Geosynthetics in Challenging Regulatory Environments

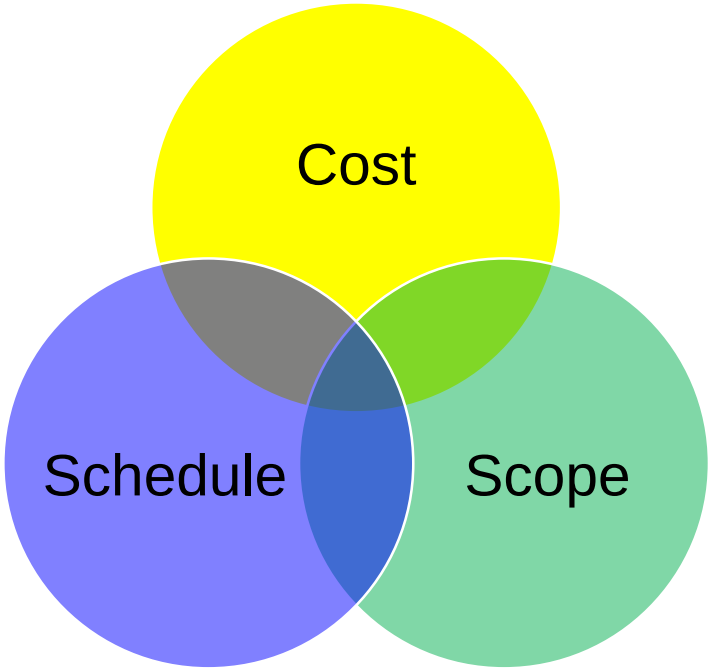
Evan Andrews, PE, PMP
Landfill Programmatic Engineering

Challenging Regulatory Environments

- What Makes Regulatory Environments Challenging?
  - Regulatory ‘Certainty’
  - Geopolitical Influences
  - Market Dynamics
  - Rate of Change
  - Technology Advances

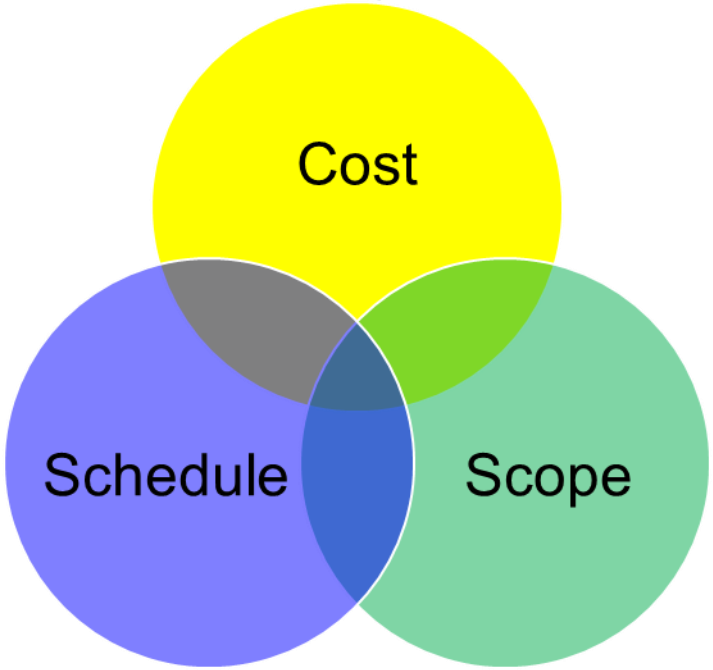
Challenging Regulatory Environments

- Balancing Prudency, Expediency and Risk
- Advancing Projects in the Right Direction at the Right Pace to Demonstrate Prudency of Action
- Barriers:
  - Confusing Terminology
  - Unrealistic Timelines
  - Legal Action
  - Fact vs Emotion



Geosynthetic Solutions

- How Can Geosynthetics Play a Role in these Environments?
  - Versatile
  - Scalable
  - Mature Production and Installation Network
  - Known Design Methods / Parameters
  - Replacement for Resource Intensive Natural Materials
  - Ongoing Research to Respond to New Market Challenges
  - Proven Performance Track Record



