

**APPENDIX 5-E**

# ALTERNATE LINER OPTIONS

# MicroDrain®

INTEGRATED DRAINAGE  
SYSTEM GEOMEMBRANE  
FOR HIGH FLOW RATES AND  
RELIABLE DRAINAGE





## The Plastics Experts.

AGRU geosynthetic liners are manufactured with only the highest-grade polyethylene resins using the calendared flat-die extrusion process. This manufacturing technique allows for highly precise liners such as MicroDrain. This process produces liners with consistent stud height and thickness without compromising liner integrity.

The AGRU success story has been unfolding for seven decades. Founded in 1948 by Alois Gruber, who set the company on the course for plastic manufacturing, AGRU has become one of the world's most important single-source suppliers for piping systems, semi-finished products, concrete protection liners, and lining systems made from engineered plastics. We use only top-grade thermoplastic polymers as our raw materials. When it comes to application-technical consulting, we are your best partner in the field.



### Quality

Customer satisfaction comes first at AGRU. Technical consultations are an essential part of our customer service. The AGRU quality assurance system is compliant with multiple international and U.S. standards and AGRU's procedures help ensure that products meet these standards. AGRU's start-to-finish attention to quality ensures that the products meet the strictest technical requirements.

# Universally Deployable Lining Systems

MicroDrain is part of the AGRU Lining System, which offers the right solution for every application through an array of products.

## Excellent Physical Properties

Chemically resistant polyethylene gives robust durability and chemical resistance:

- Plasticiser-free plastics guarantee long-term performance
- High tensile strength, elasticity, and flexibility
- Excellent static puncture resistance.

## Economic Installation

Compatible with simple and permanent welding technologies:

- Suitable for any application
- Works with innovative installation methods (e.g., induction welding)
- MicroDrain is easy to install thanks to its light weight and flexibility.

## One-Stop Shopping

Beyond MicroDrain, let AGRU source your drainage, pipes and fittings, geotextiles, and more:

- Complete drainage and closure systems in LLDPE and HDPE
- Multi-purpose products for industrial and civil applications
- Concrete protective liners, semi-finished products, and more.





## Product Summary

AGRU MicroDrain is a combined barrier liner and drainage media unique to the industry and is the latest culmination of AGRU America's geomembrane R&D. MicroDrain is manufactured with either high-density polyethylene (HDPE) or linear low-density polyethylene (LLDPE).

The upward-facing studs in MicroDrain promotes high flow rates and reliable drainage, eliminating the need for a separate geonet or geocomposite drainage layer. This upward-facing part, or AGRU's Integrated Drainage System (IDS), yields cost savings in material usage and installation while removing what has been the weakest link (a separate material for drainage) for interface shear strength.

The bottom-facing part of the liner uses spiked asperities (leveraging AGRU's MicroSpike technology) for high slope stability against a steep subgrade. Finally, the product's smooth edges allow double-wedge welding between adjacent sheets, and a special cutting tool can remove studs or spikes from cross seams as needed prior to welding.

Manufactured using a flat-die cast extrusion process, MicroDrain features consistent stud pattern and spacing. The stud pattern also reduces the potential for chemical and biological clogging by allowing freer flow of liquids. This manufacturing process promotes full integration of surface features, removing the risk of separation during use. Furthermore, by combining separate features into one product, designers meet multiple project requirements during a single installation. MicroDrain can reduce overall installation time and lower material and CQA costs.

- MicroDrain is an effective geomembrane for use in closure and containment applications
- Available in HDPE and LLDPE
- Upward-facing studs available with heights of 130 mils (3.3 mm), for drainage
- Bottom-facing spikes available with heights of up to 18 mil for slope stability.

