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GSE ENVIRONMENTAL™

SAMPLE COPY

PRODUCT WARRANTY

PRO RATA LIMITED MATERIAL WARRANTY
FOR GSE LINING TECHNOLOGY, LLC
(U.S.A.)

Date:		Warranty No.:	
Purchaser Name:		Project No.:	
Address:		Effective Date:	
City, State:		Project Name:	
Product Type/Description:	**GSE Geomembrane Products**	Project Address:	

GSE Lining Technology, LLC ("GSE") warrants each GSE product described above to be free from material manufacturing defects (as described by the contract's material specifications) and to be able to withstand normal weathering for a period of **five (5) years** from the date of sale. This limited warranty does not include damages or defects in the GSE product resulting from acts of God, casualty or catastrophe, including but not limited to: earthquakes, floods, piercing hail, tornadoes or force majeure. The term "normal use" does not include, among other things, the exposure of GSE's product to harmful chemicals, abuse by machinery, equipment or people; improper site preparation or placement of cover materials; excessive pressures or stresses from any source. This warranty is intended for commercial use only and is not in effect for the consumer as defined in the Magnuson-Moss Warranty Act.

Should defects or premature loss of use within the scope of this warranty occur, GSE will, at its option, repair or replace the GSE product on a pro rata basis at the current price in such manner as to charge the Purchaser only for that portion of the warranted life which has elapsed since the purchase of the product. GSE shall have the right to inspect and determine the cause of the alleged defect in the product and to take appropriate steps to repair or replace the product if a defect exists that is covered under this warranty.

Any claim for any alleged breach of this warranty must be made in writing, by certified mail or courier, to GSE Lining Technology, LLC, 19103 Gundle Road, Houston, TX 77073, with the words "Warranty Claim" clearly marked on the face of the envelope, within ten (10) days of Purchaser becoming aware of the alleged defect. Should the required notice not be given, the defect and all warranties are waived by the Purchaser, and Purchaser shall not have rights under this warranty. GSE shall not be obligated to perform any inspection or obligated to perform any repair or replacement under this warranty until the area is made available free from all obstructions, water, dirt, sludge, residuals and liquids of any kind. If after inspection it is determined that there is no claim under this warranty, Purchaser shall reimburse GSE for its costs associated with the site inspection.

In the event the exclusive remedy provided herein fails in its essential purpose, and in that event only, the Purchaser shall be entitled to a return of the purchase price for so much of the product as GSE determines to have violated the warranty provided herein. GSE shall not be liable for direct, indirect, special, consequential or incidental damages resulting from a breach of this warranty including, but not limited to: damages for loss of production, lost profits, personal injury or property damage. GSE shall not be obligated to reimburse Purchaser for any repairs, replacement, modifications or alterations made by Purchaser to GSE's product, unless GSE specifically authorized, in writing, said repairs, replacements, modifications or alterations in advance. GSE liability under this warranty shall in no event exceed the replacement cost of the product sold to the Purchaser for the particular installation in which it failed.

GSE neither assumes nor authorizes any person other than an officer of GSE to assume for it any other or additional liability in connection with the GSE product made on the basis of the Limited Warranty. **GSE MAKES NO WARRANTY OF ANY KIND OTHER THAN THAT GIVEN HEREIN AND HEREBY DISCLAIMS ALL WARRANTIES, INCLUDING BOTH EXPRESS OR IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE. THIS WARRANTY IS IN LIEU OF ALL OTHER WARRANTIES, AND BY ACCEPTING DELIVERY OF THE PRODUCT, PURCHASER WAIVES ALL OTHER POSSIBLE WARRANTIES. GSE's WARRANTY BECOMES AN OBLIGATION OF GSE TO PERFORM UNDER THE WARRANTY ONLY UPON RECEIPT OF FINAL PAYMENT.**

This warranty is extended to the Purchaser and is non-transferable and non-assignable, i.e. there are no third-party beneficiaries to this warranty.

CHESAPEAKE
CONTAINMENT SYSTEMS, INC.

Haley Pike Landfill

Geosynthetic Supply Bid

Geomembrane Alternate #1

GSE- Average Thickness

352 Earls Road

Middle River, MD 21220

410-335-5886 phone

443.303.1682 fax

www.ccsliners.com

The Pioneer Of Geosynthetics

S I N C E 1 9 7 2

Product Data Sheet - GRI-GM17

GSE UltraFlex Textured Geomembrane

GSE UltraFlex Textured is a co-extruded textured linear low density polythylene (LLDPE) geomembrane available on one or both sides. It is manufactured from the highest quality resin specifically formulated for flexible geomembranes. This product is used in applications that require increased frictional resistance, flexibility and elongation properties where differential or localized subgrade settlements may occur such as in a landfill closure application.

Product Specifications

These product specifications meet or exceed GRI GM17.

TESTED PROPERTY	TEST METHOD	FREQUENCY	MINIMUM AVERAGE VALUE			
			40 mil	60 mil	80 mil	100 mil
Thickness, (minimum average) mil (mm)	ASTM D 5994	every roll	38 (0.96)	57 (1.45)	76 (1.93)	95 (2.41)
Lowest individual for 8 out of 10 values			36 (0.91)	54 (1.40)	72 (1.80)	90 (2.30)
Lowest individual for any of the 10 values			34 (0.86)	51 (1.30)	68 (1.73)	85 (2.16)
Density, g/cm^3	ASTM D 1505	200,000 lb	0.92	0.92	0.92	0.92
Tensile Properties (each direction)	ASTM D 6693, Type IV	20,000 lb				
Strength at Break, lb/in-width (N/mm)	Dumbell, 2 ipm		60 (11)	90 (16)	120 (21)	150 (27)
Elongation at Break, %	G.L. 2.0 in (51 mm)		250	250	250	250
Tear Resistance, lb (N)	ASTM D 1004	45,000 lb	22 (98)	33 (147)	44 (200)	55 (244)
Puncture Resistance, lb (N)	ASTM D 4833	45,000 lb	44 (200)	66 (300)	88 (400)	110 (489)
Carbon Black Content, % (Range)	ASTM D 1603*/4218	20,000 lb	2.0-3.0	2.0-3.0	2.0-3.0	2.0-3.0
Carbon Black Dispersion	ASTM D 5596	45,000 lb	Note[1]	Note[1]	Note[1]	Note[1]
Asperity Height, mil (mm)[2]	ASTM D 7466	second roll	10	10	10	10
Oxidative Induction Time, min	ASTM D 3895, 200° C; O_2, 1 atm	200,000 lb	>140	>140	>140	>140
TYPICAL ROLL DIMENSIONS						
Roll Length[3], ft (m)	Double-Sided Textured		700 (213)	520 (158)	400 (122)	330 (100)
	Single-Sided Textured		650 (198)	420 (128)	320 (98)	250 (76)
Roll Width[3], ft (m)			22.5 (6.9)	22.5 (6.9)	22.5 (6.9)	22.5 (6.9)
Roll Area, ft^2 (m^2)	Double-Sided Textured		15,750 (1,463)	11,700 (1,087)	9,000 (836)	7,425 (689)
	Single-Sided Textured		14,625 (1,359)	9,450 (878)	7,200 (669)	5,625 (522)

NOTES:

- [1]Dispersion only applies to near spherical agglomerates. 9 of 10 views shall be Category 1 or 2. No more than 1 view from Category 3.
- [2]8 of 10 readings ≥ 7 mils. Lowest individual ≥ 5 mils.
- [3]Roll lengths and widths have a tolerance of ± 1%.
- GSE UltraFlex Textured Double-Sided is available in rolls weighing approximately 4,000 lb (1,800 kg) and Single-Sided weighing approximately 3,000 lb (1,360 kg).
- All GSE geomembranes have dimensional stability of ±2% when tested according to ASTM D 1204 and LTB of <-77° C when tested according to ASTM D 746.
- *Modified.

CHESAPEAKE
CONTAINMENT SYSTEMS, INC.

Haley Pike Landfill

Geosynthetic Supply Bid

Geocomposite Option #1

SKAPS

352 Earls Road

Middle River, MD 21220

410-335-5886 phone

443.303.1682 fax

www.ccsliners.com

SKAPS INDUSTRIES, INC.

HISTORY

SKAPS Industries began producing geonets and geocomposites in February 1997 in Commerce, Georgia. Geonet thicknesses range from 160 mils to 330 mils. Geocomposites are laminated either single or double sided.

SKAPS Industries operates three state-of-the-art Geonet Extrusion Lines. This ensures that our customers who have special project-specific requirements are serviced without interfering with standard daily production.

The quality control testing laboratory is equipped with the most up-to-date equipment and operates six days per week. SKAPS maintains a strict QA/QC program designed around GRI and ASTM procedures and standards.

SKAPS Industries is committed to manufacturing the highest quality drainage nets and geocomposites as well as exceptional service before and after the sale.

SKAPS INDUSTRIES, INC.

Engineered Synthetic Products, Inc.

GEONET / GEOCOMPOSITE TESTING PROCEDURES

QC Sampling Schedule

All tests are performed every 35,000 square feet of production except for compressibility and melt index, which are tested once per shift (approximately every 250,000 square feet of production). Transmissivity is done once every 100,000 square feet.

Weight / Area (ASTM D 5261)

The width is determined by measuring the sample in three places--once across each cut end and once across the center. The three measurements are then averaged and reported in inches. The length is also determined by measuring three places--along both edges and along the center. These values are averaged and reported in inches. Samples are then taken and weighed to the nearest .001 lb/sf. The weight is divided by the average width to obtain a weight per length value. The weight/length number is divided by the average width value to obtain weight per area. The value is reported in lbs/sf.

Thickness (ASTM D 5199)

Five specimens are cut from across the width of the lab sample. A thickness gauge with a ¾ inch presser foot is used to measure the thickness of each specimen. The values are recorded and reported as an average in inches.

Crush Resistance (ASTM D 1621)

This test is used to determine the compressive properties (rib laydown strength) of geonet. A geonet specimen is subjected to uniformly increasing stress. Incremental deformation of the specimen is recorded and a graph of compressive stress versus deformation is recorded.

Tensile Strength (ASTM D 5035)

Five specimens are cut from across the width of the lab sample. They are **then placed in the jaws of the Instron Machine and a load is applied at a**

constant strain of 12 in/min until yield. The results of the tensile test are then averaged and recorded.

% Carbon Black (ASTM D 4218)

The carbon black test determines the percent by weight of the product that is carbon black. The percent of carbon black is the ratio of the residue weight after pyrolysis in a muffle furnace compared to the weight of input specimen. Two grams of the net are cut and placed in aluminum dishes. The samples are then placed in a muffle furnace for ten minutes at 600 degrees centigrade. The samples are removed and allowed to cool. The carbon black percentage is calculated and recorded.

Ply Adhesion (ASTM D 7005)

Five specimens are cut from across the entire width of the composite sample, each measuring one inch wide by ten inches long. The strain rate for the test is 10 in/min. The fabric is clamped in one jaw of the Instron machine while the net is clamped in the other. The fabric is pulled away from the net to test the adhesion of the fabric to the net.

