

Waste Closure Solutions with Geosynthetics & Renewable Energy

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Technical Manager – Canadian Region



AGRU Facts

The Plastics Experts.

OVER 70 YEARS OF EXCELLENCE IN PLASTICS
AND GEOSYNTHETICS

CLOSURETURF®

- Economical Subtitle D final cover system
- Predictable performance through life of cover system
- Eliminates need for cover soil and vegetation maintenance



AGRU Drain Liner®

- Efficient leak detection system
- Double-lined application
- Cost effective

Super Gripnet® Liner

- Combines drainage and friction in one liner
- Excellent drainage
- Highest friction angles available in the industry
- Cost saving closure option



MicroSpike® Liner

- Structured surface
- Smooth weld edge
- Consistent texturing
- High mechanical properties
- HDPE and LLDPE
- Available in black and white, and conductive



AGRUTex®

- Wide range of product offerings from 3 oz/yd2 to 32+ oz/yd2
- Suitable for separation, stabilization, filtration, and cushioning applications

AGRU Geocomposite

- Drainage/filtration media
- Single- and double-sided
- High compression & flow
- Gas venting capabilities
- Excellent cushioning
- 160-300 mil core net

AGRU Smooth Liner®

- Optimum weld speed and weld quality
- Consistent thickness
- 23" wide
- HDPE and LLDPE
- Available in black and white, and conductive



Transition Fittings

- Exceptional corrosion resistance and extended service life
- Available from 1 1/4" CTS through 4" IPS sizes
- 3" Externally Coated Thread End Transition



AGRU GeoClay®

- Hydraulically superior to several feet of 1x10-7 cm/sec compacted clay
- Natural sodium bentonite self-healing self-sealing
- Polymer-enhanced for leachage resistance



Sheet Stack

- Available in PE, PP, PVDF, ECTFE, FEP, and PFA
- Available with fabric backing
- High and low temp applications
- Large variety of sizes



Large Diameter Pipe

- Outstanding chemical and corrosion resistance
- Strong leak-free fusion welded joints
- Long-term durability, ductility and flexibility
- Available in diameters 24" - 138"



Sure-Grip®

- Concrete protective liner
- Variety of applications including manholes, pipes & cast in place
- High pullout strength
- Various resins/thicknesses



Hydroclick®

- Rehabilitation of potable water systems
- Long life, low maintenance
- Easy, leak tight installation
- NSF 61



AGRUFlex®

- Tunnel waterproofing system
- Signal layer
- State-of-the-art VELCRO® and induction welding attachments
- Waterstop profiles/accessories



Electrofusion Fittings

- Advanced fusion welding using automated electrofusion processors
- Fusion joint integrity with ease of installation in tight areas
- Eliminates internal bead for increased flow
- Diameters up to OD 48" IPS



HDPE Pipe Fittings

- Same chemical and corrosion resistance of HDPE pipe
- Full HDPE fittings range assuring max. system compatibility
- Exceptional piping system design capability
- Strong leak-free fusion welded joints



