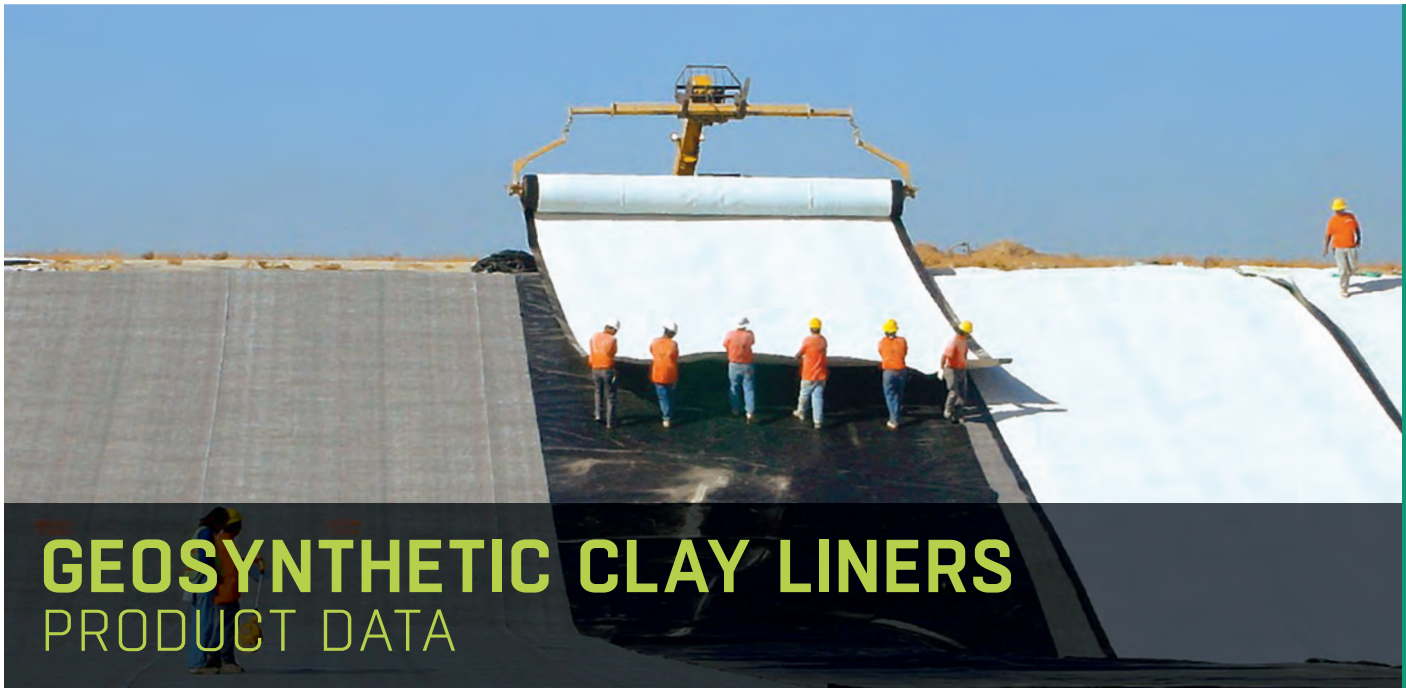

GEOSYNTHETIC CLAY LINERS
PRODUCT DATA

FOR MORE INFORMATION

The specification charts have been provided for comparative purposes only. Designers should contact manufacturers for additional details and to discuss site-specific considerations.

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

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PUBLISHER'S NOTE

All information included in this Specifier's Guide was compiled from information submitted by firms in the geosynthetics industry. Specifications were submitted voluntarily and their 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 Specifier's Guide is intended as a guide, and *Geosynthetics* and IFAI encourage readers to contact the companies listed for further information.

Bonding clay to geosynthetic materials has 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 landfills.