Project Case Studies

- Solutions for Storm Preparation and Recovery
- Roadway Improvements
- Storm Water Management
- Replacing Drainage Media

Storm Preparation and Recovery

- Coastal Coal Ash Basin Closure Site
- Very Poor Site Soils
- Landfill Ash Placement Rates up to 25,000 TPD
- Protection from Hurricane Events
- Reduction in Post Closure Care / Maintenance Activities

Landfill Vegetation Challenges

Hurricane Florence - 2018

Landfill Vegetation Challenges Post Hurricane Florence in 2018

Hurricane Florence 2018

- 1,000 Year Storm Event
- 33” of Rain in 72 Hours
- 9” in 3 hours
- 105 MPH Winds
- Expectation of Containment Even with Events Well Beyond the Design Storm

Ground level photos of erosion damage following Hurricane Florence

Exposed Synthetic Turf Cap

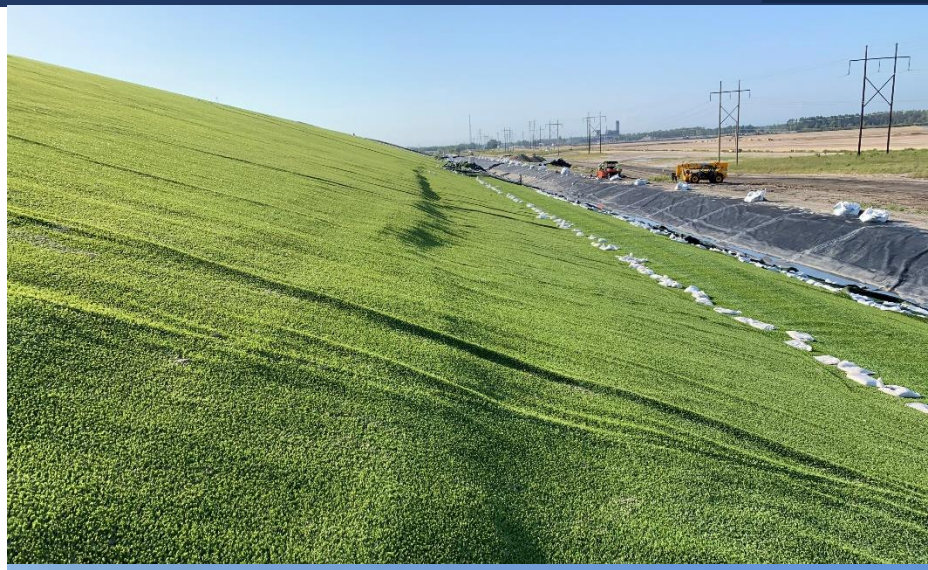
Synthetic Turf Cap Installation June 2019

Benefits of a Synthetic Turf System

- Speed of Install and able to be ‘storm ready’
- Eliminates concerns about seeding and erosion control
- For soil poor or poor soil sites, often more economical than soil imports or amendments
- Long term maintenance and inspection benefits
- Flexibility in future additions or removals to the landfill.

Installation Lessons Learned

- Work with Manufacturer to Include Latest Lessons from Current Projects
- Design of High Velocity Areas
- Sequence of the Closure from ‘High to Low’
- Sand Infill Specification Versus Ability to Spread
- ‘Relaxing’ the Liner
- Sharp Grade Transition Issues



Lined Stormwater Ditches

- Cost Effective for High Velocities Versus Stone / Concrete
- Easier to Clean / Maintain
- May Prevent a Release to the Environment

Roadway Improvements

Coal Station Site Plan showing Roadway Improvement Corridor

Pavement Assessment

Subgrade California Bearing Ratio (CBR)	Existing Pavement Design Section (inches)	Existing Pavement Structural Number (SN)	Equivalent Single Axle Loading Capacity (Millions)	Fully Loaded Dump trucks and Tractor-Trailers per Day (TPD)
10	Asphalt = 4.5 ABC Stone = 14.5	2.75	1.57	176

Light Duty Vehicles Per Day (VPD)	Inbound Truck Traffic per Day (TPD)	Outbound Truck Traffic per Day (TPD)	Miscellaneous Truck Traffic per Day (TPD)
100	325	325	25

	Required Flexible ESALs Capacity (Millions)	Minimum Flexible Structural Number (SN)	Required Rigid ESALs Capacity (Millions)
10-Year Design Life	5.86	4.9	N/A
20-year Design Life	11.72	5.4	20.16

Interlayer Benefits

FIGURE 1: Cracks migrate toward surface in an unreinforced overlay.

