EGC Benefits & Purposes

- Odor Control
- Reduction of Leachate Generation
- Reduce Infiltration & Liquid Levels
  - Improve Gas Collection
  - Enhance Slope Stability
- Reduce GHG Emissions, Control Gas Migration and Improve SEM Compliance
- Delay Final Cover Construction
  - In Future Planned Expansion Areas
  - To Regain Airspace from Settlement
- Erosion & Sediment Control
  - Reduce Erosion & Cover Maintenance
  - Reduce SS
  - Improve NPDES Compliance
- Mitigation
  - For Elevated Temperatures
  - Subsurface Reaction Events
Benefits – Leachate Reduction 2019 Project

• Construction Cost → $660,000
  • Approximately $63,000 / acre installed

• Savings in Leachate Treatment Cost
  • Approximately 1,200 gallons / acre-day @ $0.036 / gallon
  • $15,800 / acre-year

• 4 year ROI
Benefits – Erosion & Sediment Control

- Eliminate rills
  - Reduce gas migration odors & GHG
  - Reduce infiltration
- Lower suspended solids
- Meet NPDES limits
- Reduce O&M
EGCs are Unique Projects

- Not prescriptive like cell or final cap projects
- Often unplanned and unbudgeted
- Often implemented to mitigate operational problems or future potential concerns
- Often high profile projects that require expedited design and construction
Project Planning Activities

- Define project area, goals, impacts,
- Project budget/cost estimate,
- Amortization period, life of EGC,
- Project schedule,
- Contracting and procurement of materials,
- Prep work (subgrade, slope grading, gas system & stormwater management improvements),
- Design and bid process,
- Regulatory notifications and approvals,
- Survey & CQA requirements
Design Elements for EGC

1. Selection of geomembrane & cap area,
2. Updates / modifications to the GCCS,
3. Subgrade Preparation,
4. Undercap management of liquids and gas uplift,
5. Anchorage to prevent wind & gas uplift,
6. Stormwater management modifications,
7. Access for waste disposal operations, if necessary
8. Post construction GCCS O&M and monitoring considerations
Design - GCCS

- Location of piping location (above or below the EGC)
- Improvements needed prior to EGC installation
- Control of uplift
- Access for future GCCS O&M and monitoring – consider piping above cap where significant settlement is expected
Design – Geomembrane Selection

- Design life
- Tensile & puncture strengths
- Wrinkle impacts
- Abrasion resistance
- Equipment traffic
- Aesthetics
- Availability
- Cost
## Design – Geomembrane Selection

<table>
<thead>
<tr>
<th>Material</th>
<th>2020 Material Cost Per Acre</th>
<th>Typical Life</th>
<th>Panel Size</th>
</tr>
</thead>
<tbody>
<tr>
<td>8 mil LLDPE Smooth Skrim Reinforced</td>
<td>$4,000</td>
<td>&lt; 5 years</td>
<td>45,000 ft²</td>
</tr>
<tr>
<td>12 mil LLDPE Smooth Skrim Reinforced</td>
<td>$6,000</td>
<td>5 years</td>
<td>28,000 ft²</td>
</tr>
<tr>
<td>20 mil LLDPE Smooth Skrim Reinforced</td>
<td>$7,000</td>
<td>5 years</td>
<td>25,000 ft²</td>
</tr>
<tr>
<td>40 mil LLDPE Textured</td>
<td>$13,000</td>
<td>5 to 10 years</td>
<td>16’ x 500’</td>
</tr>
<tr>
<td>60 mil HDPE Textured</td>
<td>$17,000</td>
<td>10 to 20 + years</td>
<td>16’ x 700’</td>
</tr>
<tr>
<td>60 mil EVOH</td>
<td>$24,000</td>
<td>10 to 20 + years</td>
<td>24’ x 550’</td>
</tr>
<tr>
<td>Versacap Turf</td>
<td>$48,000</td>
<td>20 years</td>
<td>12’ x 300’</td>
</tr>
<tr>
<td>Closure Turf</td>
<td>$80,000</td>
<td>100+ years</td>
<td>15’/23’ x 300’</td>
</tr>
</tbody>
</table>
EVOH Ethyl Vinyl Alcohol Geomembrane

- Used for strong odors
- 7 Layer co-extruded FML with outside HDPE layers
- Combines the strength and durability of polyethylene with the gas barrier properties of EVOH
- 50 to 400 times less permeable to VOCs than 80 mil HDPE geomembranes
- Produced by Raven Industries since 2013
Versacap

- **PE Grass** (Durability & Aesthetics)
- **High Strength Woven Textiles** (Dimensional Stability)
- **Impermeable PE Barrier** (Controls Rainfall Infiltration and gas emissions)
- **Daily Cover**
Closure Turf

0.5" Specified infill

Engineered Turf 1-2"

Agru Super Gripnet®
Design – Subgrade Preparation

- Fill in erosion gullies
- Regrade benches & diversion berms?
- Strip vegetation or not?
- Cover protruding trash
- Add soil for provide positive drainage allowing for future settlement?
- Add soil or regrade existing surface for EGC subgrade?
- Smooth drum roll?
- Add geotextile cushion for rock protection?
- Construct upslope diversion berm to divert runon away from EGC
Design – Undercap Liquids & Gas Management

Construction of Undercap Flat Drains
EGCs Require Anchoring to Resist Wind and Gas Uplift

Wind Uplift Force

Example of Uplift
Anchoring to Resist Wind Uplift

Methods for Anchoring

- Traditional earthen anchor trenches $8.5k/acre
- Wind Defender geotextile fabric over the EGC $12k/acre
- Roads over cap $15k/acre
- Platypus soil anchors $10k to $16k/acre
- Roped sandbags $6k/acre
- Roped tires
Design – Anchor Trenches