The products have been used commercially for more than 10 years. 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, 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

Product Name	Bonding Method	Needlepunched 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]
									Upper Geosynthetic		Lower Geosynthetic		
			Panel Size Roll Width/ Length m/m (ft/ft)	Average Roll Weight kg (lb)	Bentonite Mass/Unit Area ASTM D5993 gm/m^2 (lb/ft^2)	Flux [1] ASTM D 5887 [2] m^3/m^2-s	Swell Index ASTM D 5890 (min) ml/2g	Fluid Loss ASTM D 5891 ml	Type or structure	Weight ASTM D5261 or Thickness ASTM D5199 g/m^2 or mm (oz/yd^2 or mil)	Type or structure	Weight ASTM D5261 or Thickness ASTM D5199 g/m^2 or mm (oz/yd^2 or mil)	
Agru America | www.agruamerica.com													
Agru Geo Clay NN66	needle punch	6.1 (3.5)	4.7/45.7 (15.5/150)	1700 (3750)	3600 (0.75)	1x10-8	24	18	nonwoven	200 (6.0)	nonwoven	200 (6.0)	
Agru Geo Clay WN36	needle punch	6.1 (3.5)	4.7/45.7 (15.5/150)	1590 (3500)	3600 (0.75)	1x10-8	24	18	nonwoven	200 (6.0)	woven	105 (3.1)	
CETCO | www.cetco.com													
Bentomat 600CL	needlepunched laminated	175 (1.0)	4.6/45.7 (15/150)	1250 (2750)	3660 (0.75)	1 x 10-9	24	18	geofilm/geotextile composite	NP	woven	105 (3.2)	LL, LC, SIC, CL, SIL
Bentomat CL	needlepunched laminated	610 (3.5)	4.6/45.7 (15/150)	1250 (2750)	3660 (0.75)	1 x 10-9	24	18	smooth FML/ geotextile composite	NP	woven	105 (3.2)	LL, LC, SIC, CL, SIL
Bentomat CLT	needlepunched laminated	610 (3.5)	4.6/45.7 (15/150)	1340 (2950)	3660 (0.75)	1 x 10-9	24	18	textured FML/ geotextile composite	NP	woven	105 (3.2)	LL, LC, SIC, CL, SIL
Bentomat DN	needlepunched	610 (3.5)	4.4/45.7 (14.5/150)	1220 (2700)	3660 (0.75)	1 x 10-8	24	18	nonwoven	200 (6.0)	nonwoven	200 (6.0)	LL, LC, SIC
Bentomat SDN	needlepunched	520 (3.0)	4.4/45.7 (14.5/150)	1200 (2650)	3660 (0.75)	1 x 10-8	24	18	nonwoven	200 (6.0)	nonwoven	90 (2.7)	LL, LC, SIC
Bentomat ST	needlepunched	610 (3.5)	4.6/45.7 (15/150)	1200 (2650)	3660 (0.75)	1 x 10-8	24	18	nonwoven	200 (6.0)	woven	105 (3.2)	LL, LC, SIC
Bentomat 200R	needlepunched	175 (1.0)	4.6/45.7 (15/150)	1200 (2650)	3660 (0.75)	1 x 10-8	24	18	nonwoven	105 (3.2)	woven	105 (3.2)	LL, LC, SIC
Resistex	needlepunched	per design	4.4/45.7 (14.5/150)	1300 (2870)	4400 (1.0)	4 x 10-9**	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 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.