Transmissivity (ASTM D 4716)

The transmissivity test for the composite is identical to the test for the geonet.

Melt Index (ASTM D 1238)

The melt index determines the rate of the extrusion of the molten resin through a die of specified length and diameter at a temperature of 190 degrees centigrade under a load of 2.16 kg and is measured in g/10min. A sample of approximately 2.5 grams of geonet is then put through the melt plastometer to verify flow rates.

Density of Polymer (ASTM D 1505)

Taking samples from the melt index test, small strands are cut and measured in a density column. A mixture of distilled water and isopropyl alcohol is used as the suspension fluid.

Transmissivity (ASTM D 4716)

The transmissivity test measures the inplane flow of water across the net sample. In the standard test, the sample is placed between two steel plates with the water temperature at 20 degrees centigrade. Different gradients and loads are applied to the sample. The values are then calculated and converted to gallons per min/ft, or meters^2/sec. Transmissivity is not a standard manufacturing quality control test but rather a design indicator and is tested once per 100,000 sf.

TRANSNET

DRAINAGE NET

GEOCOMPOSITE

HANDLING AND INSTALLATION MANUAL

Engineered Synthetic Products, Inc.
Phone (770) 564-1857
Fax (770) 564-1818

Feb 2003

SKAPS INDUSTRIES, INC.

Engineered Synthetic Products, Inc.

Introduction

Geocomposites provide a solution to various drainage problems. As with any synthetic product, the quality assurance and quality control does not stop once the product is shipped from the factory. Whether the product has been specified for vertical wall hydrostatic relief or horizontal flow zones for landfill cells/closure and roadways, care in handling and installation is critical to the future functioning of the product.

TRANSNET is manufactured utilizing high quality HDPE resin and lamination of high strength to weight ratio nonwoven geotextiles. The lamination process is completed at the same location where the net is manufactured, minimizing additional handling and allowing for supply of custom lengths. TRANSNET can have one or both sides laminated in order to meet the design specification.

Manufacturing

TRANSNET is manufactured utilizing state-of-the-art counter rotating dies and the highest quality resin. TRANSNET is manufactured with the addition of carbon black to stabilize against degradation from UV exposure.

Packaging

Upon completion of the lamination process, the geocomposite will be wrapped in an opaque wrap to prevent exposure to UV and for protection from the weather, dust, etc. In the event only TRANSNET is required, shipping in a wrapper is not necessary.

Each roll will be stickered or tagged so that the following information is available at all times from the manufacturer:

- Manufacturer's Name
- Product Identification
- Lot Number
- Roll Dimensions

SKAPS INDUSTRIES, INC.
Engineered Synthetic Products, Inc.

Shipping and Storage

Geocomposite rolls will be shipped in original packaging. In the event the packaging is damaged during shipment, repairs should be made to ensure protection against UV and weather. Care should be used during the off loading to ensure that the machinery used does not penetrate packaging.

Storage of the rolls prior to installation should be in an area where they are not in standing water. For storage longer than 30 days, rolls should be elevated off the ground with tires, pallets or 2x4's to prevent water from saturating the bottom row. The stack should then be covered with a material that will give additional protection from the elements. Should the product be exposed to excessive dust, the product should be washed prior to installation.

Site Preparation

The design engineer will determine how and where the geocomposite is to be utilized. With any application, care should be used in placing net or composite so that it is not damaged by stones or other protrusions that may compromise the functionality of the product.

Installation

TRANSNET should be installed by hand. Once the roll is delivered to the installation location via rubber-tired loader or other appropriate machinery, the rolls should be inspected for any damage from shipping or handling. Once the rolls are positioned, they should be unrolled by hand. For slope applications, the rolls should be rolled from top to bottom and hand tightened to remove any wrinkles. The TRANSNET portion of adjacent rolls shall be overlapped two to four inches or according to the Engineer's recommendation. When placing TRANSNET end to end, overlap in shingle placement fashion a minimum of one foot. For end-to-end placement, the top layer of geotextile shall be peeled back and excess TRANSNET will be trimmed so that the top layer of geotextile covers the attachment of the two layers of geocomposite. The TRANSNET will be attached to adjacent rolls utilizing plastic wire ties. These ties will be placed at a maximum spacing of 5 feet along the sides of the rolls and a maximum of 2 feet for end to end attachment, or according to the Engineer's specification.

Metal ties or hog rings are not to be used.

Anchoring

For slope applications, TRANSNET should be placed in a trench so that pull out or slippage is prevented. The trench should be in accordance with the Design Engineer's requirements. Sand bags should be on hand at all times and placed on edges not seamed to prevent uplift from the wind. Welding of the TRANSNET to HDPE liner or any other geomembrane is not recommended.

SKAPS INDUSTRIES

INSTALLATION GUIDELINES

Nonwoven Geotextile, Nets and Composites

INSTALLATION

Heat Seaming

Nonwoven Separate or Laminated

Nonwoven geotextiles can be joined together by using fusion seaming methods. The minimum overlap for this type of welding is four inches. Prior to fusion seaming the geotextile together, the installer must demonstrate to the Field Engineer the ability to perform this type of installation method. Areas burned through that are damaged by fusion welding shall be properly repaired. Care should be taken during installation to prevent damage to the geotextile. Torn or punctured material shall be patched with sufficient overlap to prevent separation.

Sewing Procedure

Nonwoven Separate or Laminated

Fabric layers should be placed on the ground (preferably firm ground) so that the edges to be sewn are parallel and overlapping. The sewing operation typically requires three men--a machine operator and a man on each side of the machine. The lead man should hold the fabric edges evenly together and feed the fabric into the sewing machine head or folder. The man behind the machine should hold tension on the fabric so the machine operator has a taut and straight edge to sew across. If the machine misses a stictch or runs off the fabric, terminate the seam by cutting and tying the thread. Begin a new seam approximately one foot behind the broken seam.

Overlapping

Nonwoven-Separate or Laminated

Separate

Roll goods form of geotextile should be overlapped a minimum of 12". Care should be taken that roll goods remain parallel to each other. Extreme care should be taken to assure that soil does not intrude into the composite structure thus clogging the drainage net.

SKAPS Industries
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Commerce, GA 30529 (U.S.A.)
Phone (706) 336-7000 Fax (706) 336-7007
e-mail: info@skaps.com

SKAPS TRANSNET™ (TN)
HDPE GEOCOMPOSITE 220

SKAPS TRANSNET™ geocomposite consists of SKAPS GeoNet made from HDPE resin with non-woven polypropylene geotextile fabric heat bonded on both sides of the the geonet.

Property	Test Method	Unit	Required Value			Qualifier
			With 6 oz.	With 8 oz.	With 10 oz.	
Geonet						
Thickness	ASTM D 5199	mil.	220±20	220±20	220±20	Range
Carbon Black	ASTM D 4218	%	2 to 3	2 to 3	2 to 3	Range
Tensile Strength	ASTM D 5035	lb/in	45	45	45	Minimum
Melt Flow	ASTM D 1238[3]	g/10 min.	1	1	1	Minimum
Density	ASTM D 1505	g/cm^3	0.94	0.94	0.94	Minimum
Transmissivity[1]	ASTM D 4716	$m^2/sec.$	$2x10^{-3}$	$2x10^{-3}$	$2x10^{-3}$	MARV[2]
Composite						
Ply Adhesion (Minimum)	ASTM D7005	lb/in	0.5	0.5	0.5	MARV
Ply Adhesion (Average)	ASTM D7005	lb/in	1	1	1	MARV
Transmissivity[1]	ASTM D 4716	m^2/sec	$1x10^{-4}$	$1x10^{-4}$	$9x10^{-5}$	MARV
Geotextile						
Fabric Weight	ASTM D 5261	oz/yd^2	6	8	10	MARV
Grab Strength	ASTM D 4632	lbs	160	225	270	MARV
Grab Elongation	ASTM D 4632	%	50	50	50	MARV
Tear Strength	ASTM D 4533	lbs	65	90	100	MARV
Puncture Resistance	ASTM D 4833	lbs	95	130	165	MARV
CBR Puncture	ASTM D 6241	lbs	475	650	825	MARV
Water Flow Rate	ASTM D 4491	gpm/ft^2	125	100	75	MARV
Permittivity	ASTM D 4491	sec^{-1}	1.63	1.26	0.94	MARV
Permeability	ASTM D 4491	cm/sec	0.3	0.3	0.3	MARV
AOS	ASTM D 4751	US Sieve	70	80	100	MARV

Notes:
1. Transmissivity measured using water at 21 ± 2°C (70 ± 4°F) with a gradient of 0.1 and a confining pressure of 10000 psf between stainless steel plates after 15 minutes. Values may vary between individual labs.
2. MARV is statistically defined as mean minus two standard deviations and it is the value which is exceeded by 97.5% of all the test data.
3. Condition 190/2.16

Sales Office:
Engineered Synthetic Products, Inc.
Phone (770) 564-1857
Fax (770) 564-1818
www.espgeosynthetics.com

SAMPLE

DATE: TBD

Material Warranty
Material: Transnet 300-2-6
Project: I95 LF Phase IIIB

SKAPS Industries hereby warrants that, at the time of manufacturer, all SKAPS Industries manufactured materials will conform to the respective SKAPS Industries published material specifications for such materials. Excluded from the warranty given herein shall be any damage to or failure of the material caused by, but not limited to: acts of God; casualty; catastrophe or severe weather conditions, such as earthquakes, tornadoes, hurricanes, floods, high winds, piercing hail, lightening and fire; the exposure of the material to sharp objects, chemicals acids, gases or vapors, either known or unknown, or combinations, or specified by the manufacturer as being harmful thereto; physical abuse to the material caused by vandalism, sabotage, machinery, equipment, people and animals; damage to the material during the transportation, unloading, handling, storage or installation thereof by parties other than SKAPS Industries; excessive pressure or stress from any source, both above and below the material; after installation; subsidence or subgrade settlement; improper site preparation and engineering, and any use of the material which the manufacturer never intended. As used throughout this warranty, the term "sale" shall mean the date on which the material is shipped from SKAPS Industries manufacturing facility.

Should any significant deterioration or premature loss in use of the material occur during the term hereof which is believed to be covered by this warranty, then SKAPS Industries shall be given prompt written notice of the alleged claim within 30 days after such facts are first observed. Said notice shall be sent by registered or certified mail, return receipt requested, and addressed to SKAPS Industries, 571 Industrial Drive, Commerce, Georgia 30529, Attention: Contracts Administrator.

The warranty described above is strictly limited to sales of the material for commercial or industrial uses only in accordance with SKAPS Industries published material specifications. Said warranty also is the sole and exclusive warranty given for such material and all other warranties; either express or implied, including but not limited to any warranty of merchantability or fitness for a particular purpose, are hereby disclaimed. In no event shall SKAPS Industries be liable for any direct, indirect, incidental, specific or consequential damages of any kind or any loss or profits resulting from failure of the material or the breach of this warranty; it being further understood that should said warranty fail in its essential propose, and in that event only, SKAPS Industries liability hereunder shall in no event exceed the sales price of the material actually received from SKAPS by the Original Purchaser thereof.