AGRU Plants



AGRU Kunststofftechnik
Austria



AGRU Oberflächentechnik
Austria



AGRU-FRANK
Germany



TWS
Poland



AGRU AMERICA
Fernley, NV/USA



AGRU AMERICA
Georgetown, SC/USA



AGRU AMERICA
Andrews, SC/USA



TAICANG AGRU PLASTICS
China



AGRU AMERICA
Charleston, SC/USA



Large Diameter Pipe

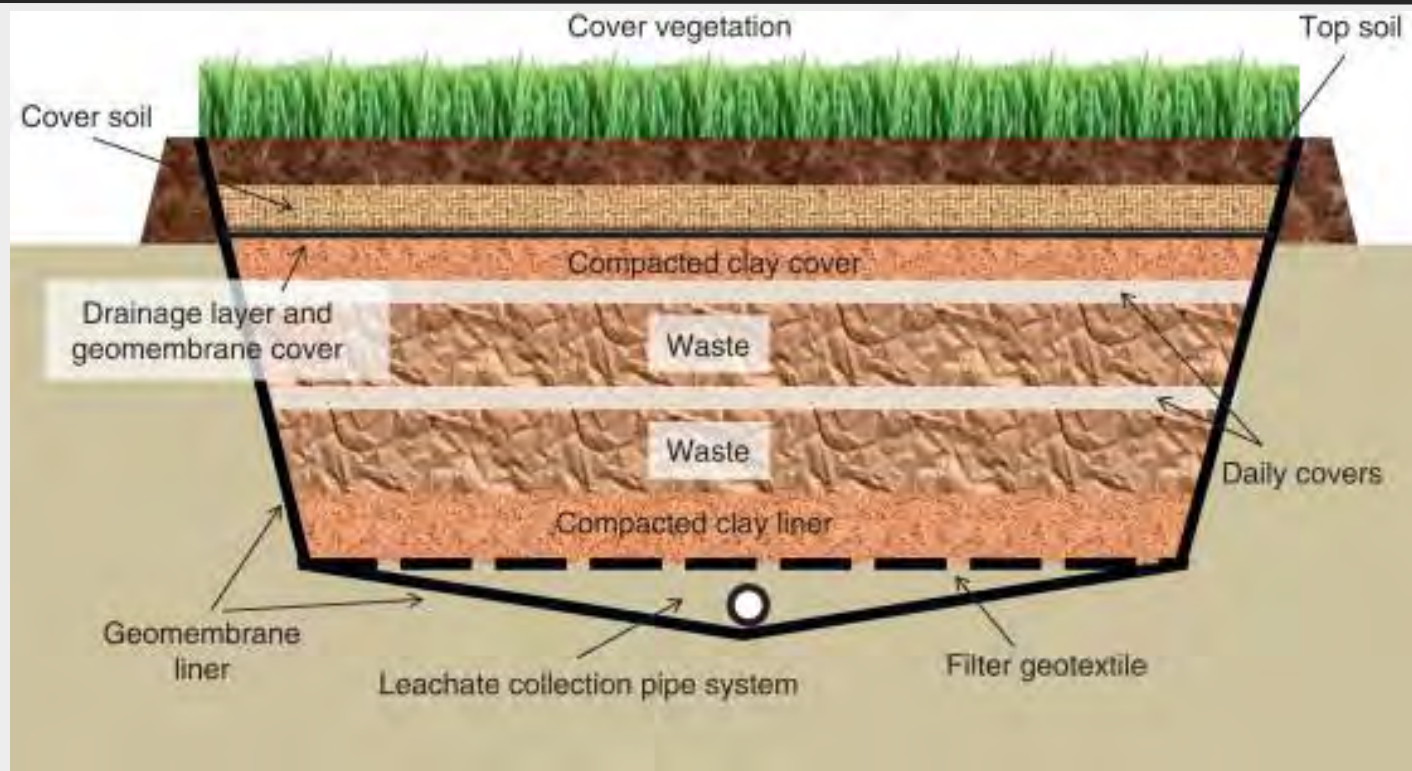




Solid Waste Closure Options

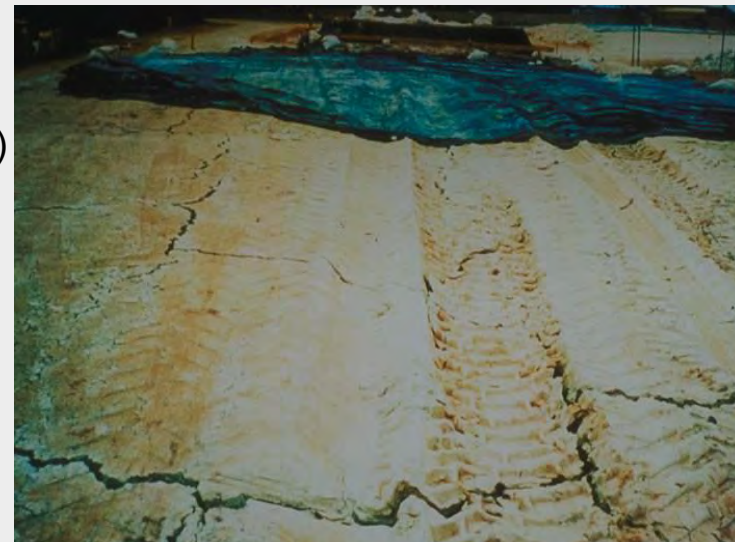
- Compacted Clay Liner
- Traditional: 40mil Geomembrane (LLDPE) with Geocomposite drainage
- IDS (Integrated Drainage System) with geotextile
- Turf closure with geomembrane
- Turf closure with geomembrane and solar





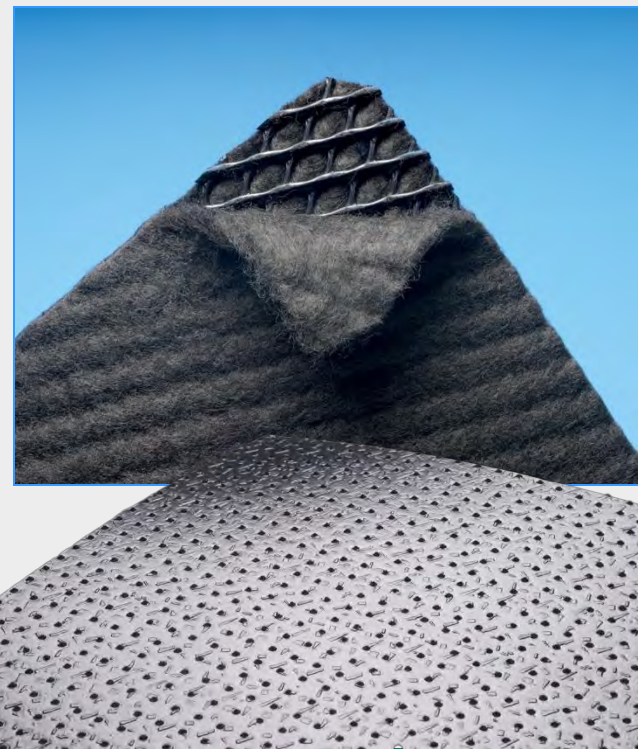
Clay Liner Issues

- Moisture content control
- Compaction effort (machinery used, number of passes, slope, etc)
- Nearly saturated and can desiccate during construction, upon rewetting little self-healing occurs
- Suitable materials not always available; may require expensive transportation
- Settlement repair extensive
- Consistency of source material
- Complex CQA
- Weather variables (temp, humidity, solar intensity)

