Overview & Update of an Engineered Turf Closure Solution

SWANA SC - Palmetto Chapter 2016 Spring Conference

Agru America | Chris Eichelberger
Outline & Objectives

Closure Systems Discussion

Overview ClosureTurf® Solution

Completed Projects

Questions
Landfill Cover Lining
Landfill & Impoundment Closure
Agru America Closure Solutions
Subtitle D Compliant Closure Systems for Impoundments and Landfills

Traditional Closure System
The traditional method for closures, which utilizes Agru's MicroSpiker® or smooth geomembrane, overlain by a geocomposite drainage layer, soil cover layer and vegetative layer.

Agru Advantages:
• Cost saving geocomposite drainage layer
• Highest and most consistent asperity height available provides consistent and dependable shear strengths for delivered product

Integrated Drainage System (IDS)
The IDS solution features an Agru structured geomembrane called Super Griptite® or Drain Liner® overlain with an AgruTex® geotextile. Simply place soil on top of the geotextile to complete the system. The greatest performing, and most versatile of the traditional methods, the IDS system can feature an aggressive texturing on the underside of the Super Griptite geomembrane providing unmatched shear strength and stability even on steepened slope applications.

Agru Advantages:
• IDS reduces drainage material layers and can provide substantial cost savings
• Installs 15% faster when compared to the traditional closure system
• High factor of safety for steep-slope stability

ClosureTurf® System
A patented final cover system comprised of Agru’s Super Griptite overlain by engineered synthetic turf infilled with sand. ClosureTurf® is a proven “hybrid” composite system that outperforms traditional closure methodologies.

Agru Advantages:
• Approved as an EPA Subtitle-D compliant final cover system since 2009
• Installs on average more than 50% faster than the traditional closure system
• Eliminates the need for large quantities of soil and related equipment activities, dramatically improving site safety, while often lowering construction costs
• Reduces average maintenance costs by roughly $1,300 per acre per year
• ClosureTurf® dramatically improves runoff water quality, making it an effective BMP for Clean Water Act requirements
• Reduces the carbon footprint by approximately 80%

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Soil Cover Design Challenges

Shear Strength
Landfill Gas Uplift Pressure
Transmissivity
Case Study: Post-Construction Failure

• To evaluate the effect of the active LFG system shutdown, a single recovery well was removed from an active LFG system and the subsequent increase in LFG observed.

• From an initial vacuum of 9-inch H₂O (-2,240 Pa), it took only one hour to achieve a zero pressure. Over the next five (5) hours, the LFG pressure increased to 1.5-inch (374 Pa).

• Thus, over a 10-inch increase in LFG pressure required less than six (6) hours. This increase occurred despite the presence of adjacent LFG wells that remained in service and under the full operational vacuum.
Initial Closure “Design”

- 30 Acre Disposal Footprint
- Maximum Height: 120 feet
- Bench-to-Bench Sideslopes: 2.5H to 3H:1V
- Bench Spacing: 50 feet (vertical)
- Available Cover Soils: Processed (4-inch minus) Shaley Clays
Integrated Drainage System (IDS)
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About Watershed Geosynthetics

- Company founded in 2007 by Civil Engineers
- Based in Alpharetta, GA
- Over 100…
  - Years of landfill experience
    - Design, Construction, Maintenance and Management
  - Years of geosynthetic experience
  - Individual sites managed through closure & post-closure
  - Minority ownership held by Shaw Industries, A Berkshire Hathaway Company
Why Agru Geomembrane?

- Unmatched plastics history
- Significant financial strength
- Consistent leadership
- Extreme manufacturing capacity
- Engineered products
Flat Die Calendar Manufacturing
AGRU Advantage – “Strength in Numbers”…

<table>
<thead>
<tr>
<th></th>
<th>Standard GM - 17 Textured Values - LLDPE</th>
<th>Agru MicroSpike Value - LLDPE</th>
<th>Microspike Exceeds Standard Blown Film by:</th>
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<tbody>
<tr>
<td>Thickness (mil)</td>
<td>40</td>
<td>40</td>
<td>0%</td>
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<tr>
<td>Break Strength (lb/in)</td>
<td>60</td>
<td>112</td>
<td>87%</td>
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<tr>
<td>Break Elongation (%)</td>
<td>250</td>
<td>400</td>
<td>60%</td>
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<tr>
<td>Tear Resistance (lbs)</td>
<td>22</td>
<td>25</td>
<td>14%</td>
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<tr>
<td>Puncture Resistance (lbs)</td>
<td>44</td>
<td>50</td>
<td>14%</td>
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<tr>
<td>Asperity Height (mil)</td>
<td>18</td>
<td>20</td>
<td>11%</td>
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Introduction to ClosureTurf

• Features and Benefits
• Key Performance Properties
• Projects
• ClosureTurf ® is NOT an exposed cover system.

• ClosureTurf provides protection of the geomembrane by the added Geosynthetic layer (Engineered Turf). It is a “Hybrid” system that has all the advantages of a soil cover protection with out the disadvantages.
Slow Erosion Failures
Desiccation and Poor Vegetative Support
Veneer Slope Failure
Early Approaches

- Steep slopes
- No availability of cover soils

Sabine Landfill, LA
Over 28 Million Square Feet Installed in 18 States
What is Closure Turf®?

