Effects of Drainage on Landslide Movement at Interstate 40 across the Cumberland Plateau Escarpment

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Site Location

Nashville

Knoxville

Rockwood

I-40
Site Location

Eastern Cumberland Plateau Escarpment separating Valley and Ridge and Cumberland Plateau

City of Rockwood
April 2017 Aerial Photo looking East at MM342

- WB I-40
- EB I-40
- Approx. slide limits
- Construction Access Road
Cross-Section through Slide

- Gizzard Group
- Pennington Fm.
- Newnan Limestone
Outline of Presentation

- History of slide
- Desktop review & subsurface investigation
- Short-term remediation in 2010-2011
- Key findings & conclusions
- Long term options & recommendations
- Selected option and the 2018 geotechnical program
Original Construction-1968
Other Slides on Rockwood Mountain

Pennington Fm.
Project History 1974 - 2003

- East-bound lanes opened in 1974
- Horizontal drains, trench drains and dewatering wells installed in 1968, 1972, 1974, and 1994
- Geomembrane-lined ditches installed in 1990’s
- Slope inclinometers installed 1974 and 2003
Project History 1976-2009

- ~0.5 in/yr from 1976-2009
- TDOT retained Golder in 2009 for review of files
Desk Study and Geologic Mapping

- Historic headscarps
- Topographic bulge
- Colluvial lobes
Desk Study and Geologic Mapping
Interpreted Geologic Model

Gizzard Group

Pennington – slide-prone formation in TN & GA

Newnan Limestone
Short-Term Remediation - Dewatering

I-40 WESTBOUND

HORIZONTAL DRAIN

I-40 EASTBOUND

TOE OF EMBANKMENT

DEWATERING WELL

STREAM

BLACK HOLLOW ROAD

All water piped and discharged here
Composite Cumulative Displacement of Inclinometer and Yearly Precipitation
Key Findings & Conclusions

- Roadway embankment construction in 1968 exacerbated on-going creep landslide
- Sliding is within Pennington Shale at depth of more than 70 ft below embankment toe
- Movement has slowed to ~0.1 in/yr since April 2014 (when adjustments to pumps started)
- Total movement since 2011 has been about 2 inches
- Incremental movement has been larger in years with higher annual rainfall
- Movement likely to continue indefinitely
- Performance to date suggest catastrophic movement is unlikely
- Slide has progressed eastward since 1969 & recently northward near Westbound lanes, and may continue
- Slide extends downhill below inclinometers
Options - Earthwork

Re-alignment of I-40

- Construct new westbound lanes
- Relocate eastbound lanes onto current westbound lanes
- High probability of triggering multiple landslides

Toe berm or buttress

- Key imported earth into toe of slide
- May require relocating local roads below I-40
- Additional investigation needed to delineate extent of slide
- Risk of new slide daylighting above or below berm or buttress; thus, not considered feasible
Options – Drainage
Options – Ground Anchors
Options: Reticulated Micropiles
Options: Status Quo with Risk Mitigation Measures

- Delineate extent of slide
- Dewatering system
- Inclinometers
- Remote monitoring
- Emergency action plan
- Miscellaneous
Summary of Long-Term Options

- Earthwork
- Groundwater drainage
- Ground anchors
- Reticulated micropiles
- Status quo with risk mitigation measures
2018 Geotechnical Program

SLIDE DELINEATION AND EVALUATION

- 14 Boreholes and Inclinometer Casing
  - PQ Drilling
  - 2.75-inch Casing
- Geologic Mapping
  - New Lidar Data Review
- Evaluate Effect of Additional Drains
- Plan for Remote Monitoring

CONTINUED PUMP IMPROVEMENT

CONTINUED INCLINOMETER MONITORING
Thank You