# Applications

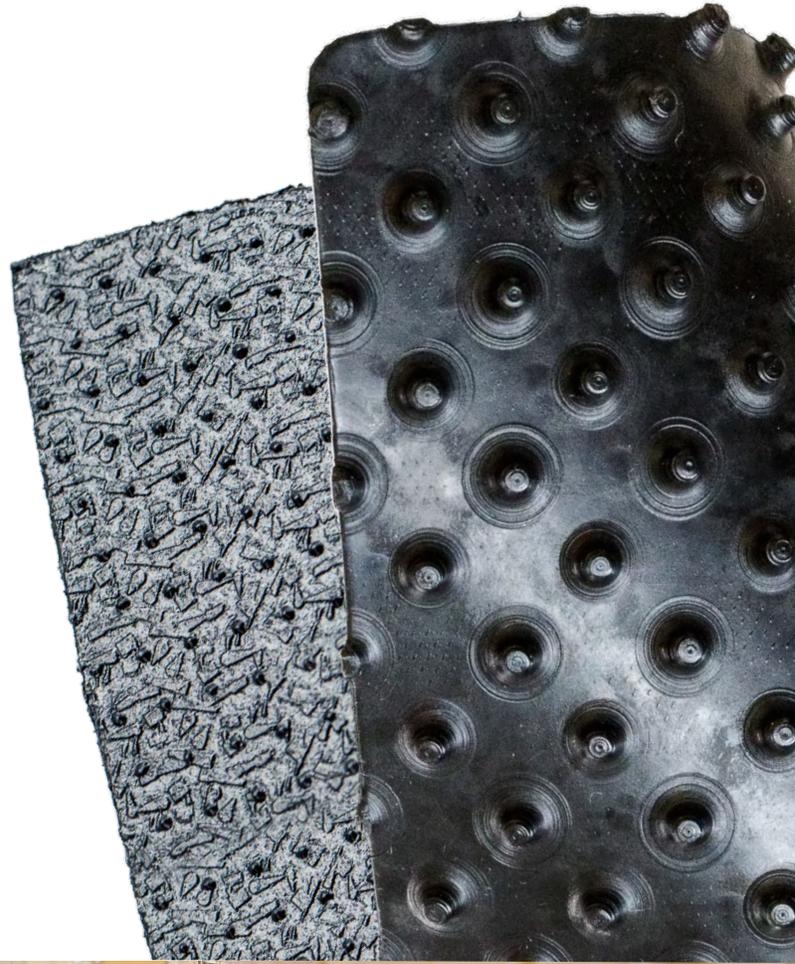
The consistent textured pattern and spacing in MicroDrain makes it an ideal liner solution in high-precision applications.

## Closure

MicroDrain is a dual-purpose geomembrane landfill closure solution that works with the ClosureTurf® Final Cover System or with a more traditional soil-based cover system with soil and geotextile. The typical configuration for soil-based landfill closures includes a filter layer in the form of AGRUTEX, an 8 oz/sy nonwoven geotextile.

## Containment

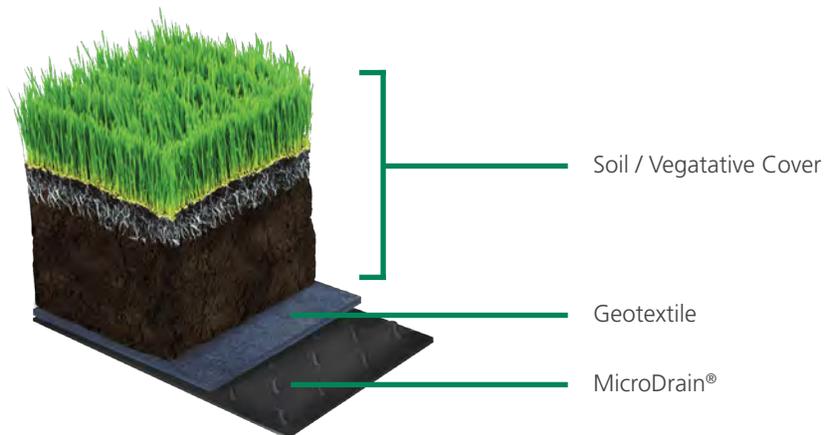
For containment applications, MicroDrain offers excellent performance and a cost-savings containment solution for double-lined ponds, reservoirs, pits, and containment cells. In this situation, MicroDrain works as the secondary geomembrane in applications with slopes of up to 3H:1V.