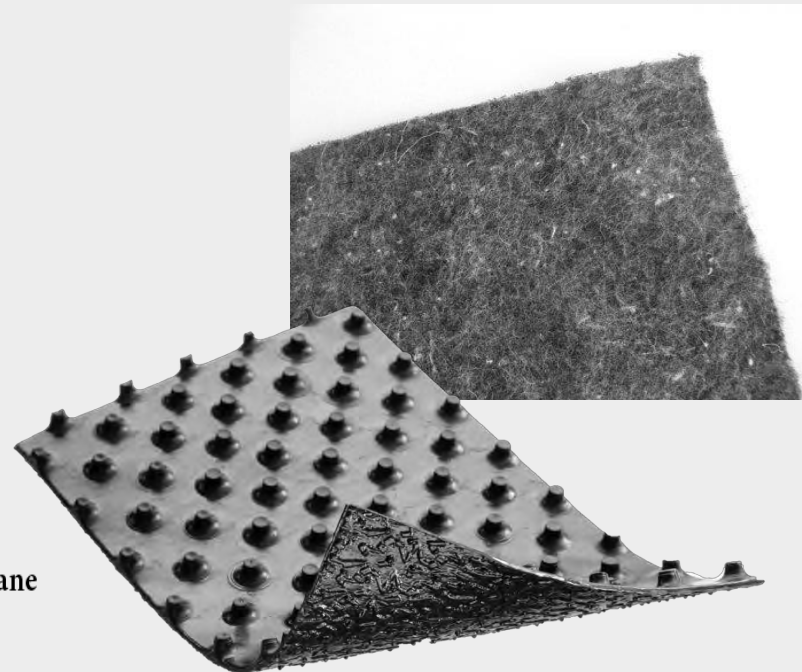
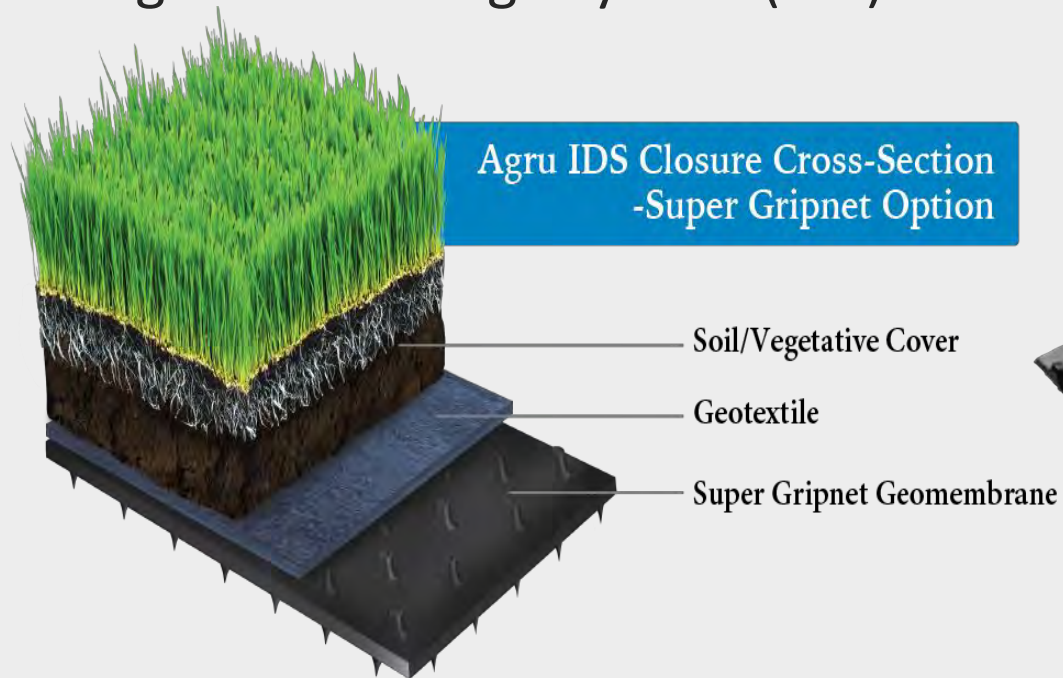


CCL = Highly variable field performance

Conventional Geosynthetic Cover System



Integrated Drainage System (IDS)



Solid Waste Closures on Steep Slopes



Super Gripnet for Steep Slopes

- Containment and drainage in single layer
- Exceptional interface on steepest slopes
- Greater factors of safety
- Consistent drain and structure pattern for consistent test results and performance
- Smaller laydown area



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

Geosynthetic Closure Systems



Traditional Closure System



Integrated Drainage System (IDS)



ClosureTurf® System

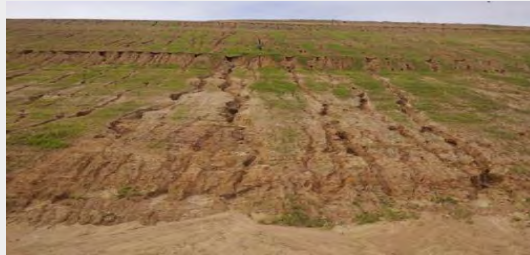
Synthetic Turf Waste Closures



Why Synthetic Turf?

Challenges with traditional soil covers:

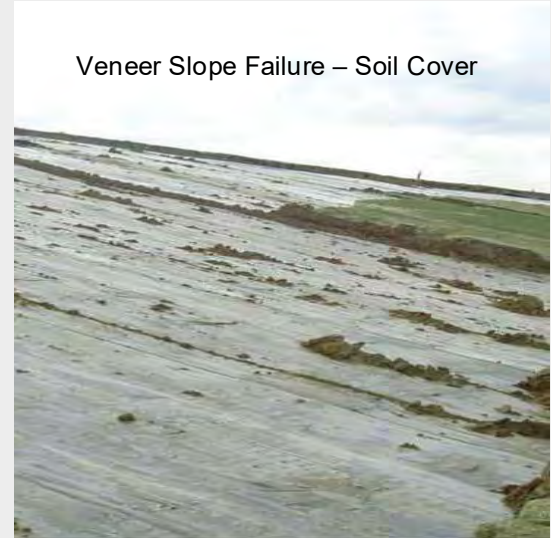
- Soil erosion and sedimentation – soil quality, vegetation, and weather
- Final cover veneer stability – interface friction, drainage, and gas uplift
- Availability of soil
- Post-closure maintenance



