 (3.5)	4.6/45.7 (15/150)	1220 (2700)	3660 (0.75)	1 x 10 <sup>-8</sup>	24	18	Nonwoven	200 (6.0)	Woven	105 (3.2)	LL, LC, SIC
<b>BENTOMAT 200R</b>	Needle-punched	175 (1.0)	4.6/45.7 (15/150)	1200 (2650)	3660 (0.75)	1 x 10 <sup>-8</sup>	24	18	Nonwoven	105 (3.2)	Woven	105 (3.2)	LL, LC, SIC
<b>RESISTEX</b>	Needle-punched	Per design	4.4/45.7 (14.5/150)	1360 (3000)	4400 (1.0)	4 x 10 <sup>-9</sup> ±	NP	NP	Per design	Per design	Per design	Per design	LL, SIL*
[1]: 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. ↳ RESISTEX® geosynthetic clay liners were tested against various leachates including, but not limited to, samples from Electric Power Research Institute (EPRI) and other industrial leachates, and should be considered as guide only. CETCO® offers project-specific compatibility testing to verify the suitability of CETCO® products. GCL mechanical properties can be tailored to meet project-specific geotechnical engineering requirements.													
<b>NAUE GmbH &amp; Co. KG</b>   <a href="http://www.naue.com">www.naue.com</a>													
<b>Bentofix</b>	Needle-punched	360 - 800 (2 - 4.6)	5/>40 (16.5 />130)	1,000 - 1,500 (2,200 - 3,300)	3,000 - 8,000 (0.6 - 1.7)	5 x 10 <sup>-9</sup>	24	18	Nonwoven	200 (6.0)	Woven	100 (3.0)	All
<b>Bentofix X</b>	Needle-punched/ PE extruded coating	360 - 800 (2 - 4.6)	4.85/40 (16 /130)	1,000 (2,200)	3,600 (0.75)	5 x 10 <sup>-9</sup> (bentonite); GCL < 10 <sup>-14</sup>	24	18	Nonwoven	200 (6.0)	Woven and PE extruded coating (200 - 1000 g/sqm)	100 (3.0)	All

[1] Flux is defined as "Flow rate/unit area" which can be converted to permeability using the equation:  
Permeability = flux/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  
SIC = Surface impoundment cover  
LC = Landfill cover  
SIL = Surface impoundment liner

NP = Not provided by manufacturer  
NA = Not applicable, per manufacturer

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

« Geosynthetics recommends you contact the manufacturers before making any specifying/purchasing decisions »

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			Panel Size Roll Width/ Length m/m (ft/ft)	Average Roll Weight kg (lb)	Bentonite Mass/Unit Area ASTM D5993 gm/m <sup>2</sup> (lb/ft <sup>2</sup> )		Flux [1] ASTM D 5887 [2] m <sup>3</sup> /m <sup>2</sup> -s	Swell Index ASTM D 5890 (min) ml/2g	Fluid Loss ASTM D 5891 ml	Upper Geosynthetic		Lower Geosynthetic		
										Type or structure	Weight ASTM D5261 or Thickness ASTM D5199 g/m <sup>2</sup> or mm (oz/yd <sup>2</sup> or mil)	Type or structure		Weight ASTM D5261 or Thickness ASTM D5199 g/m <sup>2</sup> or mm (oz/yd <sup>2</sup> or mil)
<b>Solmax BentoLiner® Series CNSL</b>	Needle-punched, polymer-coated	610 (3.5)	4.7/46 (15.5/150)	1180 (2600)	3660 (0.75)	1 x 10 <sup>-9</sup>	24	18	Nonwoven	200 (6.0)	PP geofilm/ woven composite	105 (3.1)	High head applications with low hydraulic conductivity	
<b>Solmax BentoLiner® Series EC</b>	Needle-punched	175 (1.0)	4.7/46 (15.5/150)	1180 (2600)	3660 (0.75)	1 x 10 <sup>-8</sup>	24	18	Nonwoven	100 (3.0)	Woven	105 (3.1)	Low loads and flat slopes	
<b>Solmax BentoLiner® Series NSL</b>	Needle-punched	610 (3.5)	4.7/46 (15.5/150)	1180 (2600)	3660 (0.75)	1 x 10 <sup>-8</sup>	24	18	Nonwoven	200 (6.0)	Woven	105 (3.1)	Medium loads and slopes	
<b>Solmax BentoLiner® Series NWL</b>	Needle-punched	610 (3.5)	4.7/46 (15.5/150)	1180 (2600)	3660 (0.75)	1 x 10 <sup>-8</sup>	24	18	Nonwoven	200 (6.0)	Nonwoven/ woven composite	200 (6.0)	Medium loads and slopes	
<b>Solmax BentoLiner® Series NWL-35</b>	Needle-punched	928 (5.3)	4.7/46 (15.5/150)	1180 (2600)	3660 (0.75)	1 x 10 <sup>-8</sup>	24	18	Nonwoven	200 (6.0)	Nonwoven/ woven composite	200 (6.0)	High loads and steep slopes	
<b>Solmax BentoLiner® Series NWL-60</b>	Needle-punched	2,100 (12.0)	4.7/46 (15.5/150)	1180 (2600)	3660 (0.75)	1 x 10 <sup>-8</sup>	24	18	Nonwoven	200 (6.0)	Nonwoven/ woven composite	200 (6.0)	Very high loads and steep slopes	
<b>Solmax GundSeal® Series Smooth HDPE</b>	Adhesive	NA	5.3/61 (17.5/200)	1900 (4200)	3660 (0.75)	<<4 x 10 <sup>-14</sup>	24	18	Smooth HDPE geomembrane	0.4-2.0 mm (15-80 mil)	Spunbond geotextile	25 (0.75)	All	
<b>Solmax GundSeal® Series Textured HDPE</b>	Adhesive	NA	5.3/51 (17.5/170)	1900 (4200)	3660 (0.75)	<<4 x 10 <sup>-14</sup>	24	18	Textured HDPE geomembrane	0.5-2.0 mm (20-80 mil)	Spunbond geotextile	25 (0.75)	All	

Note: Also available with polymer enhanced bentonite for high ionic leachates such as coal ash and brine resistant formulas.

## TerraFix Geosynthetics Inc./TerraFix Environmental Technology Inc. | www.terrafixgeo.com

<b>Bentofix NSL</b>	Needlepunched / Bentonite	610 (3.5)	4.72m x 45.75m (15.5/150)	1050 (2300)	3660 (0.75)	5 x 10 <sup>-9</sup>	24	18	Nonwoven	200 (6.0)	Woven	105 (3.2)	LL, LC, SIL
<b>Bentofix SRNWL</b>	Needlepunched / Bentonite	610 (3.5)	4.72m x 45.75m (15.5/150)	1135 (2500)	3660 (0.75)	5 x 10 <sup>-9</sup>	24	18	Nonwoven	200 (6.0)	Scrim-nonwoven	200 (6.0)	LL, LC, SIL, Slopes
<b>Bentofix CNSL</b>	Needlepunched / Polypropylene coated / Bentonite	610 (3.5)	4.72m x 45.75m (15.5/150)	1135 (2500)	3660 (0.75)	1 x 10 <sup>-9</sup>	24	18	Nonwoven	200 (6.0)	PP Geofilm / woven	300 (8.8)	LL, LC, SIL

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