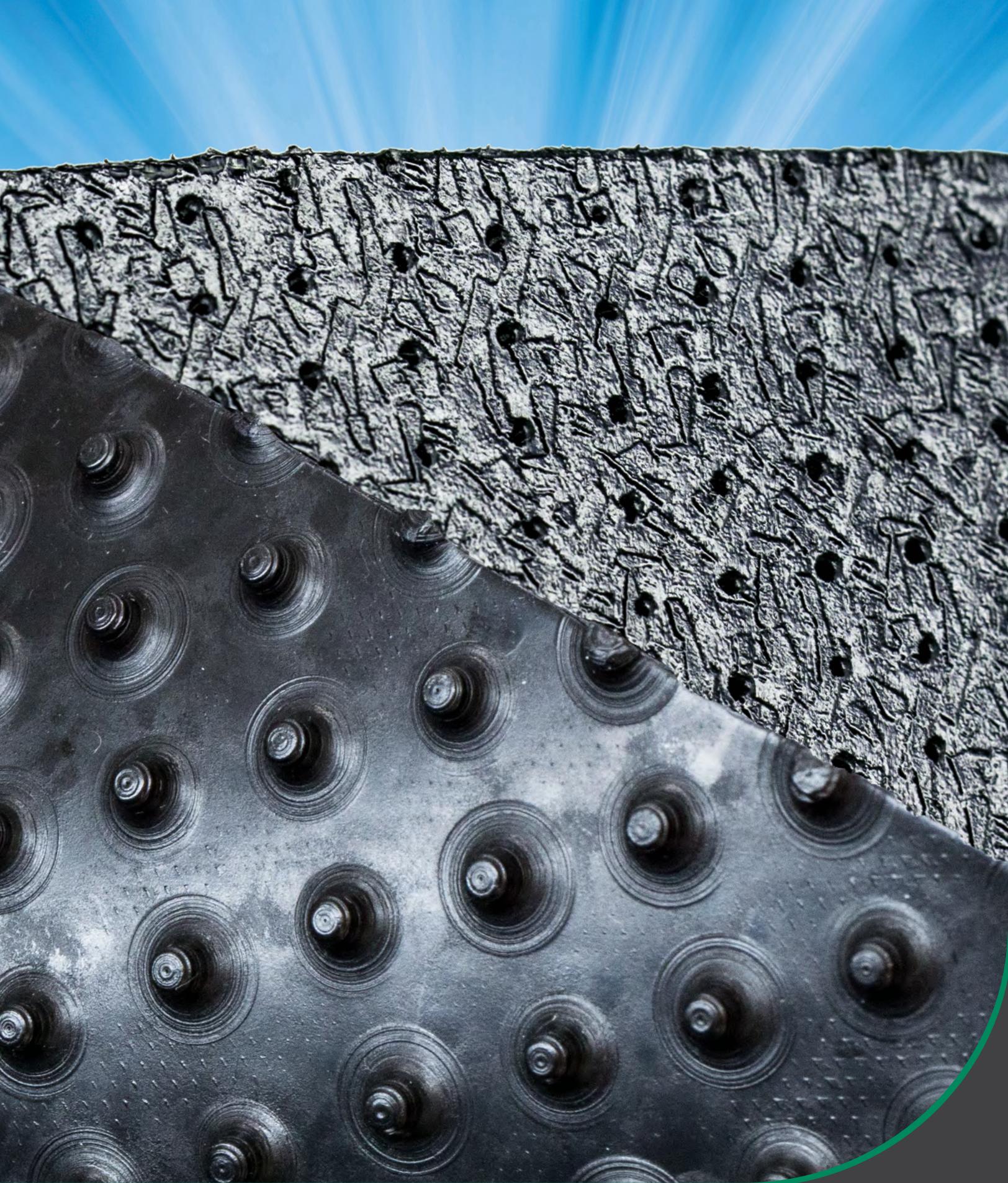


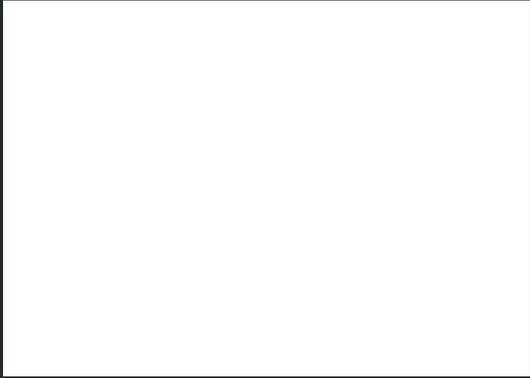
# Essential Component to the AGRU Integrated Drainage System

## Integrated Drainage System

The essential ingredient in MicroDrain is AGRU America's IDS, a Subtitle D-compliant closure and containment solution. IDS incorporates an advanced drainage structure within the geomembrane. By combining drainage media and geomembrane—each with its unique benefits—into one product, AGRU gives a powerful closure and containment solution that also delivers significant cost savings. IDS has increased shear strength performance, reliable long-term drainage performance, a reduction in needed geosynthetic material, and reduced installation time and cost. As of 2018, over 140 million square feet of IDS has been installed and in use for closure and containment applications.