Poor Vegetation and Soil Erosion



Veneer Slope Failure – Soil Cover



- **Structured Geomembrane**
 - Impermeable geomembrane
 - Provides environmental containment
 - 500 year ½ life
- **Engineered Synthetic Turf**
 - Conservatively placed 100 year ½ life
 - Shields geomembrane just like a soil fill layer
 - Turf fibers anchor sand infill
 - Provides aesthetic benefits
- **Sand Infill**
 - Maintenance traffic cushion
 - UV shield for turf layer substrates

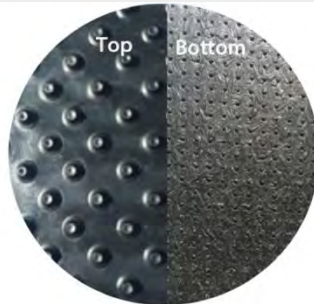


System Components

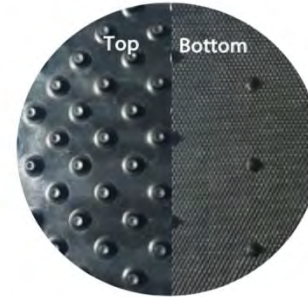
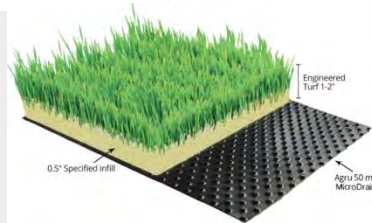
Structured HDPE or LLDPE Geomembrane



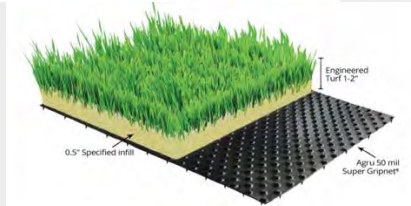
AGRU MicroSpike®
(40 mil)



AGRU MicroDrain®
(50 mil)



AGRU Super GripNet®
(50 or 60 mil)



Selection of geomembrane is typically based on slope (interface friction), drainage (hydraulic shear of sand), and cost.

Installation Process



Subgrade Preparation and
Anchor Trenches



Geomembrane – unrolling



Geomembrane - Welding



Synthetic Turf – unrolling



Synthetic Turf – Heat Weld

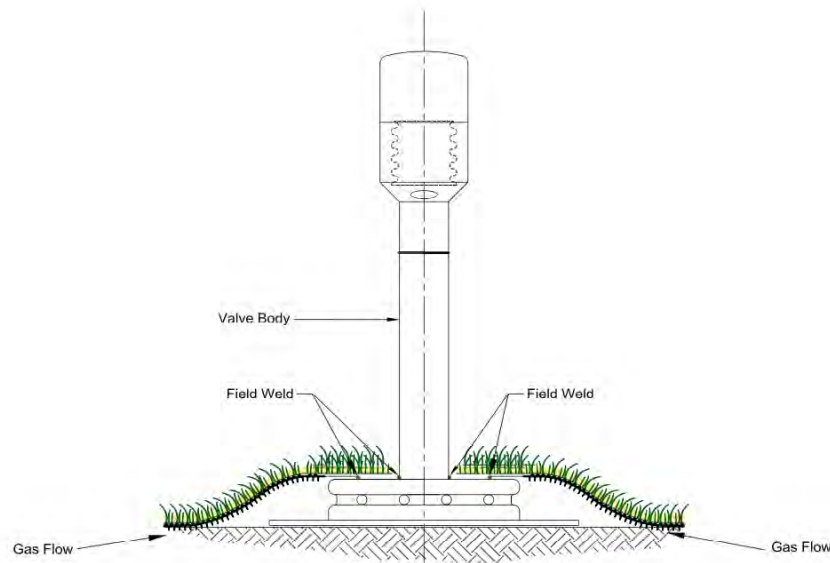


Sand Infill – Brushing and Grooming



Sand Infill Installation Using Air Pump

Pressure Relief Valves



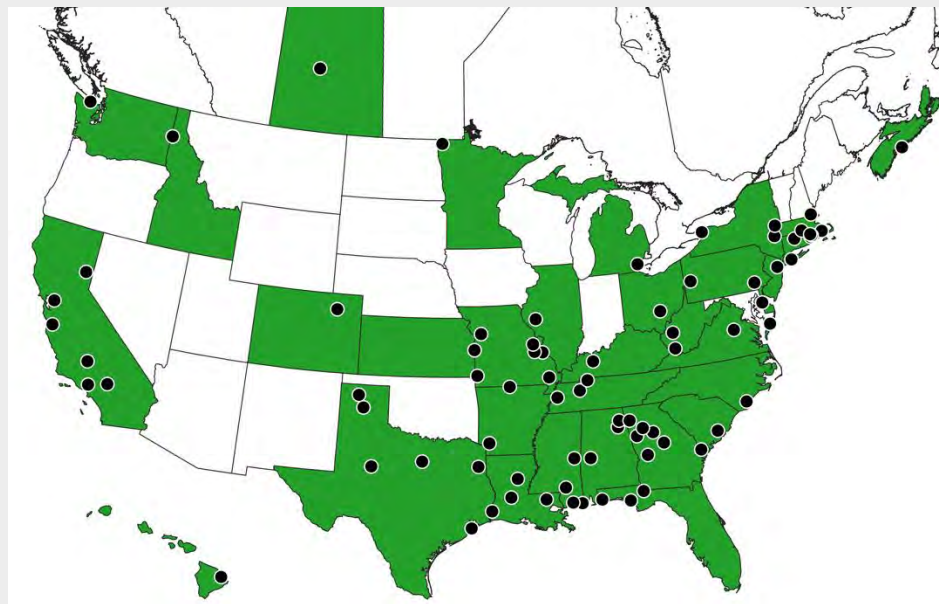
Section

Notes:

1. Pressure Relief Valves are designed to convey 50 SCFM. 1 per acre is supplied with the ClosureTurf® system. Engineer of Record will determine the amount of Pressure Relief Valves required.
2. Please verify latest revision of drawing by checking at www.closureturf.com.