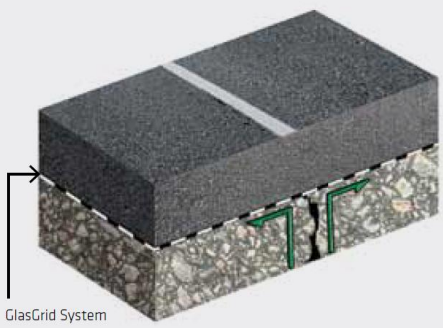
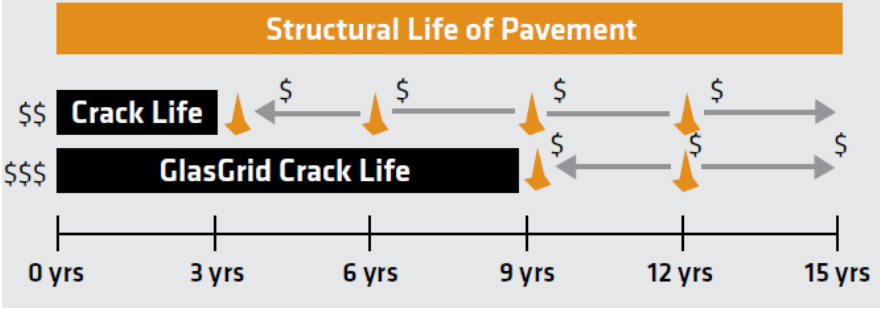


FIGURE 2: Cracks are redirected in a GlasGrid reinforced overlay.

type of reinforcement	number of cyclic loadings until a crack reaches the surface	multiplier (improvement factor)
unreinforced reference sample	145715	1
uncoated glass fibre reinforcement 1	396119	2.7
glass on a thick PP-nonwoven 2	393582	2.7
coated glass fibre grid	421429	2.9
HaTelit C 40/17	584375	4

Life Cycle Cost Savings

Parameter	Life	Reference
Structural life of overlay	15 years	AASHTO 93
Thermal crack of overlay	3 years	National Science Foundation (1 in. per year)
Crack life of overlay with GlasGrid 8502	9 years	ArcDeso software
Maintenance Interval	3 years	Crack sealing



Information provided by Heusker and Tensar International Corp. from Product Literature

Paving Mat Installation

Pavement Condition Before Installation and Interlayer Installation

Interlayer Benefits

- Quick and Economical Installation Compared to Additional Overlay (about 9% of Overall Project Cost)
- Less Prep Time / Subgrade Improvements Required
- Allowed Duke to Eliminate Full Depth Undercut of Moderately Distressed Areas
- Achieved a 20 Year Design Life for Anticipated Truck Loading with Protection from Heavy Water Truck Use in Advance of Project Needs