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Illustrations are generic and for reference only.

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# MicroDrain Liner®

## HIGH DENSITY POLYETHYLENE

AGRU America's structured geomembranes are manufactured on state-of-the-art manufacturing equipment using the flat die calender manufacturing process, a method that produces a more consistent core thickness than other processes, such as the blown film extrusion process. AGRU uses only the highest-grade HDPE and LLDPE resins manufactured in North America.

### PRODUCT DATA

Property	Test Method	Frequency	Minimum Average Values			
Thickness (nominal), mil (mm)	ASTM D5994	Per Roll	50 (1.25)	60 (1.5)	80 (2.0)	100 (2.5)
Thickness (min avg), mil (mm)			47.5 (1.19)	57 (1.43)	76 (1.9)	95 (2.38)
Thickness (min 8 of 10), mil (mm)			45 (1.12)	54 (1.35)	72 (1.8)	90 (2.25)
Thickness (lowest individual), mil (mm)			42.5 (1.06)	51 (1.28)	68 (1.7)	85 (2.13)
Drainage Stud Height, mil (mm)	ASTM D7466	2nd Roll	130 (3.3)	130 (3.3)	130 (3.3)	130 (3.3)
MicroSpike® Asperity Height, mil (mm)	ASTM D7466	2nd Roll	20 (0.51)	20 (0.51)	18 (0.46)	18 (0.46)
Density, g/cc, minimum	ASTM D792, Method B	200,000 lb	0.94	0.94	0.94	0.94
Tensile Properties (both directions)	ASTM D6693, Type IV					
Strength @ Yield, lb/in width (N/mm)	2 in/minute	20,000 lb	110 (19.3)	132 (23.1)	176 (30.8)	220 (38.5)
Elongation @ Yield, % (GL=1.3in)			12	12	12	12
Strength @ Break, lb/in width (N/mm)			110 (19.3)	132 (23.1)	176 (30.8)	220 (38.5)
Elongation @ Break, % (GL=2.0in)			300	300	300	300
Tear Resistance, lb,s. (N)	ASTM D1004	45,000 lb	38 (169)	42 (187)	56 (249)	70 (310)
Puncture Resistance, lbs. (N)	ASTM D4833	45,000 lb	80 (356)	95 (422)	126 (560)	158 (703)
Carbon Black Content, % (range)	ASTM D4218	20,000 lb	2-3	2-3	2-3	2-3
Carbon Black Dispersion (Category)	ASTM D5596	45,000 lb	Only near spherical agglomerates: 10 views Cat. 1 or 2			
Stress Crack Resistance (SP-NCTL), hrs.	ASTM D5397 Appendix	200,000 lb	500	500	500	500
Oxidative Induction Time, minutes	ASTM D3895, 200°C, 1 atm O <sub>2</sub>	200,000 lb	≥140	≥140	≥140	≥140
Transmissivity, m <sup>2</sup> /sec <sup>1</sup>	ASTM D4716	Periodic	4 x 10 <sup>-3</sup>			

AGRU America's geomembranes are certified to pass Low Temp. Brittleness via ASTM D746 (-80°C), Dimensional Stability via ASTM D1204 (±2% @ 100°C). Oven Aging and UV Resistance are tested per GRI GM 13. These product specifications meet or exceed GRI's GM13. <sup>1</sup>Transmissivity at a temp. of 21°C, gradient of 0.1 and a load of 10,000 psf: seating time 15 min. between steel plates.