Said warranty is not effective until all payments due to SKAPS Industries, for materials shipped, are paid in full.

Perry Vyas

Perry Vyas - President
SKAPS Industries

011904

CHESAPEAKE
CONTAINMENT SYSTEMS, INC.

Haley Pike Landfill

Geosynthetic Supply Bid

Geocomposite Option #2

GSE

352 Earls Road

Middle River, MD 21220

410-335-5886 phone

443.303.1682 fax

www.ccsliners.com

PRODUCT DATA SHEET

GSE FabriNet Geocomposite

GSE FabriNet geocomposite consists of a 200 mil thick GSE HyperNet geonet heat-laminated on one or both sides with a GSE nonwoven needle-punched geotextile. The geotextile is available in mass per unit area range of 6 oz/yd² to 16 oz/yd². The geocomposite is designed and formulated to perform drainage function under a range of anticipated site loads, gradients and boundary conditions.

AT THE CORE:
A 200 mil thick HyperNet geonet heat-laminated on one or both sides with a nonwoven needlepunched geotextile.

Product Specifications

Tested Property	Test Method	Frequency	Minimum Average Value[1]		
Geocomposite			6 oz/yd²	8 oz/yd²	10 oz/yd²
Transmissivity[2], gal/min/ft	ASTM D 4716	1/540,000 ft²			
Double-Sided Composite			0.48	0.48	0.43
Single-Sided Composite			4.83	4.83	4.34
Ply Adhesion, lb/in	ASTM D 7005	1/50,000 ft²	1.0	1.0	1.0
Geonet Core[3] – GSE HyperNet					
Transmissivity[2], gal/min/ft	ASTM D 4716		9.66	9.66	9.66
Density, g/cm³	ASTM D 1505	1/50,000 ft²	0.94	0.94	0.94
Tensile Strength (MD), lb/in	ASTM D 5035/7179	1/50,000 ft²	45	45	45
Carbon Black Content, %	ASTM D 1603*/4218	1/50,000 ft²	2.0	2.0	2.0
Geotextile[3,4]					
Mass per Unit Area, oz/yd²	ASTM D 5261	1/90,000 ft²	6	8	10
Grab Tensile, lb	ASTM D 4632	1/90,000 ft²	160	220	260
Puncture Strength, lb	ASTM D 4833	1/90,000 ft²	90	120	165
AOS, US sieve	ASTM D 4751	1/540,000 ft²	70	80	100
Permittivity, sec⁻¹	ASTM D 4491	1/540,000 ft²	1.5	1.3	1.0
Flow Rate, gpm/ft²	ASTM D 4491	1/540,000 ft²	110	95	75
UV Resistance, % retained	ASTM D 4355 (after 500 hours)	once per formulation	70	70	70
NOMINAL ROLL DIMENSIONS					
Geonet Core Thickness, mil	ASTM D 5199	1/50,000 ft²	200	200	200
Roll Width[5], ft			14.5	14.5	14.5
Roll Length[5], ft	Double-Sided Composite		270	260	230
	Single-Sided Composite		300	300	290
Roll Area, ft²	Double-Sided Composite		3,915	3,770	3,335
	Single-Sided Composite		4,350	4,350	4,205

[Product specifications continued on back]

PRODUCT DATA SHEET

(*)

AT THE CORE:
A 200 mil thick GSE HyperNet geonet heat-laminated on one or both sides with a nonwoven needlepunched geotextile.

Product Specifications [continued]

NOTES:

- (1)AOSin mm is a maximum value.
- (2)Gradient of 0.1, normal load of 10,000 psf, water at 70˚F between steel plates for 15 minutes. Contact GSE for performance transmissivity value for use in design.
- (3)Component properties prior to lamination.
- (4)Refer to geotextile product data sheet for additional specifications.
- (5)Roll widths and lengths have a tolerance of ±1%.
- *Modified.

GSE is a leading manufacturer and marketer of geosynthetic lining products and services. We've built a reputation of reliability through our dedication to providing consistency of product, price and protection to our global customers.

Our commitment to innovation, our focus on quality and our industry expertise allow us the flexibility to collaborate with our clients to develop a custom, purpose-fit solution.

GSE ENVIRONMENTAL™

DURABILITY RUNS DEEP

For more information on this product and others, please visit us at GSEworld.com, call 800.435.2008 or contact your local sales office.

GSE ENVIRONMENTAL

SAMPLE COPY

PRODUCT WARRANTY

PRO RATA LIMITED MATERIAL WARRANTY FOR GSE LINING TECHNOLOGY, LLC (U.S.A.)

Date:	_____	Warranty No.:	_____
Purchaser Name:	_____	Project No.:	_____
Address:	_____	Effective Date:	_____
City, State:	_____	Project Name:	_____
Product Type/Description:	**GSE Geocomposite Products**	Project Address:	_____

GSE Lining Technology, LLC ("GSE") warrants the geonet component of each GSE product described above to be free from material manufacturing defects (as described by the contract's material specifications) and to be able to withstand normal weathering for a period of **five (5) years** from the date of sale. This limited warranty does not include damages or defects in the GSE product resulting from acts of God, casualty or catastrophe, including but not limited to: earthquakes, floods, piercing hail, tornadoes or force majeure. The term "normal use" does not include, among other things, the exposure of GSE's product to harmful chemicals, abuse by machinery, equipment or people; improper site preparation or placement of cover materials; excessive pressures or stresses from any source. This warranty is intended for commercial use only and is not in effect for the consumer as defined in the Magnuson-Moss Warranty Act.

Should defects or premature loss of use within the scope of this warranty occur, GSE will, at its option, repair or replace the GSE product on a pro rata basis at the current price in such manner as to charge the Purchaser only for that portion of the warranted life which has elapsed since the purchase of the product. GSE shall have the right to inspect and determine the cause of the alleged defect in the product and to take appropriate steps to repair or replace the product if a defect exists that is covered under this warranty on a pro rata basis at the current price in such manner as to charge Purchaser only for that portion of the warranted life which has elapsed since the purchase of the product. GSE warrants the geotextile portion of this product for a period of one year from the date of sale.

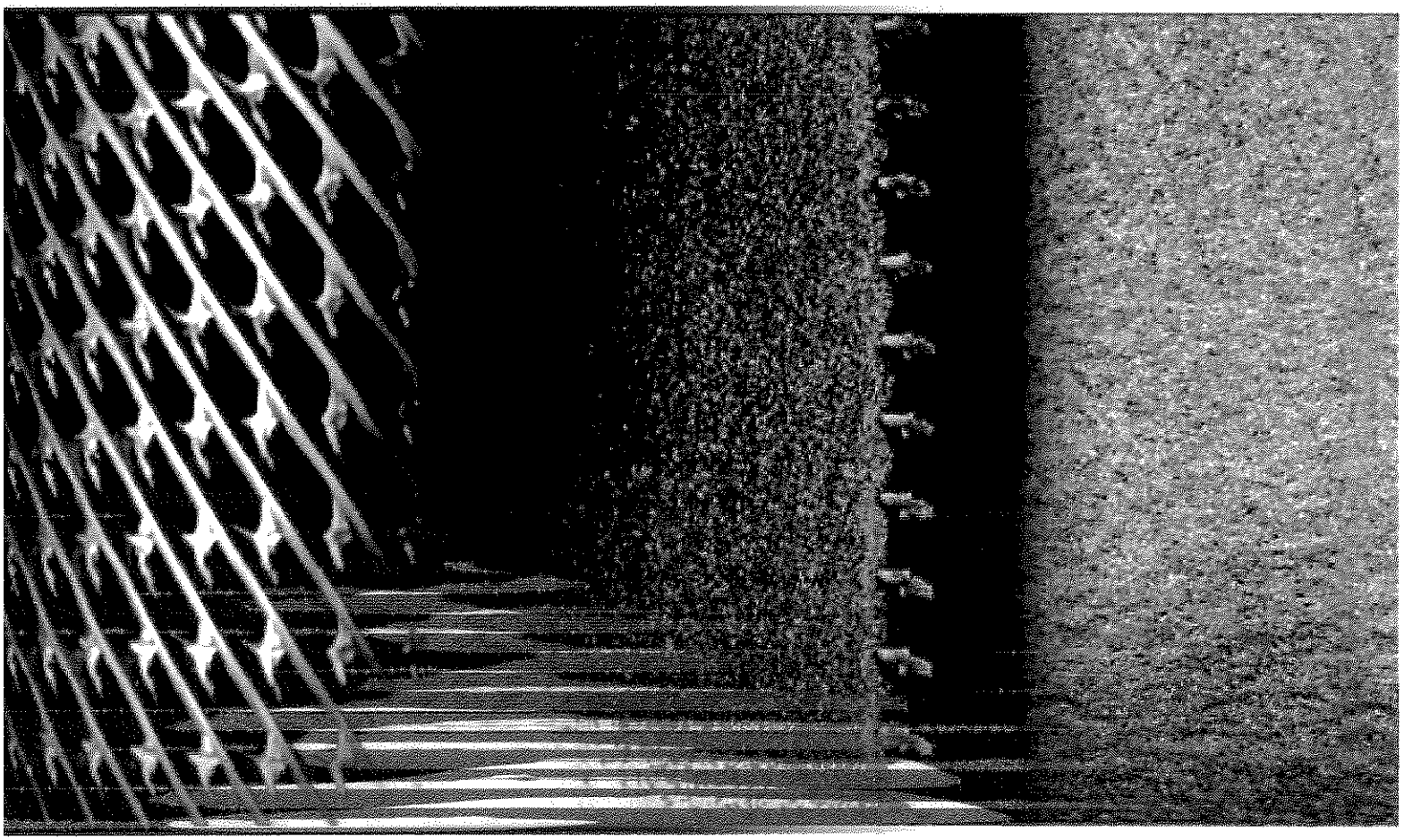
Any claim for any alleged breach of this warranty must be made in writing, by certified mail or courier, to GSE Lining Technology, LLC, 19103 Gundle Road, Houston, TX 77073, with the words "Warranty Claim" clearly marked on the face of the envelope, within ten (10) days of Purchaser becoming aware of the alleged defect. Should the required notice not be given, the defect and all warranties are waived by the Purchaser, and Purchaser shall not have rights under this warranty. GSE shall not be obligated to perform any inspection or obligated to perform any repair or replacement under this warranty until the area is made available free from all obstructions, water, dirt, sludge, residuals and liquids of any kind. If after inspection it is determined that there is no claim under this warranty, Purchaser shall reimburse GSE for its costs associated with the site inspection.

