71st Highway Geology Symposium

Better highways through applied geology

HGS Field Trip Guide

Asheville and the North Carolina Blue Ridge

HGS 2022 Field trip route and schedule

8:00 AM: Depart Renaissance Hotel, downtown Asheville

-travel SE on Interstate 26: 20 mile widening project

-travel down Blue Ridge escarpment

9:00 AM: Stop 1: Arrive at Old Howard Gap slide area.

9:45 AM: Depart Stop 1

10:45 AM: Arrive Stop 2: Gerton Slide

11:15 AM: Depart Stop 2

12:00 PM: Stop 3: LUNCH. 12 Bones BBQ at The Wedge Brewery

1:15 PM: Depart The Wedge

-travel East on Interstate 40 down Blue Ridge escarpment

2:00 PM: Stop 4: MM 68 Shallow Landslide Barrier

2:30 PM: Depart Stop 4

-travel Interstate 26 north

3:15 PM: Stop 5: Buckner Gap cut

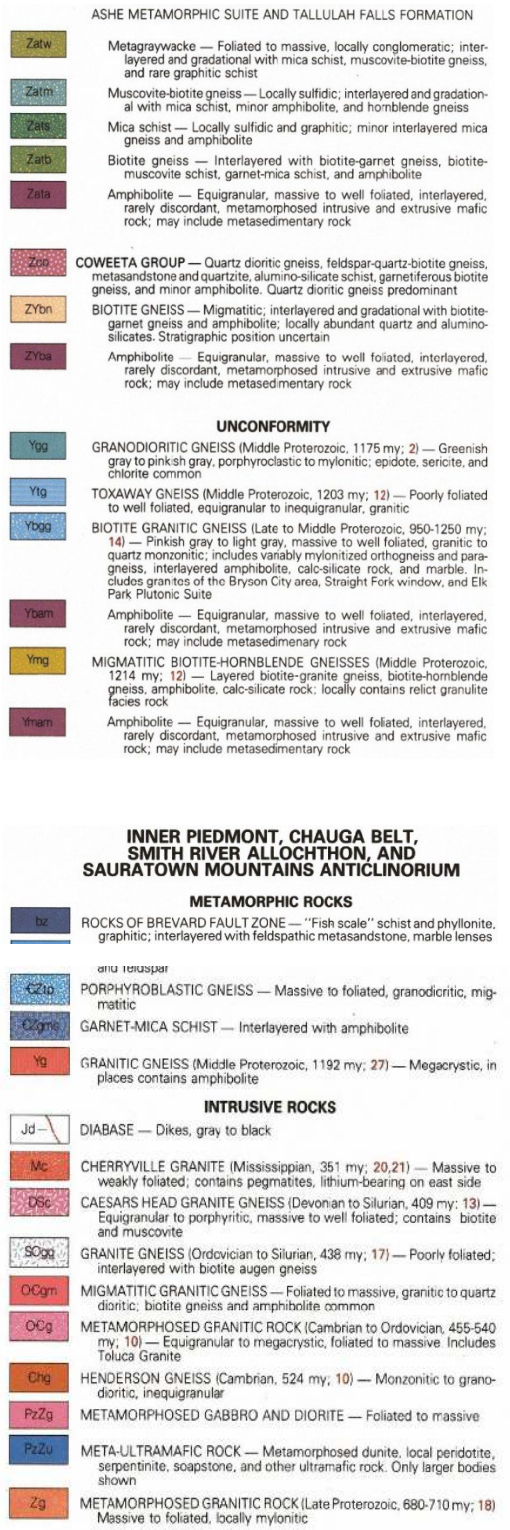
3:45 PM: Depart Stop 5

-travel I-26 into TN, turn around at Flag Pond exit