### SUPPLY INFORMATION (STANDARD ROLL DIMENSIONS)

THICKNESS		WIDTH		LENGTH		AREA (APPROX.)	
mil	mm	ft	m	ft	m	ft <sup>2</sup>	m <sup>2</sup>
50	1.25	23	7	500	152	11,500	1,068
60	1.5	23	7	500	152	11,500	1,068
80	2.0	23	7	300	91.4	6,900	640
100	2.5	23	7	300	91.4	6,900	640

Note:

Average roll weight is 5,000 lbs (2,268 kg) for 50 and 60 mil and 4,000 lbs (1,814 kg) for other thicknesses. All rolls are supplied with two slings. Rolls are wound on a 6" core. Special length available upon request. Roll length and width have a tolerance of ±1%. The weight values may change due to project specifications (i.e. absolute minimum thickness or special length) or shipping requirements (i.e. international containerized shipments).

All information, recommendations and suggestions appearing in this literature concerning the use of our products are based upon tests and data believed to be reliable; however, it is the users responsibility to determine the suitability for their own use of the products described herein. Since the actual use by others is beyond our control, no guarantee or warranty of any kind, expressed or implied, is made by AGRU America as to the effects of such use or the results to be obtained, nor does AGRU America assume any liability in connection herewith. Any statement made herein may not be absolutely complete since additional information may be necessary or desirable when particular or exceptional conditions or circumstances exist or because of applicable laws or government regulations. Nothing herein is to be construed as permission or as a recommendation to infringe any patent.



# MicroDrain Liner®

## LOW DENSITY POLYETHYLENE

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### PRODUCT DATA

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Drainage Stud Height, mil (mm)	ASTM D7466	2nd Roll	130 (3.3)	130 (3.3)	130 (3.3)	130 (3.3)
MicroSpike® Asperity Height, mil (mm)	ASTM D7466	2nd Roll	20 (0.51)	20 (0.51)	18 (0.46)	18 (0.46)
Density, g/cc, maximum	ASTM D792, Method B	200,000 lb	0.939	0.939	0.939	0.939
Tensile Properties (both directions)	ASTM D6693, Type IV		105 (18.4)	126 (22.1)	168 (29.4)	210 (36.8)
Strength @ Break, lb/in width (N/mm)			300	300	300	300
Elongation @ Break, % (GL=2.0in)						
Tear Resistance, lb.s. (N)	ASTM D1004	45,000 lb	30 (133)	40 (178)	53 (236)	67 (298)
Puncture Resistance, lbs. (N)	ASTM D4833	45,000 lb	55 (245)	70 (311)	90 (400)	110 (489)
Carbon Black Content, % (range)	ASTM D4218	20,000 lb	2-3	2-3	2-3	2-3
Carbon Black Dispersion (Category)	ASTM D5596	45,000 lb	Only near spherical agglomerates: 10 views Cat. 1 or 2			
Oxidative Induction Time, minutes	ASTM D3895, 200°C, 1 atm O <sub>2</sub>	200,000 lb	≥140	≥140	≥140	≥140

AGRU America's geomembranes are certified to pass Low Temp. Brittleness via ASTM D746 (-80°C), Dimensional Stability via ASTM D1204 (±2% @ 100°C). Oven Aging and UV Resistance are tested per GRI GM 17. These product specifications meet or exceed GRI's GM17.

### SUPPLY INFORMATION (STANDARD ROLL DIMENSIONS)

THICKNESS		WIDTH		LENGTH		AREA (APPROX.)	
mil	mm	ft	m	ft	m	ft <sup>2</sup>	m <sup>2</sup>
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# Super Gripnet®