In the event the exclusive remedy provided herein fails in its essential purpose, and in that event only, the Purchaser shall be entitled to a return of the purchase price for so much of the product as GSE determines to have violated the warranty provided herein. GSE shall not be liable for direct, indirect, special, consequential or incidental damages resulting from a breach of this warranty including, but not limited to: damages for loss of production, lost profits, personal injury or property damage. GSE shall not be obligated to reimburse Purchaser for any repairs, replacement, modifications or alterations made by Purchaser to GSE's product, unless GSE specifically authorized, in writing, said repairs, replacements, modifications or alterations in advance. GSE liability under this warranty shall in no event exceed the replacement cost of the product sold to the Purchaser for the particular installation in which it failed.

GSE neither assumes nor authorizes any person other than an officer of GSE to assume for it any other or additional liability in connection with the GSE product made on the basis of the Limited Warranty. **GSE MAKES NO WARRANTY OF ANY KIND OTHER THAN THAT GIVEN HEREIN AND HEREBY DISCLAIMS ALL WARRANTIES, INCLUDING BOTH EXPRESS OR IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE. THIS WARRANTY IS IN LIEU OF ALL OTHER WARRANTIES, AND BY ACCEPTING DELIVERY OF THE PRODUCT, PURCHASER WAIVES ALL OTHER POSSIBLE WARRANTIES. GSE's WARRANTY BECOMES AN OBLIGATION OF GSE TO PERFORM UNDER THE WARRANTY ONLY UPON RECEIPT OF FINAL PAYMENT.**

This warranty is extended to the Purchaser and is non-transferable and non-assignable, i.e. there are no third-party beneficiaries to this warranty.

Manufacturing Quality Assurance Manual



Geonet & Geocomposite Products

GSE

Table of Contents

1.0 INTRODUCTION

This manual provides an overview of the GSE Manufacturing Quality Assurance Program for GSE geonet and geocomposite products. It is intended for use by GSE's customers to enhance their understanding of the quality system under which GSE geonet and geocomposite products are manufactured.

2.0 COMMITMENT TO QUALITY

GSE is committed to meeting or exceeding customer's requirements and industry standards. This commitment to quality is established through a documented quality management system, continuous employee training, investment in technology and emphasis on process control. GSE has allocated resources to ensure that this commitment to quality translates into the best products and services for its customers.

3.0 MANUFACTURING QUALITY ASSURANCE

GSE has an on-site quality assurance laboratory at each manufacturing facility worldwide. Each facility has a fully equipped, well staffed, dedicated laboratory with strict guidelines to maintain a high level of quality and up-to-the-minute results on GSE's finished products.

GSE has a rigorous set of minimum standards and an effective test program to assure compliance has been established. These procedures and requirements are frequently reviewed and adjusted to assure compliance with current market demands and/or predetermined project specifications. Also raw materials and process parameters are controlled to provide products complying with GSE's minimum characteristics and regulatory standards.

4.0 MANUFACTURING QUALITY ASSURANCE ORGANIZATION

GSE quality assurance department assures that only products meeting GSE and/or the customer's requirements are released for shipment. The quality assurance personnel are directly responsible for monitoring, testing, and providing feedback to the manufacturing department ensuring the production of the specified product quality. Each member of the quality assurance team must participate in detailed training that includes factory exposure.

The GSE quality assurance team consists of the manufacturing quality assurance laboratories, engineering staff and manufacturing personnel. The combination of expertise and experience from these groups provide GSE with the proper tools to maintain the highest level of product quality and customer service in the industry.

5.0 STAFF & SCHEDULING

The quality assurance laboratories are staffed during any manufacturing run. A continuous communication link is maintained between the laboratory and manufacturing personnel, maximizing production efficiency and product quality.

6.0 PRODUCT IDENTIFICATION & DOCUMENTATION

A. Roll Numbering

Each roll of geonet and geocomposite is assigned a unique roll number. The quality assurance laboratory maintains records documenting the raw materials and resulting product quality information.

B. Approval Procedure

Results for each tested roll of product are checked against both GSE and customer's specifications for compliance. The quality assurance laboratory approves those materials that meet these requirements for shipment.

C. Non-Conformance

Material that does not meet GSE's minimum standards or customer's specifications is given a roll number, but is rejected and separated from the approved material. The rejected material is then identified as non-conformaning and will not be used. Material that meets GSE's minimum standards, but does not meet a stricter customer's specification will not be allocated to that customer, but will be placed into inventory as a GSE's standard material.

D. Documentation

Quality assurance certificates are generated and supplied for each roll of geonet and geocomposite product to include all relevant quality assurance information about the material. The geotextile components of the drainage geocomposite materials are tracked throughout the manufacturing process. Therefore, traceability reports are available.

7.0 RECORDS RETENTION

GSE maintains reports and/or samples for products produced and sold. Records and/or samples are maintained according to GSE's standard retention policy as outlined below.

MATERIAL	ITEM	YEAR
Raw Materials	Resin Supplier Test Reports and Certifications	≥ 2
	GSE Resin Test Reports	≥ 2
	Resin Sample Retain (Archive)	≥ 2
Geonets & Geocomposites	Raw Test Data (in computer database)	≥ 5
	Quality Control Certificates (in computer database)	≥ 5
	Sample Retain (approximately one square foot)	≥ 5

8.0 TESTING CAPABILITIES

GSE maintains high capacity, state-of-the-art laboratory equipment suitable for performing the procedures (see Appendixes) in Houston, Texas, and Kingstree, South Carolina. Both quality assurance laboratories are accredited by the GAI-LAP Program. The appropriate certificates are maintained for review upon request by authorized parties.

A. *Routine Testing*

GSE has developed a strict quality assurance program, which exceeds all industry's standard practices and/or customer's specifications. The testing program covers raw materials and finished goods and is adhered to by all GSE's quality assurance laboratories. The laboratory equipment used by GSE represents the most modern equipment available and it meets or exceeds the requirements of all the test standards used. Test frequencies and the number of test specimen per sample are established based on statistical analysis and complexity of procedures.

B. *Other Testing Capabilities*

In addition to routine testing, GSE's laboratories are equipped to perform a wide variety of other tests as required for unusual requests or product development. Further, although the GSE quality assurance laboratories are fully equipped and able to perform most routinely specified tests in the industry, there are some tests that are more economically performed by a dedicated testing facility. GSE believes requirements for such testing should be carefully considered and defined in terms of specific design requirements if they are found to be necessary.

9.0 MATERIAL QUALITY ASSURANCE

GSE has established strict specifications for all raw materials and finished products. Test results must fall within the acceptable limits of GSE and customer's specifications.

A. *Raw Material*

GSE uses two types of raw materials in the manufacture of geonet products: natural resin and masterbatch. Natural resin is the base material that is used to make a geonet. It contains stabilizers to prevent degradation from occurring during and after extrusion. Masterbatch is the term referring to the concentrated carbon black material blended with the natural resin to produce the finished product. The natural resin and masterbatch are blended at the appropriate ratio at the manufacturing stage. The masterbatch can contain other additives depending upon the geonet product to be produced. GSE verifies the properties of each lot of raw material prior to their utilization.

When natural resin is received, samples are taken and subjected to the tests as outlined in Appendix A. All test data are entered into the computer database and checked for accuracy, consistency and compliance with GSE's specifications. The material is not accepted unless all standard test requirements are met and the GSE's test values meet the requirements set forth in the raw material specifications.

The GSE test results for each lot of resin are provided in a separate report upon request. Virgin resin is normally received in railcar lots. If resin is received by other transport and/or in other quantities, an equivalent suitable sampling procedure is provided (i.e. not less than one sample per shipment or one sample for each 50,000 lb, 23,000 kg).

In the production of geocomposite products, geotextiles laminated to one or both sides of the geonet can also be considered a raw material or component of the finished product. Quality assurance certificates are provided for all geotextile rolls bonded to the geocomposite.

B. *Geonet Products*

Geonet drainage products are produced with biplanar geometry. Please see GSE geonet data sheets for test methods, frequencies and specifications in Appendixes B-E.

1. Sampling

   A one foot by roll width sample is cut for quality assurance testing from every tenth roll produced. An archive sample is cut from each tested roll. This sample is taken from a random location then labeled and stored for future reference. Test frequencies and the number of test specimen per sample are established based on statistical analysis of the available data and complexity of the test procedures.

2. Evaluation of Results

   All data are entered into a computer database for calculation and comparison to established order specifications. If materials do not meet the required GSE's standards and/or the customer's specifications, the manufacturing personnel will appropriately make the adjustments. Only products meeting GSE's standards and/or customer's specifications will be approved for shipment.

3. Reporting

   A quality assurance certificate is issued for every roll of finished product. This report identifies the standards on which the GSE approval is based along with the actual test results demonstrated by the material.

C. *Geocomposite Products*

Geocomposite products are produced by heat bonding a geotextile to one or both sides of a geonet product. Sampling evaluation of results and reporting practices are the same as for geonet products with the exception of testing for composite products. Please see GSE geocomposite data sheets for test methods, frequencies and specifications in Appendixes F-O.

D. *Third Party Conformance Sampling*

Some specifications require independent quality assurance and/or conformance testing. GSE can provide assistance with the sampling of products by arranging for the conformance samples to be taken during production. By taking samples during production rather than on site or after production, the customer can be assured that the samples are clean and available for conformance testing in a timely manner.

GSE encourages customers to audit its manufacturing operations, to collect samples and conduct independent conformance testing prior to shipment of materials.

E. *Product Shipping*

It is GSE's policy to ship only products that have been tested and approved. All shipments are packaged according to industry's standard practices and/or customer's specifications. Only approved handling methods are used to move rolls into and out of shipping containers, please see the GSE Installation Quality Assurance Manual for more details.

Appendix A: Minimum Testing Frequencies for GSE Raw Materials

Propertiy	Test Method	Natural Resin
Density	ASTM D 1505	once per resin lot
Melt Flow Index	ASTM D 1238 (190/2.16)	once per resin lot
Carbon Black Content	ASTM D 1603*/4218	N/A
Carbon Black Dispersion	ASTM D 5596	NA

NOTES:

- GSE utilizes test equipment and procedures that enable effective and economical confirmation that the product will conform to specifications based on the noted procedures. Some test procedures have been modified for application to geosynthetics. All procedures and values are subject to change without prior notification.
- Refer to GSE's ISO 9000 quality manual for raw material requirements for individual products.
- *Modified.

