METRO THERMAL ASH MONOFILL CLOSURE CAP
STORMWATER DAMAGE AND RESTORATION UPDATE

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Metro Thermal Ash Monofill

- Located in Downtown Nashville along Cumberland River
- Closed in October 2004
- Total Footprint 15 acres

As-Built Closure Grades – January 2005
Final Cover Design Configuration

- 3H:1V Sideslopes – low permeability soil (placed at k < 10^{-7} cm/s)

- Mid-Slope Benches (10' width; 10:1 backslope – 1' Bench Gutter) with Underdrains (4" pipe/Stone/GT-S wrap)

- Three Letdown Structures (with Underdrains)

- Perimeter Drainage Channels (with Underdrains)

- Plunge Pools at Letdowns

- All flows to on-site Sediment Pond
May 1, 2010 to May 3, 2010

- >13.4 " Rainfall at site (elsewhere 17" to 19.4 ")
- >1,000-Year/48-Hour event
- Site inaccessible until ~ May 5th
- New Record River Flood Levels across Middle TN
Photo 2. (North Slope) Scarp Immediately Down Slope from Bench

Photo 3. (North Slope) Scarp and Exposed Geocomposite
Photo 4. (North Slope) Crack and Letdown at East Side of Failure. Scarp at Top

Photo 5. (North Slope) Sloughed Cover Soil at Toe
Photo 6. (North Slope) Bulge at Toe

Photo 7. (South Slope) Bulge at Toe
Photo 8. (South Slope) Bulge at Toe

Photo 9. (South Slope) Tension Crack Below Bench
May 7, 2010 Conditions

- No intrusive/exploratory investigations “allowed” — just replace
- South & North Slopes impacted (~ 2 acres total)
- Significant material movement - North Slope only – DGC exposed
- Both areas: toe bulging & extensive upslope Tension Cracking
- Perimeter channels - flat bottom slopes/lower capacity
- No visible water flow in toe areas – although signs of significant water beneath North Slope Material
- Benches – flatter than designed and backslope less than designed
- Drainage Geocomposite and bench drain piping outlets - not visible

Analysis


- North & South benches have similar slopes & capacities
- Perimeter Channels have flat slopes (North 0.4% avg) and South (1% avg) & low capacities
- Contributing watersheds – similar for each slide area
Analysis (Theorized)

Combination of Factors:

- Initial, small displacements due to toe saturation - progressed upslope - created T-cracks
- Mobilized shear strength along soil/DGC interface and within soil cover
- Progressive loss of frictional resistance along the soil/geocomposite interface
  - Tension in upper DGC GT- $ reduced "pillowing" friction
- Increase in downslope driving force - eventually exceeded buttressing
- Tension crack development - accelerated surface water to the geocomposite creating excessive head in the drainage geocomposite
  - Decreased normal load on soil/DGC interface
- Final Cover "floated" over the geosynthetics (North Slope only) - exposing DGC
- Excessive head was believed to be due to:
  - Loss in perimeter channel/underdrain capacity to drain the final cover drainage layer
  - Rate of flow into the drainage geocomposite
- Why North Slope Only? Differences in North and South slopes - none apparent, prior to construction

Factors (Theorized)

- Backwater in the plunge pools and Perimeter Channels contributed to inundate the upgradient perimeter underdrains on both slopes
- Critical movement occurred along the weakest un-reinforced interface (soil/drainage geocomposite)
- Critical movement did not occur along the DGC/GCL interface - due to tensile strength of the materials (anchored at the top of slope)
- Soils with high PI (33) increased susceptibility to shrink/swell (tension crack development)
Recommended Remediation

South Slide Zone (SubArea A):

- Regrade T-cracked slope areas and revegetate
- Provide a "break" in the bench drainage geocomposite (inspect underdrains)
- "Daylight" the drainage geocomposite into the perimeter channel through cap drain modification - disconnect from P. Underdrain
- Clean/reshape perimeter channel

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Recommended Remediation

North Slide Zone (SubAreas B, C, D):

- Completely reconstruct the cap and drains subgrade to topsoil - (C only)
- Regrade T-cracked slope areas and revegetate (B, D)
- Provide a "break" in the bench drainage geocomposite (inspect underdrains) (B,C,D)
- "Daylight" the drainage geocomposite into the perimeter channel through cap drain modification - disconnect from P. Underdrain (B,C,D)
- Clean/reshape perimeter channel
FEMA Estimates/Site Inspections
(mid-May 2010 through June 2010)

- Cost Estimates (Time and unit price based)
- Site Interviews (2)
Excavation for Cap Drain Modification, Subarea-A

Metro Thermal Ash Monofill Cap Restoration

Subarea "A" prior to cap drain modifications being installed.
Subarea-B, completed bench restoration. Backfilled bench, added topsoil

Cutting in slope for cap drain modification, Subarea-B, looking east
Subarea-C, underdrain in eastern let-down structure

Subarea-C, Removing cover material to expose liner in bench
Subarea-C, sand placement over GCI.

Subarea-C, drainage composite in anchor trench.
Subarea-C, soil cover placement

Metro Thermal Ash Monofill Restoration

Installation of drainage and geocomposite in subarea "C"
Subarea-C, drainage composite deployment

Subarea-C, zip tie drainage composite
Subarea-C, cap drain modification construction

Subarea-C, soil cover placement over cap drain modification
Subarea-C, final grading

Subarea-C, seed and straw placement
North perimeter channel placement

Subarea-C, letdown structure
North leidown structure, plunge pool

Subarea-C, top of landfill
Subarea-C straw, access road gravel placed

Subarea-D, removing vegetative layer
Exposing Bench Drain, top of slope, Subarea-D, looking west

Subarea-D, exposed composite in toe of slope soil bulge, close up
Subarea-D, locating underdrain, edge of drainage composite exposed

Metro Thermal Ash Monofill Cap Restoration

Excavation to expose underlying synthetics for installation of Cap-Drain Modification in Subarea "D"
Metro Thermal Ash Monofil Cap Restoration

Subarea D, locating underground pipe, pipe out of subgrade ditch, standing water where pipe should be in ditch.
Subarea-D, completed bench restoration. Backfilled bench, added topsoil

Subarea-C, soil boring 2 depth
Key Findings During Construction

- Perimeter Toe Drain in SubArea C/D was crushed (~ 120 LF)
- Perimeter Toe Drain in SubArea D was mis-located (i.e. not in the low point) and not perforated.

Restored Slope As-Built – November 2011
Post – Remedial Construction
2012 to Present
2014 Aerial

Discharge end of Cap Drain Modification Piping
Possible Culprits

OR
South Slope July 2012

South Slope Cracks – July 2012
South Slope Cracks – August 2012

South Slope Cracks – September 2012
Take-Aways:

1. Good (perimeter) drainage is critical.

2. There is a storm coming that will exceed your design and impact even "good" final cover designs.

   Redundancy in final cover designs is needed

3. Post-closure monitoring/inspection & maintenance is never finished