INTEGRATED DRAINAGE  
SYSTEM (IDS) GEOMEMBRANE





## The Plastics Experts.

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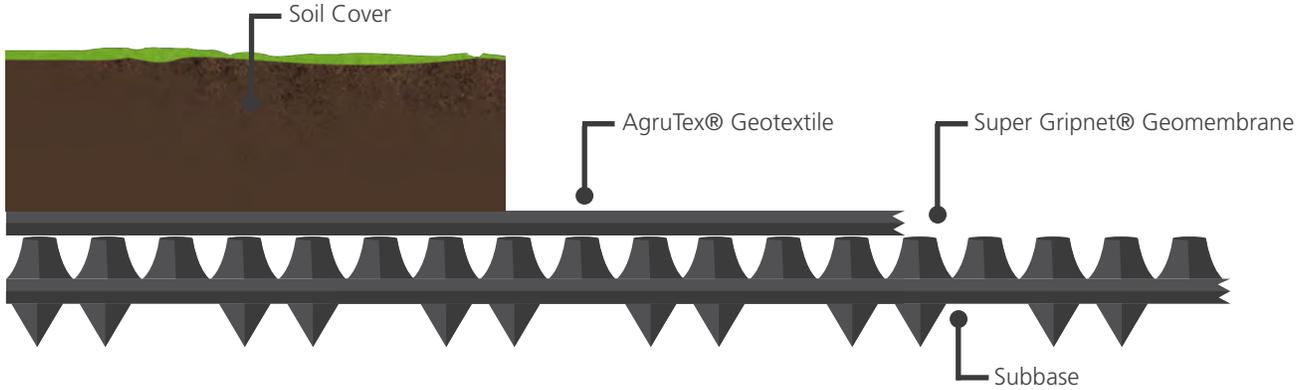
The AGRU success story has been unfolding now for about seven decades. Founded in 1948 by Alois Gruber Sr., the company has grown to become one of the world's most important single-source suppliers for geosynthetic materials, piping systems, semi-finished products and concrete protection liners made from engineered plastics. Our ability to manufacture and supply everything from a single source is a unique differentiator. And, when it comes to application-technical consulting, we are your best partner.



### Quality

At AGRU, customer satisfaction comes first. Our start-to-finish attention to quality ensures that our products meet and exceed the strictest technical specifications, providing safe operation within municipal solid waste, coal combustion residual (CCR), mining, oil & gas, water and wastewater infrastructures.

As a replacement and improvement to traditional geocomposite drainage products overlying textured geomembrane, facility owners capitalize on the increased performance and decreased costs that using Super Gripnet® provides. This is evident from over 150,000,000 square feet of Integrated Drainage System (IDS) installation across the United States and beyond.



HDPE and LLDPE Super Gripnet® applications include projects where containment, drainage, interface friction and economic dynamics are critical. These projects include landfill closures, containment facilities, oil & gas applications, mining reclamation projects, to name a few.

The structured Integrated Drainage System (IDS) geomembrane is manufactured by continuous horizontal flat die extrusion into profile rollers, which produces the final structured surface of drainage studs and spikes. This manufacturing process provides a smooth edge for on-site welding and a consistent core thickness, which provides industry leading geomembrane physical properties. This IDS product results in environmental containment, higher interface friction capabilities, consistent drain capacity and decreased project costs.





# Super Gripnet® Liner

## Features

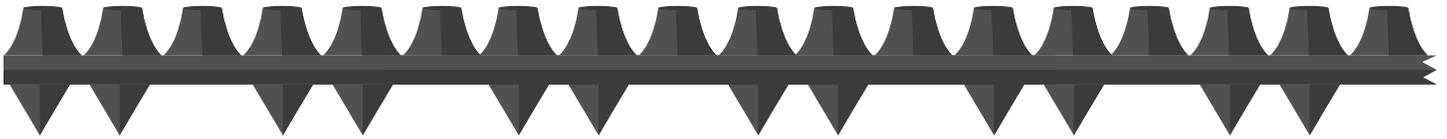
- Combines Containment Layer & Drainage Layer w/ Single IDS Geomembrane
- Exceptional Interface Performance on Steep Slopes
- Increased Performance / Decreased Cost
- Decreased number of laydown area
- Greater Factors of Safety
- Two Layer Closure versus Traditional Four Layer Closure
- Consistent Drain and Structure Pattern
- Single Point of Contact for Material Delivery

Interface	Peak Angle*	Peak Adhesion*
Super Gripnet® Spikes/Granular Soil	40d	35 psf
Super Gripnet® Spikes/Cohesive Soil	35d	45 psf
IDS/GT	30d	75 psf

Note:

\*Based on linear regression best fit line of current DST data

Our engineered profile rollers provide the structured surface with a 130 mil (3.3 mm) studded drain surface on the top side and 175 mil (4.45 mm) spiked friction surface on the bottom side. The 23 feet (7 meter) wide rolls of finished product include a smooth edge on both sides of the roll for ease of thermal welding in the field. Due to the moulded structure, core thickness variation is dramatically reduced as compared with blown film textured sheets, so the mechanical properties of the sheet are greatly superior. In addition, the consistent high-profile spike surface ensures optimum interface friction characteristics at any point on the sheet surface and provides greater factor of safety values.