Appendix B: GSE HyperNet Geonet Data Sheet

Product Specifications

TESTED PROPERTY	TEST METHOD	FREQUENCY	MINIMUM AVERAGE VALUE			
			HyperNet	HyperNet HF	HyperNet HS	HyperNet UF
Transmissivity[1], gal/min/ft (m^2/sec)	ASTM D 4716	1/540,000 ft^2	9.66 (2 x 10^{-3})	14.49 (3 x 10^{-3})	28.98 (6 x 10^{-3})	38.64 (8 x 10^{-3})
Density, g/cm^3	ASTM D 1505	1/50,000 ft^2	0.94	0.94	0.94	0.94
Tensile Strength (MD), lb/in (N/mm)	ASTM D 5035/7179	1/50,000 ft^2	45 (7.9)	55 (9.6)	65 (11.5)	75 (13.3)
Carbon Black Content, %	ASTM D 1603*/4218	1/50,000 ft^2	2.0	2.0	2.0	2.0
NOMINAL ROLL DIMENSIONS						
Geonet Thickness, mil (mm)	ASTM D 5199	1/50,000 ft^2	200 (5)	250 (6.3)	275 (7)	300 (7.6)
Roll Width[2], ft (m)			15 (4.5)	15 (4.5)	15 (4.5)	15 (4.5)
Roll Length[2], ft (m)			330 (100)	290 (88)	270 (82)	250 (76)
Roll Area, ft^2 (m^2)			4,950 (460)	4,350 (404)	4,050 (376)	3,750 (348)

NOTES:

- [1]Gradient of 0.1, normal load of 10,000 psf, water at 70° F (20° C), between steel plates for 15 minutes. Contact GSE for performance transmissivity value for use in design.
- [2]Roll widths and lengths have a tolerance of ±1%.
- *Modified.

Appendix C: GSE PermaNet HL and UL Geonet Data Sheet

Product Specifications

TESTED PROPERTY	TEST METHOD	FREQUENCY	MINIMUM AVERAGE VALUE	
			PermaNet HL (High Load)	PermanNet UL (Ultra Load)
Transmissivity[1], gal/min/ft (m^2/sec)	ASTM D 4716	1/540,000 ft^2	19 (4×10^{-3}) [2]	24 (5×10^{-3}) [3]
Compression Strength, lb/ft^2 (kPa)	ASTM D 1621	1/540,000 ft^2	40,000 (1,913)	40,000 (1,913)
Creep Reduction Factor	GRI GC8	1/formulation	1.2 @ 15,000 psf	1.3 @ 25,000 psf
Density, g/cm^3	ASTM D 1505	1/50,000 ft^2	0.94	0.94
Tensile Strength (MD), lb/in (N/mm)	ASTM D 5035/7179	1/50,000 ft^2	100 (17)	100 (17)
Carbon Black Content, %	ASTM D 1603*/4218	1/50,000 ft^2	2.0	2.0
NOMINAL ROLL DIMENSIONS				
Geonet Thickness, mil (mm)	ASTM D 5199	1/50,000 ft^2	270 (6.9)	300 (7.6)
Roll Width[4], ft (m)			15 (4.6)	15 (4.6)
Roll Length[4], ft (m)			200 (60)	200 (60)
Roll Area, ft^2 (m^2)			3,000 (278)	3,000 (278)

NOTES:

- [1]This is an index transmissivity value used for quality control under test conditions listed under notes (2) and (3). Contact GSE for a performance transmissivity value for use in design.
- [2]Stress = 15,000 psf; gradient = 0.1; time = 15 minutes; and boundary conditions = plate/geonet/plate.
- [3]Stress = 25,000 psf; gradient = 0.1; time = 15 minutes; and boundary conditions = plate/geonet/plate.
- [4]Roll widths and lengths have a tolerance of ±1%.
- *Modified.

Appendix D: GSE HyperNet TRx Geonet Data Sheet

Product Specifications

TESTED PROPERTY	TEST METHOD	FREQUENCY	MINIMUM AVERAGE VALUE
Transmissivity[1], gal/min/ft (m^2/sec)	ASTM D 4716	1/540,000 ft^2	43.5 (9.0×10^{-3})
Density, g/cm^3	ASTM D 1505	1/50,000 ft^2	> 0.94
Tensile Strength [2], lb/in (N/mm)	ASTM D 5035/7179	1/50,000 ft^2	75 (13.3)
Carbon Black Content, %	ASTM D 1603*/4218	1/50,000 ft^2	> 2.0
NOMINAL ROLL DIMENSIONS			
Geonet Thickness, mil (mm)	ASTM D 5199	1/50,000 ft^2	300 (7.6)
Roll Width[3], ft (m)			15 (4.5)
Roll Length[3], ft (m)			200 (60)
Roll Area, ft^2 (m^2)			3,000 (279)

NOTES:

- [1]This is an index transmissivity value measured at stress = 1,000 psf; gradient = 0.1; time = 15 minutes; boundary conditions = plate/geonet/plate. Contact GSE for performance transmissivity value for use in design.
- [2]Tested in machine direction (MD).
- [3]Roll widths and lengths have a tolerance of ±1%.
- *Modified.

Appendix E: GSE PermaNet TRx Geonet Data Sheet

Product Specifications

TESTED PROPERTY	TEST METHOD	FREQUENCY	MINIMUM AVERAGE VALUE
Transmissivity[1], gal/min/ft (m^2/sec)	ASTM D 4716	1/540,000 ft^2	19.2 (4.0 x10^{-3})
Creep Reduction Factor	GRI-GC8	once per formulation	1.2 @ 15,000 psf
Density, g/cm^3	ASTM D 1505	1/50,000 ft^2	> 0.94
Tensile Strength [2], lb/in (N/mm)	ASTM D 5035/7179	1/50,000 ft^2	75 (13.3)
Carbon Black Content, %	ASTM D 1603*/4218	1/50,000 ft^2	> 2.0
NOMINAL ROLL DIMENSIONS			
Geonet Thickness, mil (mm)	ASTM D 5199	1/50,000 ft^2	300 (7.6)
Roll Width[3], ft (m)			15 (4.5)
Roll Length[3], ft (m)			200 (60)
Roll Area, ft^2 (m^2)			3,000 (279)

NOTES:

- [1]This is an index transmissivity value measured at stress = 10,000 psf; gradient = 0.1; time = 15 minutes; boundary conditions = plate/geonet/plate. Contact GSE for performance transmissivity value for use in design.
- [2]Tested in machine direction (MD).
- [3]Roll widths and lengths have a tolerance of ±1%.
- *Modified.

Appendix F: GSE FabriNet Geocomposite Data Sheet

Product Specifications

TESTED PROPERTY	TEST METHOD	FREQUENCY	MINIMUM AVERAGE VALUE[1]		
Geocomposite			**6 oz/yd²**	**8 oz/yd²**	**10 oz/yd²**
Transmissivity[2], gal/min/ft (m^2/sec)	ASTM D 4716	1/540,000 ft^2			
Double-Sided Composite			0.48 (1 x 10^{-4})	0.48 (1 x 10^{-4})	0.43 (9 x 10^{-5})
Single-Sided Composite			4.83 (1 x 10^{-3})	4.83 (1 x 10^{-3})	4.34 (9 x 10^{-4})
Ply Adhesion, lb/in (g/cm)	ASTM D 7005	1/50,000 ft^2	1.0 (178)	1.0 (178)	1.0 (178)
Geonet Core[3] - GSE HyperNet					
Transmissivity[2], gal/min/ft (m^2/sec)	ASTM D 4716		9.66 (2 x 10^{-3})	9.66 (2 x 10^{-3})	9.66 (2 x 10^{-3})
Density, g/cm^3	ASTM D 1505	1/50,000 ft^2	0.94	0.94	0.94
Tensile Strength (MD), lb/in (N/mm)	ASTM D 5035/7179	1/50,000 ft^2	45 (7.9)	45 (7.9)	45 (7.9)
Carbon Black Content, %	ASTM D 1603*/4218	1/50,000 ft^2	2.0	2.0	2.0
Geotextile[3,4]					
Mass per Unit Area, oz/yd^2(g/m^2)	ASTM D 5261	1/90,000 ft^2	6 (200)	8 (270)	10 (335)
Grab Tensile, lb (N)	ASTM D 4632	1/90,000 ft^2	160 (710)	220 (975)	260 (1,155)
Puncture Strength, lb (N)	ASTM D 4833	1/90,000 ft^2	90 (395)	120 (525)	165 (725)
AOS, US sieve (mm)	ASTM D 4751	1/540,000 ft^2	70 (0.212)	80 (0.180)	100 (0.150)
Permittivity, (sec^{-2})	ASTM D 4491	1/540,000 ft^2	1.5	1.3	1.0
Flow Rate, gpm/ft^2 (lpm/m^2)	ASTM D 4491	1/540,000 ft^2	110 (4,480)	95 (3,865)	75 (3,050)
UV Resistance, % retained	ASTM D 4355 (after 500 hours)	once per formulation	70	70	70
NOMINAL ROLL DIMENSIONS					
Geonet Core Thickness, mil (mm)	ASTM D 5199	1/50,000 ft^2	200 (5)	200 (5)	200 (5)
Roll Width[5], ft (m)			14.5 (4.4)	14.5 (4.4)	14.5 (4.4)
Roll Length[5], ft (m)	Double-Sided Composite		270 (82.3)	260 (79.2)	230 (70.1)
	Single-Sided Composite		300 (91.4)	300 (91.4)	290 (88.4)
Roll Area, ft^2 (m^2)	Double-Sided Composite		3,915 (364)	3,770 (350)	3,335 (310)
	Single-Sided Composite		4,350 (404)	4,350 (404)	4,205 (391)

NOTES:

- [1]AOSin mm is a maximum value.
- [2]Gradient of 0.1, normal load of 10,000 psf, water at 70°F between steel plates for 15 minutes. Contact GSE for performance transmissivity value for use in design.
- [3]Component properties prior to lamination.
- [4]Refer to geotextile product data sheet for additional specifications.
- [5]Roll widths and lengths have a tolerance of ±1%.
- *Modified.