- First ClosureTurf installation completed in 2009 at the LaSalle-Grant Landfill in Louisiana
- To date, ~4000 acres installed or being installed at 100+ sites in 35+ states & provinces
- Project size ranging from several acres to over 200 acres
- Municipal and industrial waste landfills and coal ash impoundments
- Warm and cold climates and severe weather conditions (hurricanes, storms, snows, and strong winds)



Synthetic Turf Waste Closures Benefits



Turf Post-Closure Maintenance

- 80-90% less maintenance cost than traditional soil cover:
 - ClosureTurf: ~\$200 to \$250/acre/year with sand infill;
 - Traditional cover ~\$1,000 to \$1,500 per acre/year

Traditional Cap	Advanced Engineered System
Mowing (4 events per year)	Not Required
Erosion Control (1 event per 25 acres, twice per year)	Not Required
Reseeding (1/3 area, twice per year)	Not Required
Fertilizing (1/3 area once per year)	Not Required
Soil Replacement (typical 1 ton/per acre per year average- per EPA)	Sand Infill Replacement (<2% total area every 5 years)
Pond Cleanout (avg once per every 4 years)	Not Required
Major Storm Repair (4 hours equipment after 1 event/year)	Not Required
Site Inspection (1 inspection per quarter)	Site Inspection (Every 5 to 10 years)

Site Manager's Comment on ClosureTurf (Berkeley County Landfill, South Carolina):

"The reduction in maintenance is our biggest gain. We're saving around \$24,000 a year in maintenance. We have absolutely zero eroded slopes to repair and we have eliminated mowing and grass upkeep."

Aesthetics

Site: Portola Landfill

Owner: City of Portola

Location: Portola, CA

Completed: 2014

Closure Area: 10 acres



Geotechnical Performance – Settlement

Site: Confidential Industrial Client

Location: Southeast US

Completed: 2014

Closure Area: 70 acres (Phase 1) and 70 acres (Phase 2)

Top Photo: Completed Installation of Engineered Turf Cover

Bottom Photo: Depression Areas (approximately two years after installation)



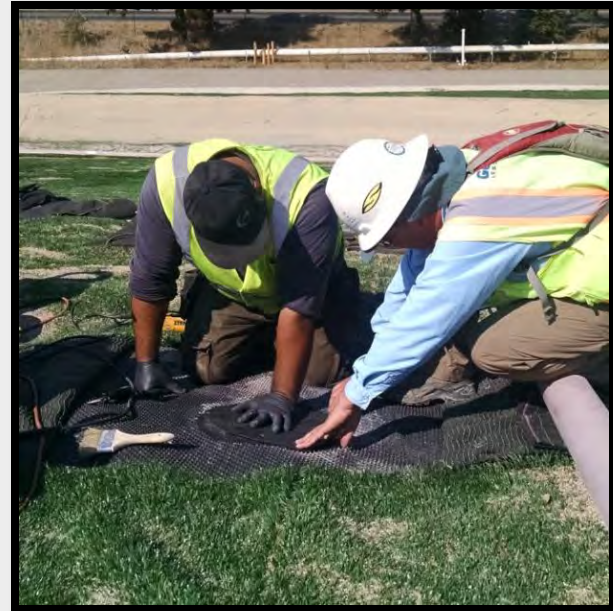
Site: MSW Landfill Located in the West Coast

Repair of depression area:

- Cut 4 small holes and “injected” a flowable fill and let it run down to the void.
- The mix was made of 3 sack fly ash and 1 sack concrete; it did not set up so hard as to damage the geomembrane.



Geotechnical Performance – Settlement Repair



Repair of Depression Area on a Landfill Final Cover Side Slope

Cold Weather Projects

Central Landfill, Johnston, RI
Completed: 2017; Closure Area: 18 acres

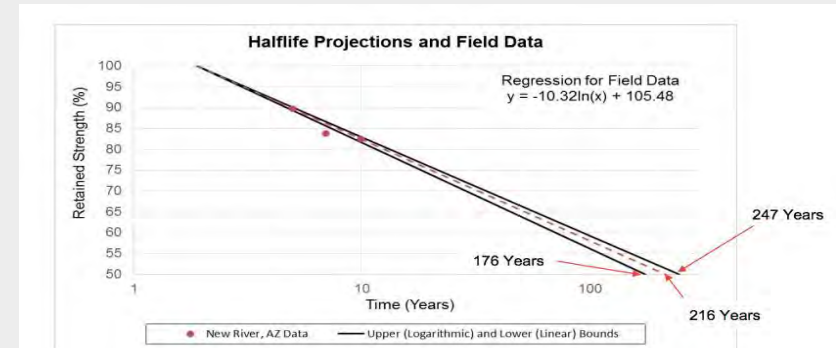
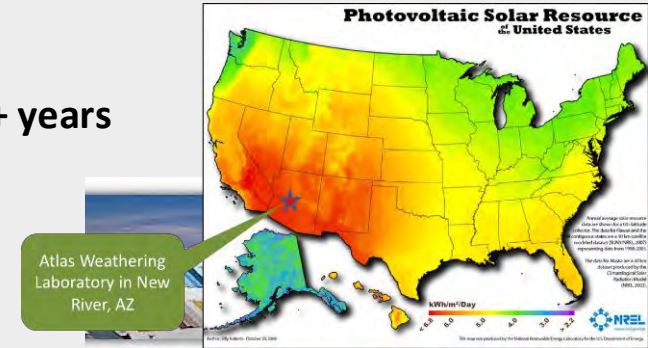


Winter storm Skylar brought high winds and over a foot of snow in March 2019 as the third Nor'easter to strike the Northeast during that winter.