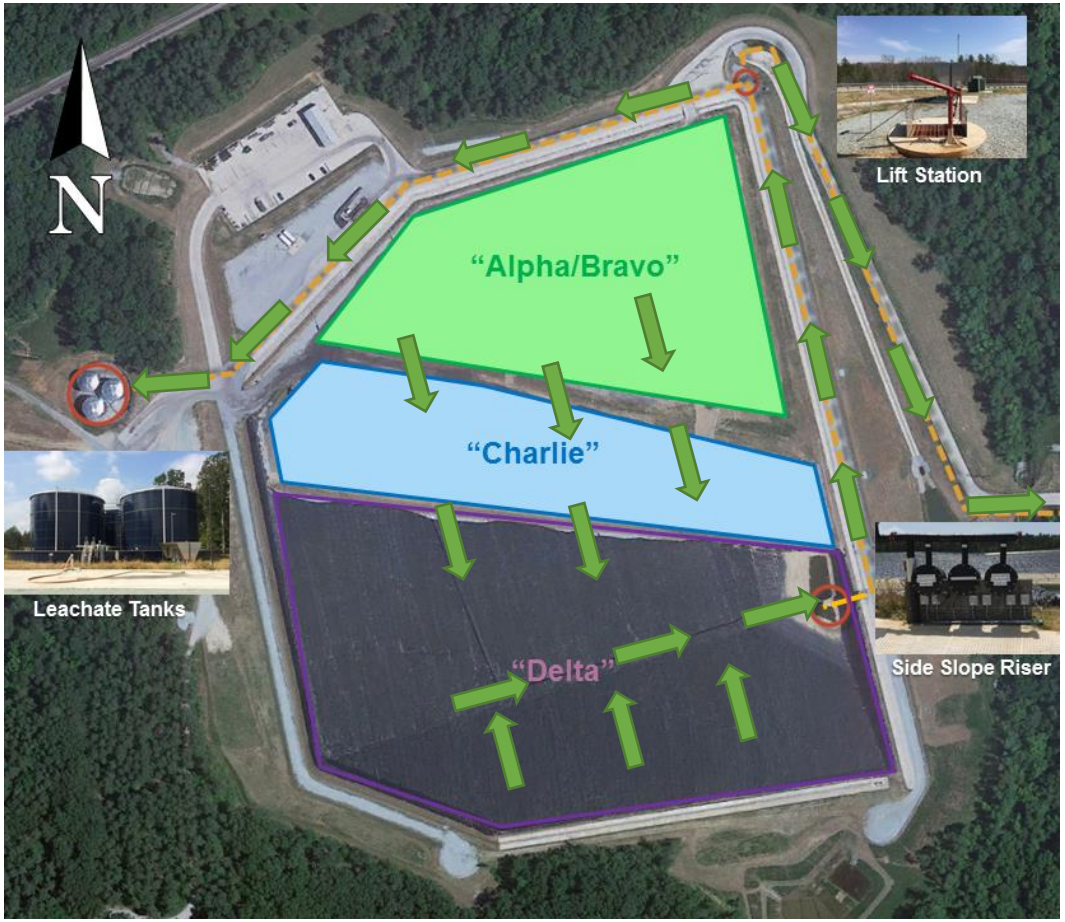
Stormwater Management

- Transitioning away from Ash Basin Treatment
- Needed better understanding of Water Storage and Treatment Variables
- Reduction in working face and use of raincovers to segregate contact /non contact water
- Optimizing segregation