Appendix G: GSE FabriNet HF Geocomposite Data Sheet

Product Specifications

TESTED PROPERTY	TEST METHOD	FREQUENCY	MINIMUM AVERAGE VALUE[1]		
Geocomposite			**6 oz/yd²**	**8 oz/yd²**	**10 oz/yd²**
Transmissivity[2], gal/min/ft (m²/sec)	ASTM D 4716	1/540,000 ft²			
Double-Sided Composite			2.41 (5 x 10^{-4})	2.41 (5 x 10^{-4})	1.45 (3 x 10^{-4})
Single-Sided Composite			7.24 (1.5 x 10^{-3})	7.24 (1.5 x 10^{-3})	4.83 (1 x 10^{-3})
Ply Adhesion, lb/in (g/cm)	ASTM D 7005	1/50,000 ft²	1.0 (178)	1.0 (178)	1.0 (178)
Geonet Core[3] - GSE HyperNet HF					
Transmissivity[2], gal/min/ft (m²/sec)	ASTM D 4716		14.49 (3 x 10^{-3})	14.49 (3 x 10^{-3})	14.49 (3 x 10^{-3})
Density, g/cm³	ASTM D 1505	1/50,000 ft²	0.94	0.94	0.94
Tensile Strength (MD), lb/in (N/mm)	ASTM D 5035/7179	1/50,000 ft²	55 (9.6)	55 (9.6)	55 (9.6)
Carbon Black Content, %	ASTM D 1603*/4218	1/50,000 ft²	2.0	2.0	2.0
Geotextile[3,4]					
Mass per Unit Area, oz/yd²(g/m²)	ASTM D 5261	1/90,000 ft²	6 (200)	8 (270)	10 (335)
Grab Tensile, lb (N)	ASTM D 4632	1/90,000 ft²	160 (710)	220 (975)	260 (1,155)
Puncture Strength, lb (N)	ASTM D 4833	1/90,000 ft²	90 (395)	120 (525)	165 (725)
AOS, US sieve (mm)	ASTM D 4751	1/540,000 ft²	70 (0.212)	80 (0.180)	100 (0.150)
Permittivity, (sec⁻¹)	ASTM D 4491	1/540,000 ft²	1.5	1.3	1.0
Flow Rate, gpm/ft² (lpm/m²)	ASTM D 4491	1/540,000 ft²	110 (4,480)	95 (3,865)	75 (3,050)
UV Resistance, % retained	ASTM D 4355 (after 500 hours)	once per formulation	70	70	70
NOMINAL ROLL DIMENSIONS					
Geonet Core Thickness, mil (mm)	ASTM D 5199	1/50,000 ft²	250 (6.3)	250 (6.3)	250 (6.3)
Roll Width[5], ft (m)			15 (4.5)	15 (4.5)	15 (4.5)
Roll Length[5], ft (m)	Double-Sided Composite		230 (70.1)	210 (64.0)	210 (64.0)
	Single-Sided Composite		260 (79.2)	260 (79.2)	250 (76.2)
Roll Area, ft² (m²)	Double-Sided Composite		3,450 (321)	3,150 (293)	3,150 (293)
	Single-Sided Composite		3,900 (362)	3,900 (362)	3,750 (348)

NOTES:

- [1]AOSin mm is a maximum value.
- [2]Gradient of 0.1, normal load of 10,000 psf, water at 70°F between steel plates for 15 minutes. Contact GSE for performance transmissivity value for use in design.
- [3]Component properties prior to lamination.
- [4]Refer to geotextile product data sheet for additional specifications.
- [5]Roll widths and lengths have a tolerance of ±1%.
- *Modified.

Appendix H: GSE FabriNet HS Geocomposite Data Sheet

Product Specifications

TESTED PROPERTY	TEST METHOD	FREQUENCY	MINIMUM AVERAGE VALUE[1]		
Geocomposite			**6 oz/yd²**	**8 oz/yd²**	**10 oz/yd²**
Transmissivity[2], gal/min/ft (m²/sec)	ASTM D 4716	1/540,000 ft²			
Double-Sided Composite			3.4 (7 x 10^{-4})	3.4 (7 x 10^{-4})	2.4 (5 x 10^{-4})
Single-Sided Composite			9.6 (2 x 10^{-3})	9.6 (2 x 10^{-3})	7.2 (1.5 x 10^{-3})
Ply Adhesion, lb/in (g/cm)	ASTM D 7005	1/50,000 ft²	1.0 (178)	1.0 (178)	1.0 (178)
Geonet Core[3] - GSE HyperNet HS					
Transmissivity[2], gal/min/ft (m²/sec)	ASTM D 4716		28.98 (6 x 10^{-3})	28.98 (6 x 10^{-3})	28.98 (6 x 10^{-3})
Density, g/cm³	ASTM D 1505	1/50,000 ft²	0.94	0.94	0.94
Tensile Strength (MD), lb/in (N/mm)	ASTM D 5035/7179	1/50,000 ft²	65 (11.5)	65 (11.5)	65 (11.5)
Carbon Black Content, %	ASTM D 1603*/4218	1/50,000 ft²	2.0	2.0	2.0
Geotextile[3,4]					
Mass per Unit Area, oz/yd²(g/m²)	ASTM D 5261	1/90,000 ft²	6 (200)	8 (270)	10 (335)
Grab Tensile, lb (N)	ASTM D 4632	1/90,000 ft²	160 (710)	220 (975)	260 (1,155)
Puncture Strength, lb (N)	ASTM D 4833	1/90,000 ft²	90 (395)	120 (525)	165 (725)
AOS, US sieve (mm)	ASTM D 4751	1/540,000 ft²	70 (0.212)	80 (0.180)	100 (0.150)
Permittivity, (sec^{-1})	ASTM D 4491	1/540,000 ft²	1.5	1.3	1.0
Flow Rate, gpm/ft² (lpm/m²)	ASTM D 4491	1/540,000 ft²	110 (4,480)	95 (3,865)	75 (3,050)
UV Resistance, % retained	ASTM D 4355 (after 500 hours)	once per formulation	70	70	70
NOMINAL ROLL DIMENSIONS					
Geonet Core Thickness, mil (mm)	ASTM D 5199	1/50,000 ft²	275 (7)	275 (7)	275 (7)
Roll Width[5], ft (m)			15 (4.5)	15 (4.5)	15 (4.5)
Roll Length[5], ft (m)	Double-Sided Composite		212 (64.6)	200 (61.0)	190 (57.9)
	Single-Sided Composite		240 (73.2)	240 (73.2)	230 (70.1)
Roll Area, ft² (m²)	Double-Sided Composite		3,180 (295)	3,000 (279)	2,850 (265)
	Single-Sided Composite		3,600 (334)	3,600 (334)	3,450 (321)

NOTES:

- [1]AOSin mm is a maximum value.
- [2]Gradient of 0.1, normal load of 10,000 psf, water at 70°F between steel plates for 15 minutes. Contact GSE for performance transmissivity value for use in design.
- [3]Component properties prior to lamination.
- [4]*Refer to geotextile product data sheet for additional specifications.*
- [5]Roll widths and lengths have a tolerance of ±1%.
- *Modified.

Appendix I: GSE FabriNet UF Geocomposite Data Sheet

Product Specifications

TESTED PROPERTY	TEST METHOD	FREQUENCY	MINIMUM AVERAGE VALUE[1]		
Geocomposite			**6 oz/yd²**	**8 oz/yd²**	**10 oz/yd²**
Transmissivity[2], gal/min/ft (m²/sec)	ASTM D 4716	1/540,000 ft²			
Double-Sided Composite			4.35 (9×10^{-4})	4.35 (9×10^{-4})	3.40 (7×10^{-4})
Single-Sided Composite			14.5 (3×10^{-3})	14.5 (3×10^{-3})	9.6 (2×10^{-3})
Ply Adhesion, lb/in (g/cm)	ASTM D 7005	1/50,000 ft²	1.0 (178)	1.0 (178)	1.0 (178)
Geonet Core[3] - GSE HyperNet UF					
Transmissivity[2], gal/min/ft (m²/sec)	ASTM D 4716		38.64 (8×10^{-3})	38.64 (8×10^{-3})	38.64 (8×10^{-3})
Density, g/cm³	ASTM D 1505	1/50,000 ft²	0.94	0.94	0.94
Tensile Strength (MD), lb/in (N/mm)	ASTM D 5035/7179	1/50,000 ft²	75 (13.3)	75 (13.3)	75 (13.3)
Carbon Black Content, %	ASTM D 1603*/4218	1/50,000 ft²	2.0	2.0	2.0
Geotextile[3,4]					
Mass per Unit Area, oz/yd²(g/m²)	ASTM D 5261	1/90,000 ft²	6 (200)	8 (270)	10 (335)
Grab Tensile, lb (N)	ASTM D 4632	1/90,000 ft²	160 (710)	220 (975)	260 (1,155)
Puncture Strength, lb (N)	ASTM D 4833	1/90,000 ft²	90 (395)	120 (525)	165 (725)
AOS, US sieve (mm)	ASTM D 4751	1/540,000 ft²	70 (0.212)	80 (0.180)	100 (0.150)
Permittivity, (sec⁻²)	ASTM D 4491	1/540,000 ft²	1.5	1.3	1.0
Flow Rate, gpm/ft² (lpm/m²)	ASTM D 4491	1/540,000 ft²	110 (4,480)	95 (3,865)	75 (3,050)
UV Resistance, % retained	ASTM D 4355 (after 500 hours)	once per formulation	70	70	70
NOMINAL ROLL DIMENSIONS					
Geonet Core Thickness, mil (mm)	ASTM D 5199	1/50,000 ft²	300 (7.6)	300 (7.6)	300 (7.6)
Roll Width[5], ft (m)			15 (4.5)	15 (4.5)	15 (4.5)
Roll Length[5], ft (m)	Double-Sided Composite		190 (57.9)	170 (51.8)	170 (51.8)
	Single-Sided Composite		220 (67.1)	220 (67.1)	200 (61.0)
Roll Area, ft² (m²)	Double-Sided Composite		2,850 (265)	2,550 (237)	2,550 (237)
	Single-Sided Composite		3,300 (307)	3,300 (307)	3,000 (279)

NOTES:

- [1]AOSin mm is a maximum value.
- [2]Gradient of 0.1, normal load of 10,000 psf, water at 70°F between steel plates for 15 minutes. Contact GSE for performance transmissivity value for use in design.
- [3]Component properties prior to lamination.
- [4]Refer to geotextile product data sheet for additional specifications.
- [5]Roll widths and lengths have a tolerance of ±1%.
- *Modified.

Appendix J: GSE FabriNet TRx Geocomposite Data Sheet

Product Specifications

TESTED PROPERTY	TEST METHOD	FREQUENCY	MINIMUM AVERAGE VALUE		
Geocomposite			**4 oz/yd²**	**6 oz/yd²**	**8 oz/yd²**
Transmissivity[1], gal/min/ft (m²/sec)	ASTM D 4716	1/540,000 ft²			
Double-Sided Composite			12.1 (2.5 x10^{-3})	12.1 (2.5 x10^{-3})	10.1 (2.2 x 10^{-3})
Single-Sided Composite			15.7 (3.2 x 10^{-3})	15.7 (3.2 x 10^{-3})	13.8 (2.9 x 10^{-3})
Ply Adhesion, lb/in (g/cm)	ASTM D 7005	1/50,000 ft²	1.0 (178)	1.0 (178)	1.0 (178)
Geonet Core - GSE HyperNet TRx					
Transmissivity[2], gal/min/ft (m²/sec)	ASTM D 4716		43.5 (9.0x 10^{-3})	43.5 (9.0x 10^{-3})	43.5 (9.0x 10^{-3})
Density, g/cm³	ASTM D 1505	1/50,000 ft²	>0.94	>0.94	>0.94
Tensile Strength[3], lb/in (N/mm)	ASTM D 5035/7179	1/50,000 ft²	75 (13.3)	75 (13.3)	75 (13.3)
Carbon Black Content, %	ASTM D 1603*/4218	1/50,000 ft²	>2.0	>2.0	>2.0
Geotextile (prior to lamination)[4]					
Mass per Unit Area, oz/yd²(g/m²)	ASTM D 5261	1/90,000 ft²	4	6	8
Grab Tensile, lb (N)	ASTM D 4632	1/90,000 ft²	120 (530)	160 (710)	220 (975)
Puncture Strength, lb (N)	ASTM D 4833	1/90,000 ft²	60 (265)	90 (395)	120 (525)
AOS, US sieve (mm)	ASTM D 4751	1/540,000 ft²	70 (0.212)	70 (0.212)	80 (0.180)
Permittivity, (sec⁻¹)	ASTM D 4491	1/540,000 ft²	1.8	1.5	1.3
Flow Rate, gpm/ft² (lpm/m²)	ASTM D 4491	1/540,000 ft²	135 (5,495)	110 (4,480)	95 (3,865)
UV Resistance, % retained	ASTM D 4355 (after 500 hours)	once per formulation	70	70	70
NOMINAL ROLL DIMENSIONS					
Geonet Core Thickness, mil (mm)	ASTM D 5199	1/50,000 ft²	300 (7.6)	300 (7.6)	300 (7.6)
Roll Width[5], ft (m)			15 (4.5)	15 (4.5)	15 (4.5)
Roll Length[5], ft (m)	Double-Sided Composite		160 (48.8)	160 (48.8)	150 (45.7)
	Single-Sided Composite		180 (54.9)	170 (51.8)	170 (51.8)
Roll Area, ft² (m²)	Double-Sided Composite		2,400 (223)	2,400 (223)	2,250 (209)
	Single-Sided Composite		2,700 (251)	2,550 (237)	2,550 (237)