ClosureTurf® Longevity

- Geomembrane (covered by the engineered turf and infill): **400+ years**
 - Engineered Turf: **100+ years**
-
- Real world testing conducted on the engineered turf at the Atlas Weathering Facility in New River, AZ
 - Direct Exposure 45° South
 - ASTM G147 and G7
 - Ten years of data collected: 1.3 years, 5 years, 7 years and 10 years





Landfill Vegetation Challenges Post Hurricane Florence in 2018

Case Study – Duke Sutton

Owner: Duke Energy –
Sutton Plant

Location: Wilmington, NC

Completed: Under
Construction

Closure Area: 70 acres

Case Study – Duke Sutton

Post hurricane Florence 2018



After Hurricane Dorian in 2019

Case Study – Duke Sutton

Owner: Duke Energy – Sutton Plant

Location: Wilmington, NC

Completed: Under Construction

Closure Area: 70 acres



MS Phosphate – Federal Superfund Site





Downchutes

A Confidential Coal Combustion
Residual (CCR) Landfill
Southeast US



Village Creek WRF Overflow Spillway - TX





Designing for the Future:
How Solar is Maximizing Productivity and
Mitigating Liabilities for Landfills &
Impoundments

PowerCap™ PATENTED SYSTEM

- **Dual Glass Panels**
 - Providing industry leading long-term reliability- bankability
 - 30-year manufacturer warranty
- **Patented attachment system**
 - No need for traditional racking
 - No penetration of the liner system
- **Increased Density**
 - Significantly higher power per Acre (Fill Factor)
 - High efficiency crystalline silicon cells
 - Installation on Slopes (typically top deck only with racked solar)
- **Lower cost & lightweight**
 - Faster and easier installation
 - In some configurations as low as 4.5kg/m²
- **Highly versatile, aesthetic design**
 - Ultra thin – from 4.5mm
 - Easy integration into structures



***Note:** Cost, production and capacity based on a variety of factors including but not limited to array size, geometry and location.



A 2.7-MW solar farm constructed on a portion of a landfill in Somerville, Tennessee, USA
(Source: <https://www.wastetodaymagazine.com/article/tennessee-landfill-solar-project-complete/>)