Raincover Used for Stormwater Segregation

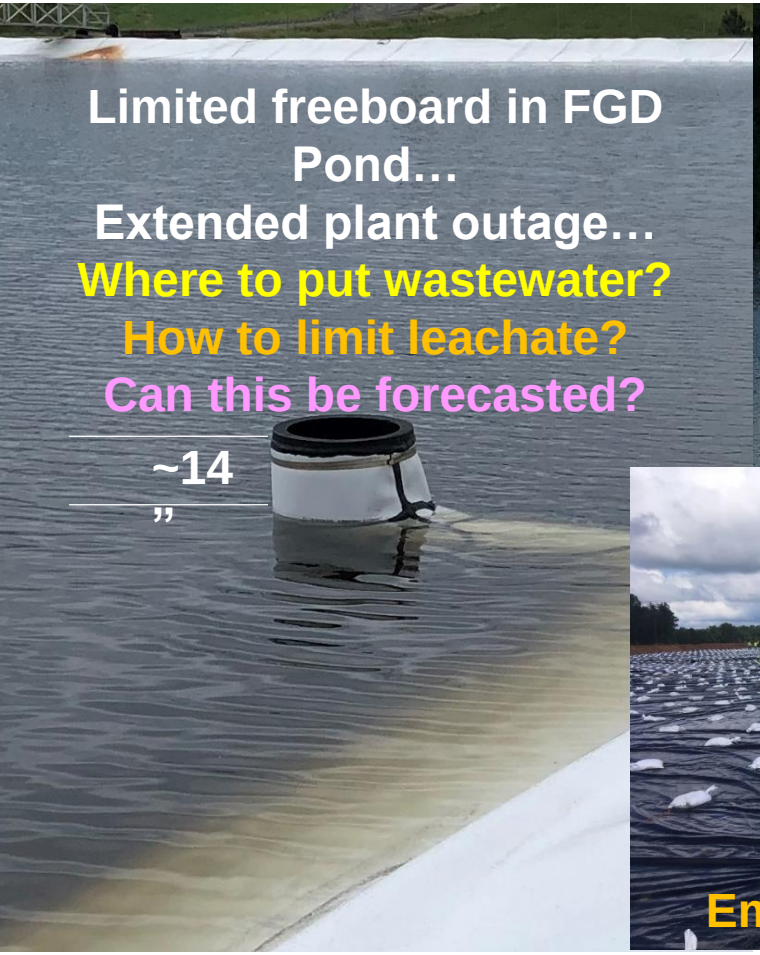
Site Background

- Single-phase; 31 acre Monofill
- Three cells: A/B, C, and D
  - 14.5-acre “Delta” cell: no CCRs
- Common leachate collection system
  - Central header to leachate sump
  - **Side Slope Riser**: pump uphill via force main
  - **Lift Station**: valve configuration allows flow to **Leachate Tanks** or **FGD Pond**



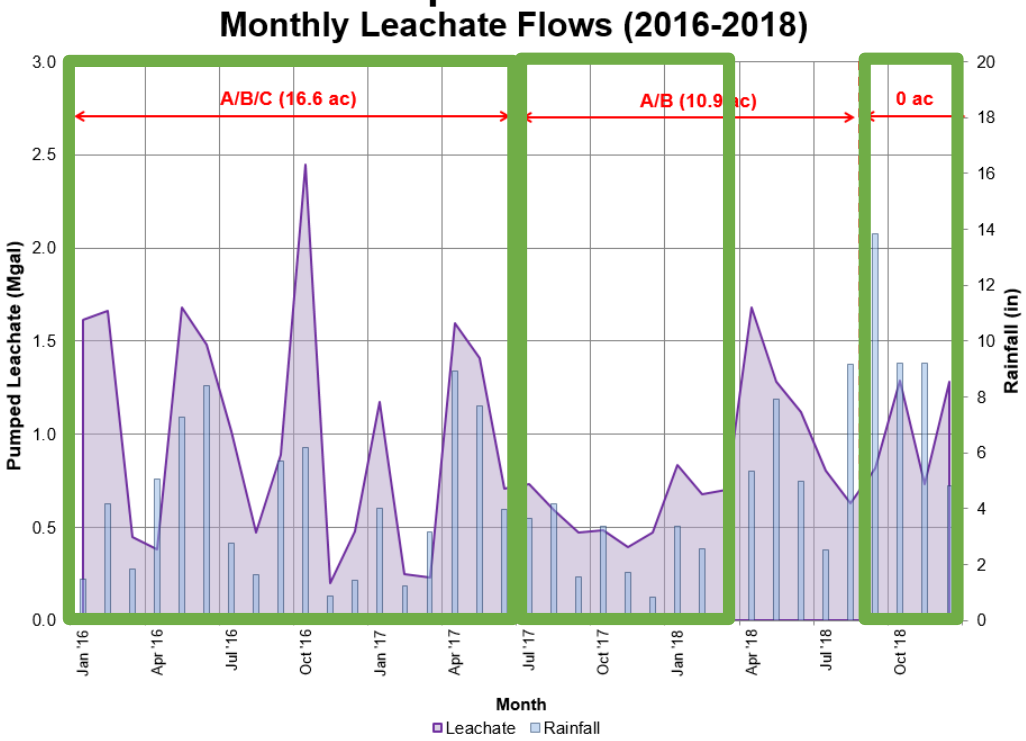
13 Acre Landfill Facility showing 3 Operational Cells

Hurricane Florence Events



Key Lesson – Water Diversion Techniques

Rain cover history: A gradual discovery on the problem



- **1/2016 – 6/2017:** Filling begins in Charlie, continues in Alpha/Bravo. Significant leachate and plant usage declines. **Let's limit the ash working face!**
- **7/2017 – 3/2018:**. Favorable response from Charlie rain cover. **The problem must be solved!**
- **4/2018 – 8/2018:** Leachate uptick from wet spring. **Maybe the rain cover isn't perfect?**
- **9/2018 – 12/2018:** Plant offline and all cells are covered. **Why is a closed landfill still producing so much leachate?**

Key Lesson – Water Diversion Techniques

Replacement of 5-year old rain cover for inactive “Delta” cell completed 3/29/19.