NOTES:

- [1]This is an index transmissivity value measured at stress = 1,000 psf; gradient = 0.1; time = 15 minutes; boundary conditions = plate/geocomposite/plate. Contact GSE for performance transmissivity value for use in design.
- [2]This is an index transmissivity value measured at stress = 1,000 psf; gradient = 0.1; time = 15 minutes; boundary conditions = plate/geonet/plate. Contact GSE for performance transmissivity value for use in design.
- [3]Tested in machine direction (MD).
- [4]All properties are minimum average values except AOS (mm) which is a maximum value and UV resistance which is a typical value.
- [5]Roll widths and lengths have a tolerance of ±1%.
- *Modified.

Appendix K: GSE PermaNet TRx Geocomposite Data Sheet

Product Specifications

TESTED PROPERTY	TEST METHOD	FREQUENCY	MINIMUM AVERAGE VALUE		
Geocomposite			**4 oz/yd²**	**6 oz/yd²**	**8 oz/yd²**
Transmissivity[1], gal/min/ft (m²/sec)	ASTM D 4716	1/540,000 ft²			
Double-Sided Composite			4.8 (1 x10⁻³)	4.8 (1 x10⁻³)	4.8 (1 x10⁻³)
Single-Sided Composite			6.2 (1.3 x 10⁻³)	6.2 (1.3 x 10⁻³)	6.2 (1.3 x 10⁻³)
Ply Adhesion, lb/in (g/cm)	ASTM D 7005	1/50,000 ft²	1.0 (178)	1.0 (178)	1.0 (178)
Geonet Core - GSE PermaNet TRx					
Transmissivity[2], gal/min/ft (m²/sec)	ASTM D 4716		19.2 (4.0 x 10⁻³)	19.2 (4.0 x 10⁻³)	19.2 (4.0 x 10⁻³)
Creep Reduction Factor	GRI-GC8	once per formulation	1.2 @ 15,000 psf	1.2 @ 15,000 psf	1.2 @ 15,000 psf
Density, g/cm³	ASTM D 1505	1/50,000 ft²	>0.94	>0.94	>0.94
Tensile Strength[3], lb/in (N/mm)	ASTM D 5035/7179	1/50,000 ft²	75 (13.3)	75 (13.3)	75 (13.3)
Carbon Black Content, %	ASTM D 1603*/4218	1/50,000 ft²	>2.0	>2.0	>2.0
Geotextile (prior to lamination)[4]					
Mass per Unit Area, oz/yd²(g/m²)	ASTM D 5261	1/90,000 ft²	4	6	8
Grab Tensile, lb (N)	ASTM D 4632	1/90,000 ft²	120 (530)	160 (710)	220 (975)
Puncture Strength, lb (N)	ASTM D 4833	1/90,000 ft²	60 (265)	90 (395)	120 (525)
AOS, US sieve (mm)	ASTM D 4751	1/540,000 ft²	70 (0.212)	70 (0.212)	80 (0.180)
Permittivity, (sec⁻¹)	ASTM D 4491	1/540,000 ft²	1.8	1.5	1.3
Flow Rate, gpm/ft² (lpm/m²)	ASTM D 4491	1/540,000 ft²	135 (5,495)	110 (4,480)	95 (3,865)
UV Resistance, % retained	ASTM D 4355 (after 500 hours)	once per formulation	70	70	70
NOMINAL ROLL DIMENSIONS					
Geonet Core Thickness, mil (mm)	ASTM D 5199	1/50,000 ft²	300 (7.6)	300 (7.6)	300 (7.6)
Roll Width[5], ft (m)			15 (4.5)	15 (4.5)	15 (4.5)
Roll Length[5], ft (m)	Double-Sided Composite		170 (51.9)	160 (48.8)	160 (48.8)
	Single-Sided Composite		190 (57.9)	190 (57.9)	180 (54.9)
Roll Area, ft² (m²)	Double-Sided Composite		2,550 (236)	2,400 (223)	2,400 (223)
	Single-Sided Composite		2,850 (265)	2,850 (265)	2,700 (251)

NOTES:

- [1]This is an index transmissivity value measured at stress = 10,000 psf; gradient = 0.1; time = 15 minutes; boundary conditions = plate/geocomposite/plate. Contact GSE for performance transmissivity value for use in design.
- [2]This is an index transmissivity value measured at stress = 10,000 psf; gradient = 0.1; time = 15 minutes; boundary conditions = plate/geonet/plate. Contact GSE for performance transmissivity value for use in design.
- [3]Tested in machine direction (MD).
- [4]All properties are minimum average values except AOS (mm) which is a maximum value and UV resistance which is a typical value.
- [5]Roll widths and lengths have a tolerance of ±1%.
- *Modified.

Appendix L: GSE PermaNet HL Geocomposite Data Sheet

Product Specifications

TESTED PROPERTY	TEST METHOD	FREQUENCY	MINIMUM AVERAGE VALUE		
Geocomposite			**6 oz/yd²**	**8 oz/yd²**	**10 oz/yd²**
Transmissivity[1], gal/min/ft (m²/sec) Double-Sided Composite Single-Sided Composite	ASTM D 4716	1/540,000 ft²	 4.8 (1 x 10^{-3}) 6.2 (1.3 x 10^{-3})	 4.8 (1 x 10^{-3}) 6.2 (1.3 x 10^{-3})	 4.8 (1 x 10^{-3}) 6.2 (1.3 x 10^{-3})
Ply Adhesion, lb/in (g/cm)	ASTM D 7005	1/50,000 ft²	1.0 (178)	1.0 (178)	1.0 (178)
Geonet Core - GSE PermaNet HL					
Transmissivity[2], gal/min/ft (m²/sec)	ASTM D 4716		19 (4x10^{-3})	19 (4x10^{-3})	19 (4x10^{-3})
Compression Strength, lbs/ft² (kPa)	ASTM D 1621	1/540,000 ft²	40,000 (1,913)	40,000 (1,913)	40,000 (1,913)
Creep Reduction Factor	GRI-GC8	once per formulation	1.2 @15,000 psf	1.2 @15,000 psf	1.2 @15,000 psf
Density, g/cm³	ASTM D 1505	1/50,000 ft²	0.94	0.94	0.94
Tensile Strength (MD), lb/in (N/mm)	ASTM D 5035/7179	1/50,000 ft²	100 (17)	100 (17)	100 (17)
Carbon Black Content, %	ASTM D 1603*/4218	1/50,000 ft²	2.0	2.0	2.0
Geotextile (prior to lamination)[3]					
Mass per Unit Area, oz/yd²(g/m²)	ASTM D 5261	1/90,000 ft²	6 (200)	8 (270)	10 (335)
Grab Tensile, lb (N)	ASTM D 4632	1/90,000 ft²	160 (710)	220 (975)	260 (1,155)
Puncture Strength, lb (N)	ASTM D 4833	1/90,000 ft²	90 (395)	120 (525)	165 (725)
AOS, US sieve (mm)	ASTM D 4751	1/540,000 ft²	70 (0.21)	80 (0.180)	100 (0.150)
Permittivity, (sec^{-2})	ASTM D 4491	1/540,000 ft²	1.5	1.3	1.0
Flow Rate, gpm/ft² (lpm/m²)	ASTM D 4491	1/540,000 ft²	110 (4,480)	95 (3,865)	75 (3,050)
UV Resistance, % retained	ASTM D 4355 (after 500 hours)	once per formulation	70	70	70
NOMINAL ROLL DIMENSIONS					
Geonet Core Thickness, mil (mm)	ASTM D 5199	1/50,000 ft²	270 (6.9)	270 (6.9)	270 (6.9)
Roll Width[4], ft (m)			15 (4.5)	15 (4.5)	15 (4.5)
Roll Length[4], ft (m)	Double-Sided Composite		160 (48.8)	150 (45.7)	140 (42.7)
	Single-Sided Composite		170 (51.8)	170 (51.8)	160 (48.8)
Roll Area, ft² (m²)	Double-Sided Composite		2,400 (223)	2,250 (209)	2,100 (195)
	Single-Sided Composite		2,550 (237)	2,550 (237)	2,400 (223)

NOTES:

- [1]This is an index transmissivity value measured at stress = 15,000 psf; gradient = 0.1; time = 15 minutes; boundary conditions = plate/geocomposite/plate. Contact GSE for performance transmissivity value for use in design.
- [2]This is an index transmissivity value measured at stress = 15,000 psf; gradient = 0.1; time = 15 minutes; boundary conditions = plate/geonet/plate. Contact GSE for performance Transmissivity value in design.
- [3]All geotextile properties are minimum average values except AOS (in mm) which is a maximum value (Max ARV); and UV resistance which is a typical value.
- [4]Roll widths and lengths have a tolerance of ±1%.
- *Modified.

