Alternative Cover Systems
RemTech 2017

[→] October 13, 2017
Outline

Capping solutions
Why use alternate cover systems
Exposed geomembrane cap systems
Geosynthetic Turf cap systems
  What is it?
  How is it installed?
Benefits of alternative caps
Potential Applications

Solid Waste Landfills
Remediation Sites
Coal Combustion Impoundments
Industrial Waste Facilities
Tailings Impoundments
Superfund Sites
Leach Pad Closures
Landfill Closure Options

Traditional Soil Cap  Exposed Geomembrane Cap  Turf Cap

Three common capping solutions and a needs based approach.
Soil Cover System – US EPA Subtitle D (Promulgated 1991)

- Top Soil: ≥ 6"
- Geomembrane: ≥ 20 mils if HDPE, ≥ 40 mils is most common
- Permeability: $k \leq \text{bottom liner} \leq 1 \times 10^{-5}$ cm/sec
- Compacted Clay Liner (CCL): ≥ 18"
- Gas Vent (if necessary)
- Solid Waste

US EPA Minimum Technical Guidance
Why use alternate cover systems

- Erosion problems
- Lack of cover soil availability
- Root penetration
- Settlement issues
- Lower maintenance
- Veneer slope failures
- Increased airspace
- Cost savings
- Water conservation
- Low carbon footprint
- Increasing regulatory approval
Alternative Cover Systems Drawbacks

- Shorter service life
- Final Closure Permit
- Wind uplift
- Landfill gas uplift
- Increased velocity and volume of stormwater runoff
- Potential damage by animals, hail etc.
EXPOSED
GEOMEMBRANE
CLOSURES
Alternative Closure System Benefits

- No cover soil import
- No soil veneer stability issues
- Reduced capital costs
  - No vegetation or topsoil
- Reduced O&M costs
  - No watering, mowing or erosion control
- Visual inspection of GM
- Color options (white, black, green)
- End of life options: what does the future hold?
Installer: GSE Lining Technology
Green-surfed HDPE geomembrane
Area: 80,000 square meters
Construction 1999
1.5 mm GSE Green Textured
Co-extrusion Technology

**Example:** Textured 60 mil (1.5mm) Green HDPE Geomembrane

- Top surface HDPE for UV and chemical resistance
- Inner layer HDPE for UV and chemical
- Bottom surface can be conductive for leak location & monitoring

- Green/Black/White/Textured ≈5 mils (0.127 mm)
- Standard Black HD/LLD ≈52 mils (1.321 mm)
- Textured Layer ≈ 3 mils (0.076 mm)
All in the Recipe

Proper Material Selection:
- Resin Polymer
- Additives
- Carbon Black
Higher Performing Geomembranes – Improved Recipe

- Multi-axial break resistance for settlement
- Greater resistance to stress cracking in exposed cold climate
- Resist damage from impact forces or equipment on exposed liner
- Longer life exposed and buried
- All in the numbers
## Geosynthetic Institute – Half-Life (in Years) at 20C

<table>
<thead>
<tr>
<th>Geomembrane Type</th>
<th>Lab Predicted ASTM D 7238</th>
<th>Phoenix, AZ</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Strength</td>
<td>Elongation</td>
</tr>
<tr>
<td>HDPE 1.5 mm</td>
<td>76</td>
<td>69</td>
</tr>
<tr>
<td>LLDPE 1.0 mm</td>
<td>49</td>
<td>46</td>
</tr>
<tr>
<td>EPDM 1.0 mm</td>
<td>60</td>
<td>70</td>
</tr>
</tbody>
</table>

*Koerner, George, PhD, PE, CQA. Geosynthetics Magazine October 2017.*

*Part of a 14 year study for geomembranes in lab and field*
GSE Green surfaced geomembrane at Polk County Florida
2001 install on a 20 acre cell
Polk County Florida - Exposed Geomembrane Cap

Vertical Anchor Trench ≈ 60 to 100 ft. apart

Vacuum-inducing Vents and Gas Pressure Relief
Polk County Hurricane Exposure
Polk County Post Hurricane Assessment

Despite standing 150 feet above ground level no single storm-related problem from any of the hurricanes.

*Roberts, Bonilla, Kelner, Choate, (2005), The EGC Takes on Three Hurricanes in Polk County, MSW Management.*
Stormwater Control

- Stormwater control measures
- Larger collection ditches
- Polk County ranged from 30” to 75” per year
- 3 direct hurricanes during 2004 at Polk County resulted in 20” of rain
Long-Term Care Plan – Polk County 13 years

- Weekly/Monthly/Quarterly site inspection
- Rainfall, gas, and leachate generation measurements
- Subsidence measurements (Avg 8.7’ across site)
- Post-hurricane damage assessment (3 direct strikes in 2004)
- Geomembrane welding repairs
- Annual coupon sample testing and analysis
- Predicted life to exceed 50 years
Equipment Traffic