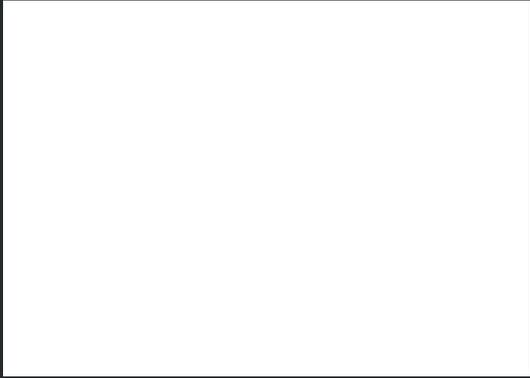
US Patent - No. 5.258.217



## Advantages

Super Gripnet® geomembrane with our Integrated Drainage System (IDS) has decided advantages over traditional closure methods, including:

- Meets & Exceeds EPA Requirements
- Increased Performance / Decreased Cost
- Unmatched Shear Strength Performance and Factors of Safety
- Environmental Containment and Drainage Component in Single Layer
- Decreased Lead Time for Materials
- Decreased Number of Trucks for Delivery
- Decreased Number of Rolls to Unload/Handle/Store
- No Geocomposite Cutting or Net Ties on Seams
- Improved Planar Flow = Less reduction for chemical/biological clogging concerns



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Revision Date: December 13, 2018



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## HIGH DENSITY POLYETHYLENE

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Drainage Stud Height, mil (mm)	ASTM D7466	2nd Roll	130 (3.3)	130 (3.3)	130 (3.3)	130 (3.3)
Friction Spike Height, mil (mm)	ASTM D7466	2nd Roll	175 (4.45)	175 (4.45)	175 (4.45)	175 (4.45)
Density, g/cc, minimum	ASTM D792, Method B	200,000 lb	0.94	0.94	0.94	0.94
Tensile Properties (both directions)						
Strength @ Yield, lb/in width (N/mm) Elongation @ Yield, % (GL=1.3in)	ASTM D6693, Type IV 2 in/minute	20,000 lb	110 (19.3)	132 (23.1)	176 (30.8)	220 (38.5)
			12	12	12	12
Strength @ Break, lb/in width (N/mm)			110 (19.3)	132 (23.1)	176 (30.8)	220 (38.5)
Elongation @ Break, % (GL=2.0in)			200	200	200	200
Tear Resistance, lb.s. (N)	ASTM D1004	45,000 lb	38 (169)	42 (187)	56 (249)	70 (310)
Puncture Resistance, lbs. (N)	ASTM D4833	45,000 lb	80 (356)	90 (400)	120 (534)	150 (667)
Carbon Black Content, % (range)	ASTM D4218	20,000 lb	2-3	2-3	2-3	2-3
Carbon Black Dispersion (Category)	ASTM D5596	45,000 lb	Only near spherical agglomerates: 10 views in Cat. 1 or 2			
Stress Crack Resistance (SP-NCTL), hrs.	ASTM D5397 Appendix	200,000 lb	500	500	500	500
Oxidative Induction Time, minutes	ASTM D3895, 200°C, 1 atm O <sub>2</sub>	200,000 lb	≥140	≥140	≥140	≥140
Transmissivity, m <sup>2</sup> /sec <sup>1</sup>	ASTM D4716	Periodic	4 x 10 <sup>-3</sup>			

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# Super Gripnet® Liner

## LINEAR LOW DENSITY POLYETHYLENE

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### SUPPLY INFORMATION (STANDARD ROLL DIMENSIONS)

THICKNESS		WIDTH		LENGTH		AREA (APPROX.)	
mil	mm	ft	m	ft	m	ft <sup>2</sup>	m <sup>2</sup>
50	1.25	23	7	500	152	11,500	1,068
60	1.5	23	7	500	152	11,500	1,068
80	2.0	23	7	300	91.4	6,900	640
100	2.5	23	7	300	91.4	6,900	640

Note:

Average roll weight is 5,000 lbs (2,268 kg) for 50 and 60 mil and 4,000 lbs (1,814 kg) for other thicknesses. All rolls are supplied with two slings. Rolls are wound on a 6" core. Special length available upon request. Roll length and width have a tolerance of ±1%. The weight values may change due to project specifications (i.e. absolute minimum thickness or special length) or shipping requirements (i.e. international containerized shipments).

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