Appendix M: GSE PermaNet UL Geocomposite Data Sheet

Product Specifications

TESTED PROPERTY	TEST METHOD	FREQUENCY	MINIMUM AVERAGE VALUE		
Geocomposite			**6 oz/yd²**	**8 oz/yd²**	**10 oz/yd²**
Transmissivity[1], gal/min/ft (m²/sec)	ASTM D 4716	1/540,000 ft²			
Double-Sided Composite			4.8 (1 x 10^{-3})	4.8 (1 x 10^{-3})	4.8 (1 x 10^{-3})
Single-Sided Composite			6.2 (1.3 x 10^{-3})	6.2 (1.3 x 10^{-3})	6.2 (1.3 x 10^{-3})
Ply Adhesion, lb/in (g/cm)	ASTM D 7005	1/50,000 ft²	1.0 (178)	1.0 (178)	1.0 (178)
Geonet Core - GSE PermaNet UL					
Transmissivity[2], gal/min/ft (m²/sec)	ASTM D 4716		24 (5x10^{-3})	24 (5x10^{-3})	24 (5x10^{-3})
Compression Strength, lbs/ft² (kPa)	ASTM D 1621	1/540,000 ft²	40,000 (1,913)	40,000 (1,913)	40,000 (1,913)
Creep Reduction Factor	GRI-GC8	once per formulation	1.3 @25,000 psf	1.3 @25,000 psf	1.3 @25,000 psf
Density, g/cm³	ASTM D 1505	1/50,000 ft²	0.94	0.94	0.94
Tensile Strength (MD), lb/in (N/mm)	ASTM D 5035/7179	1/50,000 ft²	100 (17)	100 (17)	100 (17)
Carbon Black Content, %	ASTM D 1603*/4218	1/50,000 ft²	2.0	2.0	2.0
Geotextile (prior to lamination)[3]					
Mass per Unit Area, oz/yd²(g/m²)	ASTM D 5261	1/90,000 ft²	6 (200)	8 (270)	10 (335)
Grab Tensile, lb (N)	ASTM D 4632	1/90,000 ft²	160 (710)	220 (975)	260 (1,155)
Puncture Strength, lb (N)	ASTM D 4833	1/90,000 ft²	90 (395)	120 (525)	165 (725)
AOS, US sieve (mm)	ASTM D 4751	1/540,000 ft²	70 (0.21)	80 (0.180)	100 (0.150)
Permittivity, (sec⁻²)	ASTM D 4491	1/540,000 ft²	1.5	1.3	1.0
Flow Rate, gpm/ft² (lpm/m²)	ASTM D 4491	1/540,000 ft²	110 (4,480)	95 (3,865)	75 (3,050)
UV Resistance, % retained	ASTM D 4355 (after 500 hours)	once per formulation	70	70	70
NOMINAL ROLL DIMENSIONS					
Geonet Core Thickness, mil (mm)	ASTM D 5199	1/50,000 ft²	300 (7.6)	300 (7.6)	300 (7.6)
Roll Width[4], ft (m)			15 (4.5)	15 (4.5)	15 (4.5)
Roll Length[4], ft (m)	Double-Sided Composite		150 (45.7)	140 (42.7)	130 (39.6)
	Single-Sided Composite		150 (45.7)	150 (45.7)	140 (42.7)
Roll Area, ft² (m²)	Double-Sided Composite		2,250 (209)	2,100 (195)	1,950 (175)
	Single-Sided Composite		2,250 (209)	2,250 (209)	2,100 (195)

NOTES:

- [1]This is an index transmissivity value measured at stress = 25,000 psf; gradient = 0.1; time = 15 minutes; boundary conditions = plate/geocomposite/plate. Contact GSE for performance transmissivity value for use in design.
- [2]This is an index transmissivity value measured at stress = 25,000 psf; gradient = 0.1; time = 15 minutes; boundary conditions = plate/geonet/plate. Contact GSE for performance transmissivity value for use in design.
- [3]All geotextile properties are minimum average values except AOS (in mm) which is a maximum value and UV resistance which is a typical value.
- [4]Roll widths and lengths have a tolerance of ±1%.
- *Modified.

Appendix N: GSE BioDrain LP Geocomposite Data Sheet

Product Specifications

TESTED PROPERTY	TEST METHOD	FREQUENCY	MINIMUM AVERAGE VALUE[3]	
Geocomposite				
Transmissivity[1], gal/min/ft (m^2/sec)	ASTM D 4716	1/540,000 ft^2	0.48 ($1.0x10^{-4}$)	
Ply Adhesion[4], lb/in (g/cm)	ASTM D 7005	1/50,000 ft^2	0.5 (89)	
Geonet Core (Prior to lamination)				
Transmissivity[1], gal/min/ft (m^2/sec)	ASTM D 4716	1/540,000 ft^2	9.66 ($2.0 x10^{-3}$)	
Density, g/cm^3	ASTM D 1505	1/50,000 ft^2	> 0.94	
Tensile Strength (MD), lb/in (N/mm)	ASTM D 5035/7179	1/50,000 ft^2	45 (7.9)	
Carbon Black Content, %	ASTM D 1603*/4218	1/50,000 ft^2	> 2.0	
Geotextile (Prior to lamination)			**Nonwoven**	**LP Woven**
Mass per Unit Area	ASTM D 5261	1/90,000 ft^2	6	N/A
Grab Tensile, lb	ASTM D 4632	1/90,000 ft^2	160	230 x 150
Puncture Strength, lb	ASTM D 4833	1/90,000 ft^2	90	100
AOS, US sieve (mm)	ASTM D 4751	1/540,000 ft^2	70 (0.212)	70 (0.212)
Permittivity, (sec^{-1})	ASTM D 4491	1/540,000 ft^2	1.5	0.1
Flow Rate, gpm/ft^2	ASTM D 4491	1/540,000 ft^2	110	8
UV Resistance, % retained	ASTM D 4355 (after 500 hours)	once per formulation	70	70
NOMINAL ROLL DIMENSIONS				
Geonet Core Thickness, mil (mm)	ASTM D 5199	1/50,000 ft^2	200 (5)	
Roll Width[2], ft			14.5 (4.4)	
Roll Length[2], ft			230 (70)	
Roll Area, ft^2 (m^2)			3,335 (310)	

NOTES:

- [1]This is an index transmissivity value measured at stress = 10,000 psf; gradient = 0.1; between steel plates for 15 minutes. Contact GSE for performance transmissivity value for use in design.
- [2]Roll widths and lengths have a tolerance of ±1%.
- [3]All properties are minimum average values except AOS (mm) which is a maximum value and UV resistance which is a typical value.
- [4]Tested and reported on nonwoven/geonet side only.
- *Modified.

Appendix O: GSE BioDrain HP Geocomposite Data Sheet

Product Specifications

TESTED PROPERTY	TEST METHOD	FREQUENCY	MINIMUM AVERAGE VALUE[3]	
Geocomposite				
Transmissivity[1], gal/min/ft (m^2/sec)	ASTM D 4716	1/540,000 ft^2	0.48 ($1.0x10^{-4}$)	
Ply Adhesion[4], lb/in (g/cm)	ASTM D 7005	1/50,000 ft^2	0.5 (89)	
Geonet Core (Prior to lamination)				
Transmissivity[1], gal/min/ft (m^2/sec)	ASTM D 4716	1/540,000 ft^2	9.66 ($2.0 x10^{-3}$)	
Density, g/cm^3	ASTM D 1505	1/50,000 ft^2	> 0.94	
Tensile Strength (MD), lb/in (N/mm)	ASTM D 5035/7179	1/50,000 ft^2	45 (7.9)	
Carbon Black Content, %	ASTM D 1603*/4218	1/50,000 ft^2	> 2.0	
Geotextile (Prior to lamination)			**Nonwoven**	**HP Woven**
Mass per Unit Area	ASTM D 5261	1/90,000 ft^2	6	N/A
Grab Tensile, lb	ASTM D 4632	1/90,000 ft^2	160	230 x 150
Puncture Strength, lb	ASTM D 4833	1/90,000 ft^2	90	100
AOS, US sieve (mm)	ASTM D 4751	1/540,000 ft^2	70 (0.212)	30 (0.542)
Permittivity, (sec^{-1})	ASTM D 4491	1/540,000 ft^2	1.5	0.5
Flow Rate, gpm/ft^2	ASTM D 4491	1/540,000 ft^2	110	36
UV Resistance, % retained	ASTM D 4355 (after 500 hours)	once per formulation	70	70
NOMINAL ROLL DIMENSIONS				
Geonet Core Thickness, mil (mm)	ASTM D 5199	1/50,000 ft^2	200 (5)	
Roll Width[2], ft			14.5 (4.4)	
Roll Length[2], ft			230 (70)	
Roll Area, ft^2 (m^2)			3,335 (310)	

NOTES:

- [1]This is an index transmissivity value measured at stress = 10,000 psf; gradient = 0.1; between steel plates for 15 minutes. Contact GSE for performance transmissivity value for use in design.
- [2]Roll widths and lengths have a tolerance of ±1%.
- [3]All properties are minimum average values except AOS (mm) which is a maximum value and UV resistance which is a typical value.
- [4]Tested and reported on nonwoven/geonet side only.
- *Modified.


GSE

CHESAPEAKE
CONTAINMENT SYSTEMS, INC.

Haley Pike Landfill

Geosynthetic Supply Bid

GSE Specification Clarifications

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GSE Internal Specification Review

Clarifications

Project: Haley Pike Landfill Cap Date: June 1, 2012
Products: **1)** 40 mil Minimum Double Sided Texture LLDPE Geomembrane
2) 6 oz/yd^2 Double Sided FabriNet Geocomposite
Sections: **02072 & 02073** – Page 29 thru 64

Level 1 Exceptions

Section 02072 Page 34, Section 2.1.C
GSE asks that the project specifications be amended to standard GSE specifications.

Geomembrane Property	Project Specifications	GSE Specifications
Oxidation Induction Time	ASTM D3895 100 minutes max.	ASTM D3895 100 minutes minimum
Oven Aging at 85°C	60% max. per ASTM D3895	35% min. per ASTM D3895 or 60% min. per ASTM D5885 (Note 1)

Note:
1. Per GRI GM17, manufacturer has the option to select either one of the OIT methods to evaluate the antioxidant content in the geomembrane.

Section 02072 Page 35, Section 2.2.B & C
GSE asks that this section be amended with the following statement:
- The virgin (without the addition of carbon black) polyethylene resin used in the manufacture of GSE standard LLDPE products will have a density ≥ 0.915 g/cc. Finished LLDPE products (with the addition of carbon black) will have a density ≥ 0.920 g/cc, but ≤ 0.939 g/cc.
- Melt Flow Index is an indicator of the ability of a resin to be processed and has no relation to the performance of the finished product. GSE performs melt index testing on natural resin prior to geosynthetic product manufacture. Each lot of natural resin (~180,000 lbs) is tested according to ASTM D 1238, Condition 190/2.16, to ensure the resin has a melt flow index of ≤ 1.0 gram/10 minutes.

Section 02073 Page 48 & 49, Section 2.2. A & B
GSE asks that this section be amended with the following statement:
- GSE requests that all Manufacturing Quality Assurance (MQA) testing be conducted at GSE standard testing frequencies. GSE asks that this be acceptable in lieu of testing all geocomposite and component properties at the minimum rate of 100,000 square feet as specified in the section.

Section 02073 Page 48, Section 2.2.C
GSE asks that the project specifications be amended to standard GSE specifications.

Geocomposite Property	Project Specifications	GSE Specifications
Geonet Melt Flow Index	0.5 g/10 min. (max.)	1.0 g/10 min. (max.)

Section 02073 Page 49, Section 2.2.B
GSE asks that the project specifications be amended to standard GSE specifications.

Geocomposite Property	Project Specifications	GSE Specifications
Geotextile Thickness	80 mils	Not reported
Geotextile Permeability	0.35 cm/sec	Not reported

Note:
1. Geotextile permeability is dependent on load, therefore, GSE reports permittivity values from which permeability can be calculated for specific loads.