- Foot traffic on textured
- Low ground pressure equipment; ATV, lite trucks
- Heavier equipment on roadways
  - Concrete, sand, geocomposite encapsulated
- Surface under geomembrane important
- Heavier equipment with driver care
  - No sharp turns
  - No donuts
EXPOSED GEOMEMBRANE CAP SYSTEM INSTALLATION
Midshore Maryland Exposed Geomembrane Cap System

- Maryland, USA
- Designed by Geosyntec Consultants
- 300,000 SM of High Performance, 1.5mm HDT Green
- Ballast: Earth Anchors – 7,000
- Installed by Chesapeake Containment Systems
- 2015
Earth Anchoring
Platipus Earth Anchoring Systems
Anchor Plates
Anchor Tensioning
Tensioning Complete
Covering the Anchor
Green Exposed Geomembrane Cap
Green Exposed Geomembrane Cap
SYNTHETIC TURF CAPPING SYSTEM
LiteEarth Compared to Typical Capping

**PRESCRIBED**
- 6" TOPSOIL AND VEGETATIVE COVER
- MIN 18" BARRIER PROTECTION LAYER
- DRAINAGE LAYER 1 x 10.5 cm/s
- 40-MIL OR 60-MIL (HDPE) GEOMEMBRANE
- COAL ASH

**LITEEARTH**
- LITEEARTH SYNTHETIC GRASS LINER
- 12"-18" FOUNDATION / BASE LAYER (OPTIONAL)
- COAL ASH
Synthetic Turf Growth (square feet x 1,000)
Market Segment Sales (square feet X 1,000)

- Solid Waste: 12,614 square feet
- Industrial: 10,145 square feet
- Coal Ash: 3,877 square feet
- WTE: 697 square feet
Worldwide Leader in Synthetic Turf

- ISO 9001 Quality Certified, Synthetic Turf Council Certified Manufacturer and a FIFA Preferred Producer
- 300 million square feet produced for sports fields, commercial and residential landscape, rooftops and airports in the most demanding climates
- Highest Manufacturing Quality Assurance (MQA) processes and procedures at Act Global Georgia production facilities
- Three manufacturing facilities on three continents serving clients in 70 countries
Turf has Maximum UV Inhibitors

UV EXPOSURE IN COUNTRIES WITH ACT GLOBAL INSTALLATIONS

kLY/year
220
200
180
160
140
120
100
80
60
No installation

1 kLangley = kcal/cm² = 41.84 MJ/m²
1 kLangley/year = 1.33 W/m²
Key Material and Components

High Performance Turf

- Advanced polyethylene yarn and polypropylene woven primary with high UV stabilizer packages and special resin formulas; 2X more UV stabilizer.
- Special spine 300+ micron, true monofilament fibers and woven primary independently tested for extreme weathering conditions
- Monofilament does not fibrillate and retains resilience without INFILL = NO WIND or WATER EROSION
- Minimal annual maintenance, no seeding, mowing, fertilizing, pesticides, watering
Monolithic Liner System

ISO 9001 Quality

- Performed at Act Global’s synthetic turf manufacturing facility in Calhoun, GA
- Factory bonding of the synthetic grass composite to EPDM through high compression/heated rollers for permanently “welding” of the components
- Proven synthetic elastomer hot melt technology for bonding EPDM and like substrates

Finished Liner Rolls

- Roll size: 15’ x up to 200’
- 12” exposed composite (EPDM & Polypropylene primary) for mechanical anchors and seaming
- System weight: 8.8 oz./sf
- Custom colors available

Composite Adhesive

- Operating range: -60 degrees F to 240 degrees F
- Not water soluble
- Comparative testing to 60 years
- Flash point 400 degrees F
Extensive Testing

- Fully tested for stability, longevity and performance in the most demanding environments
- MQA (Manufacturing Quality Assurance – Act Global)
- Components and Composite tested by accredited, independent laboratories for:
  - Thickness
  - Tensile properties
  - Puncture resistance
  - Linear Friction
  - Tear resistance
  - Multi-axial tensile
  - Methane gas permeability
  - Seam peel and sheer
  - Ply adhesion
  - Comparative interface friction
  - Falling head permittivity
  - UV weathering
Key Components

LiteEarth: Monolithic Synthetic Grass Liner
- UV Stabilized SYNTHETIC GRASS
- 18 PIC UV STABILIZED GEOTEXTILE
- COMPOSITE ADHESIVE
- 45-MIL NON-REINFORCED EPDM

Mechanical Anchor

Butyl Splice Tape

EPDM Liner Composite

12"-18" FOUNDATION / BASE LAYER

Coal Ash
Anchor Installation

Anchor Reinforced: Percussive Driven Earth Anchor (PDEA) system includes the correct anchor, associated tendon, load plate and top terminations such as a wedge grip as specified by the Engineer Of Record (EOR)

As the load exerted increases, a body of soil above the anchor is compressed and provides resistance to any further anchor movement. The size and spread of this body of soil is referred to as the Frustum Cone.