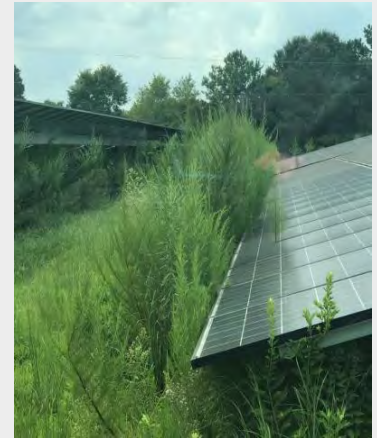
Erosion



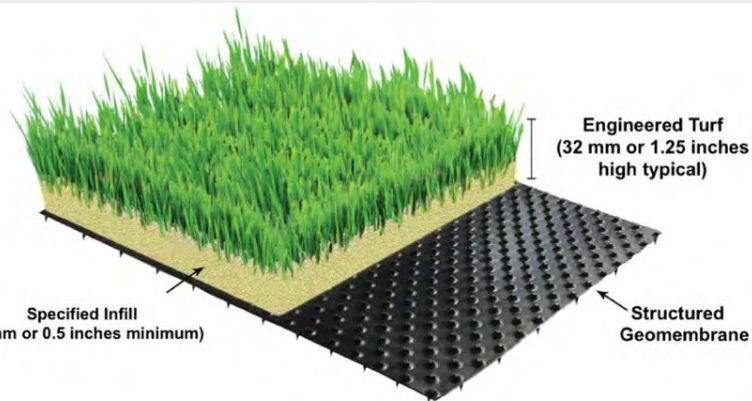
Impact of Loading on Landfill



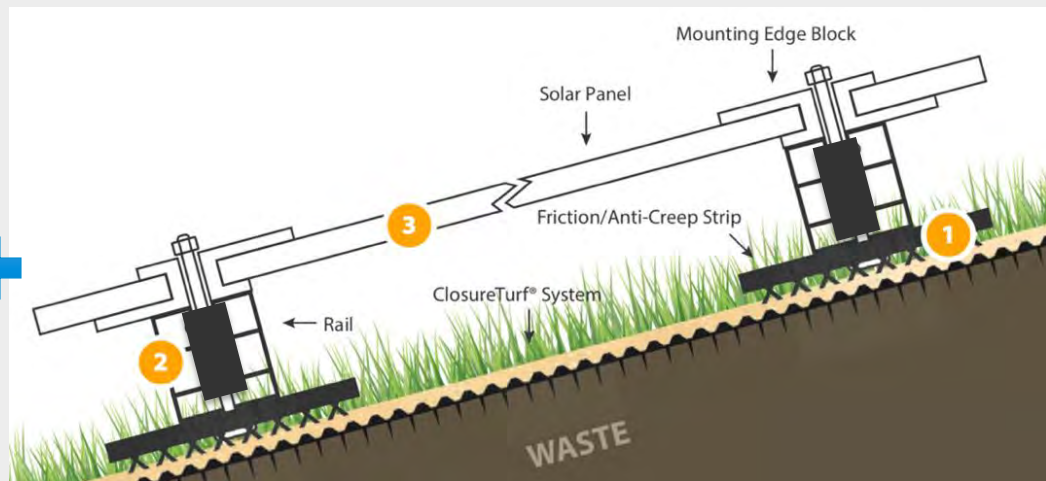
Vegetation Overgrowth



ClosureTurf® Final Cover System



PowerCap® Rackless PV Solar Panels

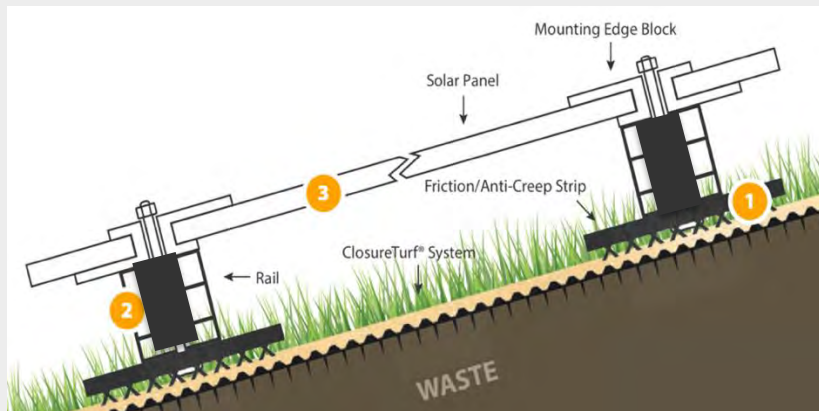


- PowerCap is a patented PV solar panel system that is custom-designed for direct installation on ClosureTurf:

Friction Strip
(backside)



Rail (with friction strip)



PowerCap™
Rackless PV Solar Panels



- 1 MW installation on 6.0 acres
- EPC: Tecta America
- Annual production of 1,500,000 kWh
- Top Deck installation
- System was connected to the grid on September 2014
- Traditional Ballasted Array on ClosureTurf

Hartford MIRA Landfill – Traditional Ballasted Array



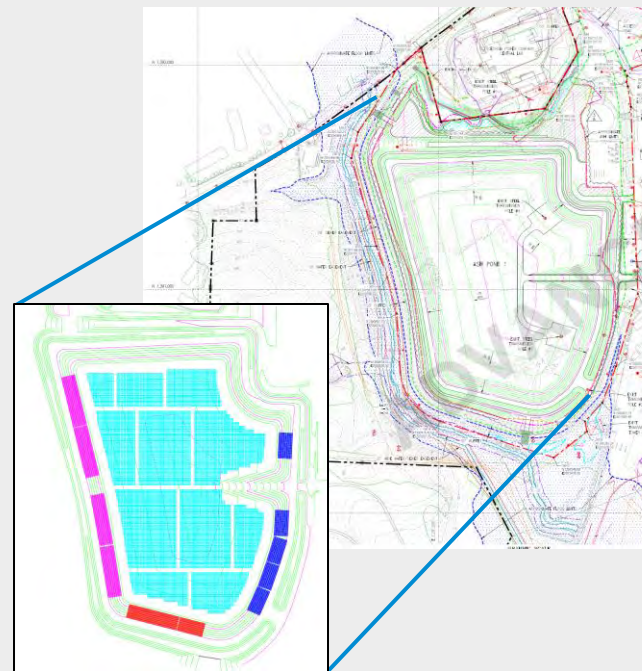
DENSITY, DENSITY, DENSITY

Typical footprint (Utility Scale)~

- 5.9 MWp system over 15 Acres
 - **1MW per 2.5 Acres**
 - Layout could get 1MW per 2.0 Acres on this site
 - Industry Average for Fixed Tilt = 1MW per 5.0 to 10.0 Acres

The details:

- **Up to 300% larger capacity** (compared to ballasted metal rack)
- **Up to 60% greater fill factor** (slopes & panel density)



***Note:** Cost, production and capacity based on a variety of factors including but not limited to array size, geometry and location.