Key Lesson – Water Diversion Techniques

Over six (6) months after rain cover replacement,
Leachate results are promising so far…
Reductions in post-storm spikes and **<u>overall generation</u>**.

1.0 Mgal/mo
(2015 – 3/2019)

1.2 Mgal/mo
(2018 – 3/2019)

.32 Mgal/mo
(4/2019- 10/2019)

Replacing Drainage Media

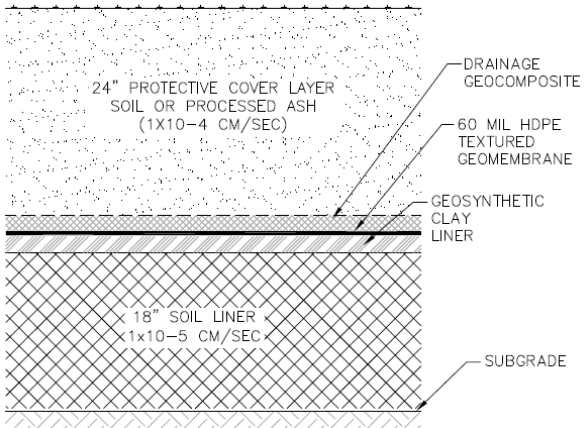
- Opportunities to reduce costs and schedule related to landfill development through the use of geosynthetics
- Use of coal ash as landfill protective cover layer
- Considerations and testing

Landfill Showing Alternating Bottom Ash / Sand Protective Cover

Design Considerations

Conformance Testing – Hydraulic Conductivity Ratio (landfill liner leachate collection system only)

1. Hydraulic conductivity ratio (HCR) testing shall be performed for the leachate collection system geocomposite and the selected protective cover material for base liner system construction. Protective cover material may be coal combustion residual (CCR) material or soil.
2. HCR testing shall be performed for the cover system geocomposite and the final cover material.
3. Perform a minimum of three HCR tests in accordance with ASTM D5567.
4. HCR tests shall be performed on site-specific materials anticipated to be used as protective cover or final cover soil. A minimum of three discrete samples representative of the range of potential protective cover or final cover soil material shall be selected at the discretion of the Engineer. Protective cover or final cover material shall be characterized by performing the following geotechnical laboratory tests:



Hydraulic Conductivity Ratio Testing

- HCR Testing Compares the Relative Flow Between a Geotextile Filter and an Underlying Soil / Material Column
- HCR = K_{sg} /K_s
- High Flow Rates Indicate Soil Piping through the Textile
- Low Rates Indicate Clogging of the Textile
- Optimal Results Range from 0.4 to 0.8 and Indicate that the Two Materials are in Equilibrium

"Designing with Geosynthetics 6th Edition" 2012, Robert M Koerner pgs. 164-165

Considerations for CCR as Protective Cover

- Placement of CCR Constitutes Placement of CCR
  - Groundwater Wells
  - EPA CCR Rule Notification
  - Leachate Generation
- Testing for Wide Ranging CCR Properties Preferred Over ‘Manufacturing’ a CCR to Spec
- Remember Geocomposite UV Exposure Window
- Two Feet of Protective Cover Material is a Minimum

Summary

- Regulatory Environment will Continue to be Challenging
- Opportunities Exist to Use Geosynthetics in a Wide Variety of Projects
- Geosynthetics Provide a Cost Effective, Proven and Versatile Solution to a Wide Variety of Project Challenges
- Our Understanding of Design Applications and the Addition of New Products to the Market are Occurring Rapidly
- We have an Opportunity to Raise the Bar and Set a New Standard for Geosyntetics Usage, but we have to do it Correctly

Considerations for CCR as Protective Cover

Active Landfill (Top Left), Protective Cover Installation (Top Right) and Clay Liner Install (Center)

Questions?

Thank You For Attending!

Evan Andrews
Duke Energy
Evan.Andrews@duke-energy.com