Hybrid CCR Impoundment Closure Value-Engineering Case Study

Steven Mayes\textsuperscript{1}, Tammy DeRamo\textsuperscript{2}

\textsuperscript{1}Chesapeake Containment Systems, 2690-D Salisbury Hwy, Statesville, NC 28677
\textsuperscript{2}Envirocon, 1999 Broadway Suite 800, Denver, CO 80202

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ABSTRACT

On a Department of Energy site (DOE) Savannah River Site in South Carolina, a value-engineering alternative to modify the final cover system design was collaboratively prepared by the prime contractor, Envirocon, and its subcontractor, Chesapeake Containment Systems, Inc. The modification resulted in approximately $300,000 in savings for the client, as well as schedule efficiencies gained due to more efficient and easier installation. The original cover system design from top to bottom included: 4-inches of topsoil, 20-inches of common fill, geocomposite drainage later (GDL), geosynthetic clay liner (GCL), and 6-inches of common fill. The alternative, value-added, cover system design from top to bottom included: 4-inches of topsoil, 20-inches of common fill, nonwoven geotextile layer, and an integrated drainage system geomembrane (i.e. 50 mil LLDPE micro drain). The cost savings are attributed to replacing the GDL and GCL with a nonwoven geotextile and micro drain; eliminating the 6-inch soil layer below the cover liner, and installation time. The schedule to install the GCL was during one of the wetter times of the year in South Carolina. Schedule was expedited because the 6-inch soil sublayer was no longer placed and the Micro Drain did not require covering immediately, allowing work to be sequenced and executed systematically and reducing stand-by time between various work crews. The Micro Drain system was also preferred because it expedited water management; it could be placed faster than the GCL cover system thus reducing the volume of contact water resulting after each rain event.

BACKGROUND

On a Department of Energy site (DOE) in South Carolina, a value-engineering alternative to modify the final cover system design was collaboratively prepared by the prime contractor, Envirocon, and its subcontractor, Chesapeake Containment Systems, Inc. The modification resulted in approximately $300,000 in savings for the client, as well as schedule efficiencies gained due to more efficient and easier installation.

The CCR impoundment was a 37-acre earthen containment basin, and included two Inlet Basins at the east end of approximately 7.5 acres, for a total of +44.5 acres. The project consisted of closing the impoundment by constructing a new perimeter berm through the
center of the original footprint, consolidating the CCRs into the eastern half of the original impoundment footprint and constructing a low-permeability cover system over the CCRs.

DESIGN OBJECTIVES

The GCL/GDL cover system performance design required a permeability of 5x10^{-9} cm/sec and a drainage layer was required within the cover system to shed water prior to infiltrating the GCL. The IDS geomembrane design exceeded the specified design requirements and combined the liner with the drainage layer in one product.

The designed liner system from bottom to top consisted of a CCR subgrade, an intermediate layer (~6-inches in thickness) of common fill, a GCL as the primary liner, a geocomposite drainage layer, 20-inches of common fill, and 4-inches of topsoil (see Figure 1 below).

The alternative, value-added, cover system design from bottom to top consisted of the CCR subgrade, an integrated drainage system geomembrane (i.e. 50mil LLDPE MicroDrain), nonwoven geotextile, 20-inches of common fill, and 4-inches of topsoil (see Figure 1 below).

![Figure 1 – Prescribed & Alternative Cover System Profiles](image)

INTEGRATED DRAINAGE SYSTEM

Over 150M SF of integrated drainage system liner has been installed in the United States to date, and it has been approved by most state regulatory agencies. An integrated drainage system is a combined barrier liner and drainage media produced using a flat die calendared manufacturing process. It may be manufactured from either LLDPE or HDPE resin formulations. The top side of the product is produced with integrated drainage studs. A nonwoven geotextile is utilized to bridge across the top of the drainage studs to form a
void space at the geomembrane which allows for channelized flow or drainage. This eliminates the need for a separate geocomposite drainage layer resulting in material and installation cost savings.

The bottom side of the product is available with either a smooth or textured surface. The textured surface is available in a variety of asperity heights depending on site specific project design considerations.

The integrated drainage system liner meets the standard specifications for both GRI GM-13 (HDPE) and GM-17 (LLDPE). It can be fusion or extrusion welded to create a homogeneous liner system. All seams can be pressure tested for continuity, destructively tested and sent to independent labs to verify the seam meet the GRI GM-19 weld requirements.