[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 »

GEOSYNTHETIC CLAY LINERS

Product Name	Bonding Method	Needlepunched 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]
									Upper Geosynthetic		Lower Geosynthetic		
			Panel Size Roll Width/ Length m/m (ft/ft)	Average Roll Weight kg (lb)	Bentonite Mass/Unit Area ASTM D5993 gm/m² (lb/ft²)	Flux [1] ASTM D 5887 [2] m³/m²-s	Swell Index ASTM D 5890 (min) ml/2g	Fluid Loss ASTM D 5891 ml	Type or structure	Weight ASTM D5261 or Thickness ASTM D5199 g/m² or mm (oz/yd² or mil)	Type or structure	Weight ASTM D5261 or Thickness ASTM D5199 g/m² or mm (oz/yd² or mil)	
GSE Environmental | www.gseworld.com													
GSE BentoLiner CNSL	needlepunched, polymer-coated	610 (3.5)	4.7/46 (15.5/150)	1180 (2600)	3660 (0.75)	1 x 10-9	24	18	nonwoven	200 (6.0)	PP geofilm/ woven composite	105 (3.1)	high head applications with low hydraulic conductivity
GSE BentoLiner EC	needlepunched	175 (1.0)	4.7/46 (15.5/150)	1180 (2600)	3660 (0.75)	1 x 10-8	24	18	nonwoven	100 (3.0)	woven	105 (3.1)	low loads and flat slopes
GSE BentoLiner NSL	needlepunched	610 (3.5)	4.7/46 (15.5/150)	1180 (2600)	3660 (0.75)	1 x 10-8	24	18	nonwoven	200 (6.0)	woven	105 (3.1)	medium loads and slopes
GSE BentoLiner NWL	needlepunched	610 (3.5)	4.7/46 (15.5/150)	1180 (2600)	3660 (0.75)	1 x 10-8	24	18	nonwoven	200 (6.0)	nonwoven/ woven composite	200 (6.0)	medium loads and slopes
GSE BentoLiner NWL-35	needlepunched	928 (5.3)	4.7/46 (15.5/150)	1180 (2600)	3660 (0.75)	1 x 10-8	24	18	nonwoven	200 (6.0)	nonwoven/ woven composite	200 (6.0)	high loads and steep slopes
GSE BentoLiner NWL-60	needlepunched	2,100 (12.0)	4.7/46 (15.5/150)	1180 (2600)	3660 (0.75)	1 x 10-8	24	18	nonwoven	200 (6.0)	nonwoven/ woven composite	200 (6.0)	very high loads and steep slopes
GSE GundSeal Smooth HDPE	adhesive	NA	5.3/61 (17.5/200)	1900 (4200)	3660 (0.75)	<<4 x 10-14	24	18	smooth HDPE geomembrane	0.4-2.0mm (15 80mil)	spunbond geotextile	25 (0.75)	all
GSE GundSeal Textured HDPE	adhesive	NA	5.3/51 (17.5/170)	1900 (4200)	3660 (0.75)	<<4 x 10-14	24	18	textured HDPE geomembrane	0.5-2.0mm (20 80mil)	spunbond geotextile	25 (0.75)	all
Note: Also available in coal ash and brine resistant formulas.													
Terrafix Geosynthetics Inc./Terrafix Environmental Technology Inc. | www.terrafixgeo.com													
Bentofix NSE	needlepunched / enhanced polymer bentonite	610 (3.5)	4.72m x 60m (15.5/196.86)	1450 (3200)	4330 (0.893)	5 x 10-9	26	16	nonwoven	200 (6.0)	woven	105 (3.2)	LL, LC, SIL, coal ash resistant
Bentofix SRNWE	needlepunched / enhanced polymer bentonite	610 (3.5)	4.72m x 60m (15.5/196.86)	1585 (3500)	4330 (0.893)	5 x 10-9	26	16	nonwoven	200 (6.0)	Scrim (woven)-nonwoven	105 (3.2)	LL, LC, SIL, slopes, coal ash resistant
Bentofix CNWE	needlepunched / polymer coated / enhancedpolymer bentonite	610 (3.5)	4.72m x 60m (15.5/196.86)	1630 (3600)	4330 (0.893)	1 x 10-9	26	16	nonwoven	200 (6.0)	PP geofilm / scrim (woven)-nonwoven	105 (3.2)	LL, LC, SIL, slopes, coal ash resistant

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

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