Three-Component HYBRID System:

1. **Structured Geomembrane (Agru America)** – integrated drainage system / aggressive spikes on bottom for stability

2. **Engineered Synthetic Turf** – covers and protects the underlying geomembrane

3. **Specified Infill** – ASTM C-33 Sand OR a cementious infill
Traditional vs. Closure Turf®

1.75 inches
ClosureTurf® Cross-Section
System Features and Benefits

• Exceeds technical performance criteria established by EPA Subtitle D:
  
  – Significantly less leakage rate (HELP Model and JP Giroud Model)
  – Less Erosion (5 to 10 cy per acre per year for soil cover vs. negligible for CT)
  – Longevity (on-going maintenance in perpetuity for soil versus well over 100 plus years of stability for CT)
Cementitious infill shown above which is used in areas of a closure that are subjected to concentrated flows that exceed velocities of 5 ft/s.
Turf and SGN Interface Evaluation

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<tr>
<td>33</td>
<td>1.5H:1V</td>
<td>1.4</td>
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<tr>
<td>26</td>
<td>2.0H:1V</td>
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<tr>
<td>18</td>
<td>3.0H:1V</td>
<td>2.8</td>
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<td>14</td>
<td>4.0H:1V</td>
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Shear Strength Parameters

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<tr>
<th>Parameters</th>
<th>δ (deg)</th>
<th>σ (psf)</th>
<th>R²</th>
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<tr>
<td>Peak</td>
<td>43</td>
<td>55</td>
<td>0.996</td>
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<tr>
<td>LD</td>
<td>38</td>
<td>25</td>
<td>0.964</td>
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Interface Friction Evaluation and Slope Stability ASTM D-5321
Hydraulic Performance Testing Program

- CSU Hydraulic Lab (ASTM D-7276 and ASTM D-7277)
- TRI Facility in South Carolina (ASTM D-6459 and ASTM D-6460)
- Tests replicate rain induced forces and concentrated flow forces
- Results concluded that the System outperforms vegetation and hard armor technologies in both instances
Wind Tunnel Testing

**Figure 1a – Model Before Final Turf Layer**

**Figure 1b – Turf Installed & Model Lowered**

- Static Pressure Tap Array
- Force Balance Live Section
- Traversable Pitot Static Boundary Layer Probe
Resists Hurricane Force Winds (Category 3)

Wind Tunnel Results

Grass blades start to bend as velocities increase due to increased drag.

Grass blades continue to bend, breaking the suction force and therefore resulting in a downward force against ClosureTurf. Drag continues to increase.
Weather and UV Resistance

- Great advancements in UV resistance of PE and PP
- Real world testing conducted at the Atlas Weathering Facility in New River, AZ
- Over ten years of data collected
- More than three (3) times the Tensile Strength is retained in the system when projected to 100 years
Synthetic Turf Fibers (PE)- Functional Longevity UV Resistance (1)

- Direct Exposure 45° South
- ASTM G147 and G7
- Four (4) Exposure Durations
  - 11,280 hours (1.3 years),
  - 43,800 hours (5 years),
  - 61,320 hours (7 years), and
  - 87,600 hours (10 year)

Atlas Weathering Laboratory in New River, AZ
Longevity Analysis

Halflife Projections and Field Data

Regression for Field Data
\[ y = -10.32 \ln(x) + 105.48 \]

- 176 Years
- 216 Years
- 247 Years

- New River, AZ Data
- Upper (Logarithmic) and Lower (Linear) Bounds
Operational Ability

Factors of Safety for heavy vehicle static weight and braking forces all above 1.5
CT’s carbon footprint = ~20% of traditional soil cover

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Bi-County Landfill
Bi-County Closure Turf – Phase 1

- Design Modification: June 2012, approved March 2013
- Construction complete: November 2013
- Project size: Approx 4 acres

Significantly Improved Aesthetics!!!
Phase I – Bi County Closure Turf
Phase I – Bi County Closure Turf
Phase I – Bi County Closure Turf
Phase I – Bi County ClosureTurf
Phase II – Bi County Closure

- Design Modification: 6/12
- Design approval: 3/13
- Construction complete: 10/15
- Project size: Approx 6.2 acres

LFG Collection System
Phase II – Bi County Closure Turf
Phase II – Bi County Closure Turf
Added Aesthetical Value of CT System
Case Study: Saufley Field Landfill

Owner: Escambia County
Location: Pensacola, FL
Closure Area: 25 acres
1 hour intensity - 500 year event
24 hour intensity - 200 year event
Case Study: Berkeley County Landfill

Owner: Berkeley County
Location: Moncks Corner, SC
Completed: 2013
Closure Area: 12 acres
Enhanced Storm Water Quality

CT improves water quality, decreases sediment loading of cover runoff by ~97%

371 NTU* 11 NTU

*Nephelometric Turbidity Units

(Photographs courtesy of Tangipahoa Parish, LA)
Case Study: Hartford MIRA Landfill

ClosureTurf® was the best solution for a sensitive, high-visibility site.
Project Overview

Owner: Materials Innovation and Recycling Authority (MIRA)
Location: Hartford, CT
Completed: 2014
Closure Area: 36 acres
Solar Capacity: 1 MW
PV Solar Panel Racking & Ballasting System
Post-Closure Cost Comparison

- Prescriptive (Soil Cap) Cover –
  - ~$900/Acre/Year

- ClosureTurf® System –
  - ~$100/Acre/Year

- $800/Acre/Year Savings x 30 Year Post Closure Period
  = $24,000/Acre Savings
Engineered Synthetic Turf – 100% Green
Engineered Synthetic Turf – 100% Tan
Engineered Synthetic Turf – 75% Green / 25% Tan
Questions

Thank you!