The size and spread of a Frustum Cone will depend upon:
- The shear angle of the soil
- The size of the anchor
- The depth of installation
- The load applied
Proven Seaming Technology

- 6 inch high-performance butyl splicing tape
- Industry proven adhesive primer technology with rapid flash-off and curing cycle
- Successful performance for more than 35 years

<table>
<thead>
<tr>
<th>Physical Characteristic</th>
<th>Standard</th>
<th>Units</th>
<th>EPDM¹</th>
<th>HDPE²</th>
<th>LLDPE³</th>
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<tbody>
<tr>
<td>Seaming method</td>
<td>Tape</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Seam Inspection method</td>
<td>Air Lance</td>
<td></td>
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<tr>
<td>Peel Strength</td>
<td>ASTM D 7272</td>
<td>ppi</td>
<td>28</td>
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<td>Shear Strength</td>
<td>ASTM D 7272</td>
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<tr>
<td>Peel Strength</td>
<td>ASTM D 6392</td>
<td>ppi</td>
<td>76</td>
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<tr>
<td>Shear Strength</td>
<td>ASTM D 6392</td>
<td>ppi</td>
<td>100</td>
<td>75</td>
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</table>

¹45 mil non-reinforced EPDM seamed to polypropylene primary, as tested by TRI
²50 mil textured HDPE, GM13
³50 mil textured LLDPE, GM19
Sand Infill or Additional Ballast Unnecessary

Sand must be dry
Turf must be dry (11:00 am)
Sand washes out
8:1 slope, sand floats
Need specialized equipment
Need special sand
Swales need binding agent
DESIGN CONSIDERATIONS
Large Scale Flume Testing (ASTM 6460)

- Flow levels of 2.3in, 4.0in, 6.7in, and 10.7in (30 minutes each)
- No loss of grass, no tearing, no slope or channel requirements
- LiteEarth equivalent to well established natural grass
Wind Tunnel Testing

- Wind Tunnel Testing recently completed by Georgia Tech Research Institute (GTRI)
- Subsonic wind tunnel
- Tested up to 120 mph
Long-Term Value and Payback

- Expected life cycle beyond 60 years
- Extreme weather and high UV tolerance
- “O” Erosion Design, including steep slopes
- Easy to monitor surface and repair
- Minimal thermal expansion/contraction
- Minimal maintenance annually, < 5% of natural sod

- High wind speed resistance
- Can be installed in progressive intermediate stages
- Can be designed for cross over recreational use
- 30 Year Manufacturer's permeability and performance warranty
## Closure System Costs – Value Added

<table>
<thead>
<tr>
<th>Option</th>
<th>Prescribed Final Closure</th>
<th>Exposed Geomembrane</th>
<th>Artificial Turf + Geomembrane</th>
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</thead>
<tbody>
<tr>
<td>Closure Costs</td>
<td>$12,695,800</td>
<td>$8,077,200</td>
<td>$14,733,600</td>
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<tr>
<td>Post-Closure Costs</td>
<td>$1,135,800</td>
<td>$565,000</td>
<td>$565,000</td>
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<tr>
<td>Custodial Care Costs</td>
<td>$16,704,000</td>
<td>$7,500,000</td>
<td>$9,915,000</td>
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<tr>
<td><strong>Subtotal - Costs</strong></td>
<td><strong>$30,535,600</strong></td>
<td><strong>$16,142,200</strong></td>
<td><strong>$25,213,600</strong></td>
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<tr>
<td>Added Revenues - Airspace Savings</td>
<td>---</td>
<td>$(6,969,600)</td>
<td>$(6,969,600)</td>
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<tr>
<td><strong>Total Net Costs</strong></td>
<td><strong>$30,535,600</strong></td>
<td><strong>$9,172,600</strong></td>
<td><strong>$18,244,000</strong></td>
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<tr>
<td>Net Cost Savings</td>
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<td>$21,363,000</td>
<td>$12,291,600</td>
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<tr>
<td>Cover Replacement</td>
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<tr>
<td>- Costs</td>
<td></td>
<td>$2,395,800</td>
<td>$4,356,000</td>
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<tr>
<td>- % Replacement</td>
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<td>100%</td>
<td>50%</td>
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<tr>
<td>- No. Replacements</td>
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<td>9</td>
<td>6</td>
</tr>
<tr>
<td>- Service Life</td>
<td></td>
<td>50</td>
<td>100</td>
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<tr>
<td><strong>Total Service Life</strong></td>
<td><strong>750</strong></td>
<td><strong>500</strong></td>
<td><strong>700</strong></td>
</tr>
</tbody>
</table>

Source: Wastecon 2015 – Orlando Florida
End of Life Options – Alternative Closure Added Benefits

- Accessibility
- Waste settlement and reopen landfill
- Value in that garbage in 20 years?
- 30 years of escrow = new synthetic cap
- Easy addition of solar modules
- Regulatory changes in 30 years? 91 years?
We’ve Got You Covered

BEFORE

AFTER
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