As compared to the GCL, the integrated drainage system is not as sensitive to precipitation, UV exposure, or confining pressure. Upon saturation, the GCL will swell into the geocomposite drainage layer reducing the flow channel openings. Because of this, performance advantages of the integrated drainage system over the GCL/GDL include:

1) Higher Transmissivity Performance
2) Greater Interface Shear Strength
3) Higher Tensile Strength

![Figure 3 – Integrated Drainage Studs](image)
Table 1 below compares the flow performance and material characteristics. The transmissivity performance of the integrated drainage system was more 3 times higher that of the specified system (GCL and geocomposite drainage layer). This can primarily be attributed to the GCL swelling into the geocomposite flow channels upon becoming saturated and the more consistent and reliable flow channels created by the drainage studs in the integrated drainage system.

<table>
<thead>
<tr>
<th>Transmissivity</th>
<th>Specification</th>
<th>MicroDrain</th>
<th>% Exceeds Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gradient = 0.25</td>
<td>2 x 10⁻⁴ m²/sec</td>
<td>8 x 10⁻⁴ m²/sec</td>
<td>300%</td>
</tr>
</tbody>
</table>

Test Conditions:
- Hydraulic Gradient: 0.25
- Confining Pressure: 50 psi
- Upper Boundary Conditions: Slope-specific Soil
- Lower Boundary Conditions (specified): GCL
- Lower Boundary Conditions (MicroDrain): MicroDrain/Your
- Sust Time: 200 hours

**Drainage Comparison**

**GCL vs. MicroDrain**

<table>
<thead>
<tr>
<th>Property</th>
<th>GCL</th>
<th>MicroDrain</th>
</tr>
</thead>
<tbody>
<tr>
<td>Permeability (cm/sec)</td>
<td>5 x 10⁻⁵</td>
<td>1 x 10⁻⁵</td>
</tr>
<tr>
<td>Elongation at Break</td>
<td>Low</td>
<td>&gt; 300%</td>
</tr>
<tr>
<td>Potential for Desiccation</td>
<td>High</td>
<td>Not Applicable</td>
</tr>
<tr>
<td>Hydraulic Performance Dependence on Confining Stress</td>
<td>Very Dependent</td>
<td>Not Applicable</td>
</tr>
<tr>
<td>Potential for Panel Separation</td>
<td>High</td>
<td>Low</td>
</tr>
</tbody>
</table>

**Table 1 – Performance Comparison**

In addition to the previously mentioned product differences, there were additional project related advantages of utilizing the integrated drainage system. These advantages can be summarized into 3 areas: schedule, health and safety, and environmental.

Eliminating the GCL and the 6-inches of common fill allowed the schedule to be reduced by ~19 days. This was significant as the project was to be installed during one of the wetter times of year in South Carolina. The schedule was expedited because the 6-inch soil sublayer was no longer placed and the Micro Drain did not require covering immediately, allowing work to be sequenced and executed systematically and reducing stand-by time between various work crews. The Micro Drain system was also preferred because it expedited water management; it could be placed faster than the GCL cover system thus reducing the volume of contact water resulting after each rain event.

In terms of safety, the integrated drainage system alternative weighed less than half of the combined base material weights. Reducing the material weight reduced the potential for muscle strains and slip/falls during deployment.

From an environmental perspective, the integrated drainage system required 15 delivery trucks as compared to 40 delivery trucks for the base bid materials; thus reducing the
carbon emissions and emissions from offloading the materials. Eliminating the 6-inch layer of common fill for the intermediate layer will also eliminate carbon emissions from equipment and subsequent land disturbance at the borrow soil area.

CONCLUSION

The value-added engineering alternative modification resulted in approximately $300,000 in savings for the client, as well as schedule efficiencies gained due to more efficient and easier installation. Cost savings were primarily realized through reduction in fill material as CCRs were acceptable for use as subgrade below the IDS, and replacing the GDL with the IDS coupled with installation costs of the IDS compared to GCL/GDL. Additional cost savings resulted from reducing the overall project schedule by 19 days since the installation process for the IDS can be performed more expeditiously than GCL/GDL cover system.

Another reward realized from this collaboration was in 2018 the SRS D-Area Ash Basin Project received the Project Management Institute Award for Project Excellence. The project team was recognized for completing the first of two phases of work ahead of schedule and significantly under budget.