• Typically 60’ to 100’ spacing (3 to 5 panel widths)
• Requires close coordination between contractors
• Can result in temporary odors if waste is encountered
Design – Anchoring with Roads Above the EGC
Design - Anchorage with Wind Defender Geotextile

- Breaks-up uplift pressure
- Eliminates stress on FML
- Aesthetic green slope
Design – Anchoring with Platypus Soil Anchors

• 20’ to 25’ grid (109 to 70 per acre)
• Patch over each anchor
• Can tear if not installed correctly
Design – Stormwater Management

- Sheet flow or concentrated?
- Regrade berms or benches?
- Perimeter channels
- Culverts
- Ponds
- Erosion protection
Design – Stormwater Management

25-year 24-hour Storm Runoff for 15 acre Area (MI)

<table>
<thead>
<tr>
<th>Cover</th>
<th>Runoff Curve No.</th>
<th>Runoff (inches)</th>
<th>Runoff Volume (ft³)</th>
<th>Peak Flow (cfs)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grassed</td>
<td>74</td>
<td>1.4</td>
<td>76,000</td>
<td>27</td>
</tr>
<tr>
<td>50% Grass &amp; 50% soil</td>
<td>79</td>
<td>1.8</td>
<td>98,000</td>
<td>35</td>
</tr>
<tr>
<td>EGC</td>
<td>100</td>
<td>3.8</td>
<td>207,000</td>
<td>93</td>
</tr>
</tbody>
</table>
Design – Stormwater Management

Is additional detention needed for the greater runoff from the EGC?
At this site 3 new stormwater ponds were required
Design – Stormwater Management at Toe of Slope
Lined Stormwater Channel
Design – Stormwater Management

Are existing stormwater structures adequate?
Design – Stormwater Management

Erosion protection at the toe of slope
## 2019 Costs Per Acre for EGC
(Based on a 15 Acre Project)

<table>
<thead>
<tr>
<th>Cost Item / Type of Cap</th>
<th>Low Range</th>
<th>Mid Range</th>
<th>High Range</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>20 mil LLDPE</td>
<td>40 mil LLDPE</td>
<td>60 mil EVOH</td>
</tr>
<tr>
<td>Engineering</td>
<td>$1,000</td>
<td>$1,500</td>
<td>$2,000</td>
</tr>
<tr>
<td>Survey</td>
<td>$300</td>
<td>$400</td>
<td>$500</td>
</tr>
<tr>
<td>Mobilization / Unloading</td>
<td>$1,000</td>
<td>$1,500</td>
<td>$2,000</td>
</tr>
<tr>
<td>Subgrade Prep</td>
<td>$2,000</td>
<td>$4,000</td>
<td>$8,000</td>
</tr>
<tr>
<td>Undercap Collection</td>
<td>$500</td>
<td>$600</td>
<td>$1,000</td>
</tr>
<tr>
<td>FML Material</td>
<td>$7,000</td>
<td>$13,000</td>
<td>$27,000</td>
</tr>
<tr>
<td>FML installation</td>
<td>$5,000</td>
<td>$10,000</td>
<td>$10,000</td>
</tr>
<tr>
<td>Boots</td>
<td>$700</td>
<td>$1,000</td>
<td>$1,500</td>
</tr>
<tr>
<td>Anchorage</td>
<td>$8,500</td>
<td>$12,000</td>
<td>$15,000</td>
</tr>
<tr>
<td>Edge Termination</td>
<td>$4,000</td>
<td>$4,000</td>
<td>$4,000</td>
</tr>
<tr>
<td>Stormwater Improvements</td>
<td>$1,000</td>
<td>$2,000</td>
<td>$3,000</td>
</tr>
<tr>
<td>CQA</td>
<td>$2,000</td>
<td>$3,000</td>
<td>$4,000</td>
</tr>
<tr>
<td><strong>Total Cost Per Acre</strong></td>
<td><strong>$33,000</strong></td>
<td><strong>$53,500</strong></td>
<td><strong>$78,000</strong></td>
</tr>
</tbody>
</table>
Design Plan Example for EGC Project

- 13 acre cap
- 8,000 ft of anchor trench (blue lines)
- 8,600 ft of undercap flat drains with 6 collection sumps
- 1,200 ft of tie-in to existing final cap
Typical $78k Cost Per Acre for 2021 60mil HDPE EGC

2021 Cost of 60 mil HDPE Temporary Cap

- $5,100 Subgrade Prep
- $5,800 GCCS / Undercap Collection
- $13,700 FML
- $16,000 Stormwater
- $37,600 Eng, Survey & CQA
2019 Ohio EGC Project
40 mil LLDPE with Wind Defender
2019 Ohio EGC Project

Preparing the anchor trench at the top of slope

Preparing the subgrade
2019 Ohio EGC Project

Benches being regraded

Benches following installation of the EGC
2019 Ohio EGC Project

Exposing the baseliner for tie-in weld

Completing the tie-in weld of the EGC to the baseliner
Example of 2019 EGC Installation

• 40 mil LLDPE / Wind Defender (north slope)
• Versacap turf cap (south slope)
2019 Michigan EGC Project

• EGC Construction While Maintaining Access Road to Active Disposal Area
2019 Michigan EGC Project – Versacap
Closure Turf 2017 CA Project
Closure Turf – 2017 CA Project
In summary, EGCs can provide major improvements to mitigate significant operational problems and challenges.

The use of EGCs involve a number of interrelated features that, when carefully evaluated during design, can achieve long-term benefits for the cost invested.
Design Elements for EGC

1. Selection of geomembrane & cap area,
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Thank You!

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