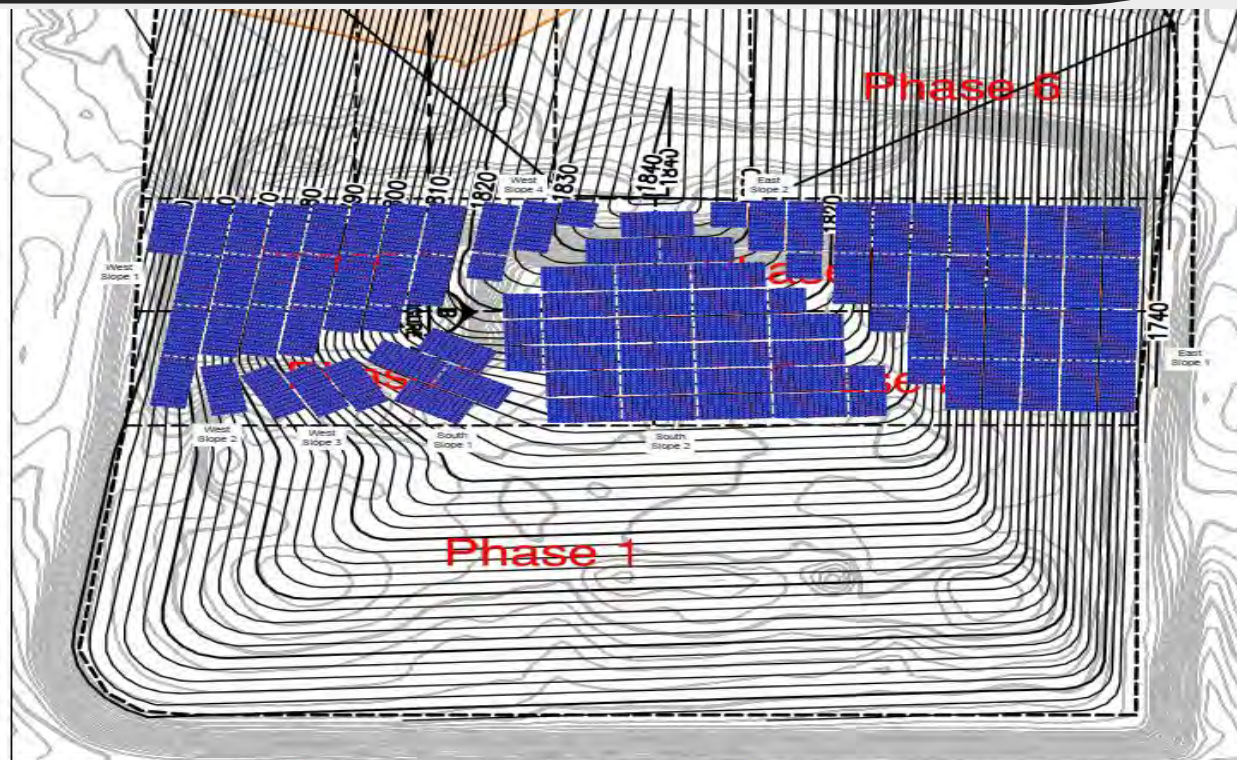
PROPOSAL SPECIFICATIONS

SYSTEM SIZE DC (kW)	5,242
SYSTEM SIZE AC (kW)	4,400
DC TO AC RATIO	1.19
MODULE INFORMATION	(10,920) Q.PEAK DUO XL-G10.3/BFG 480 (480W)
STRING INFORMATION	(546) PARALLELED STRINGS (10 AWG-COPPER)
INVERTER INFORMATION	(5) PVU-L0880GR (TMEIC)
PANELS PER STRING	20
INTERCONNECTION VOLTAGE	MEDIUM VOLTAGE (12.47 kV)
RACKING DETAILS	cFR v2 5D 28 CM BLOCK
SITE COORDINATES	47.526067, -92.483965
GROUND SNOW LOAD (PSF)	42

ARRAY INFORMATION

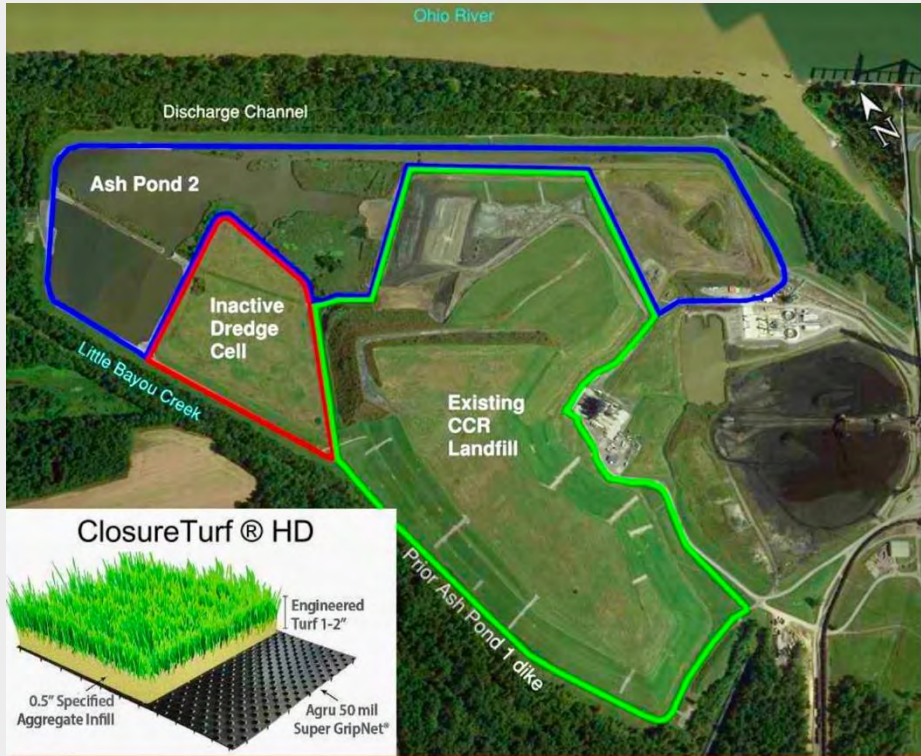
ARRAY NO.	AZIMUTH (SOUTH=180°)	TILT ANGLE	NO. OF MODULES	THERMAL BREAK	SETBACK	kW DC
West Slope 1	281.0°	16.31°	2,520	4 FT	VARIES	1,209.6
West Slope 2	260.0°	16.31°	120	4 FT	VARIES	57.6
West Slope 3	241.0°	16.31°	360	4 FT	VARIES	172.8
West Slope 4	279.0°	10.71°	360	4 FT	VARIES	172.8
South Slope 1	208.0°	16.31°	480	4 FT	VARIES	230.4
South Slope 2	178.0°	10.71°	3,360	4 FT	VARIES	1,612.8
East Slope 1	91.0°	16.31°	3,360	4 FT	VARIES	1,612.8
East Slope 2	91.0°	10.71°	360	4 FT	VARIES	172.8
TOTAL	N/A	N/A	10,920	N/A	N/A	5,241.6

NOTE(S):



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Project Phoenix: PowerCap® - TVA Shawnee Plant



PowerCap® - TVA Shawnee Plant



PowerCap® - TVA Shawnee Plant





For illustrative purposes only

SHAWNEE Potential Solar Development

309 acres • closure turf • 100MW power cap

TVA



THANK YOU

From everyone at AGRU for your
continued trust in our products and people

Questions? Comments?

Please send contact email and location for CEU certificate from Agru

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