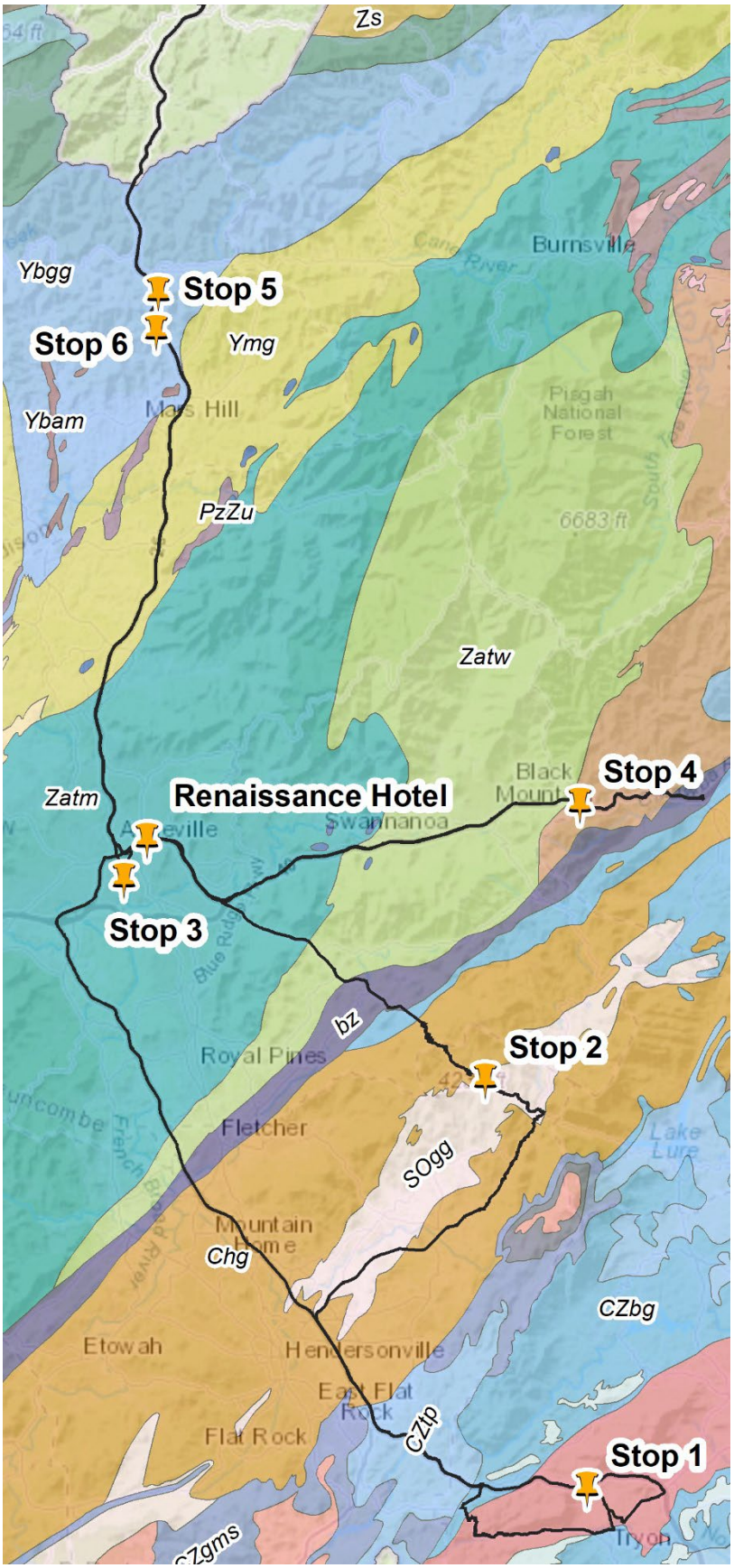
4:15 PM: Arrive Stop 6: NC Welcome Center

4:45 PM: Depart Stop 6

5:10 PM: Arrive Stop 7, Renaissance Hotel, downtown Asheville



Lithology and Geologic map, NCGS 1985



Welcome to the Blue Ridge Province! Your trip will take you through Ordovician (500 my) to Precambian (1.2 by) migmatized ortho and paragneisses, metamorphosed intrusives, thrust faults and contacts representing three orogenies and complex sequences of basement and terranes. Although you won't be travelling through any of the noted geologic windows of the southern Blue Ridge, you will cross the Brevard Fault zone several times. This structure has been studied and interpreted for 100 years; special attention is noted to the cited reference by Bobyarchick which recounts the various attempts to define the structure, especially interesting in the pre-plate tectonic era.

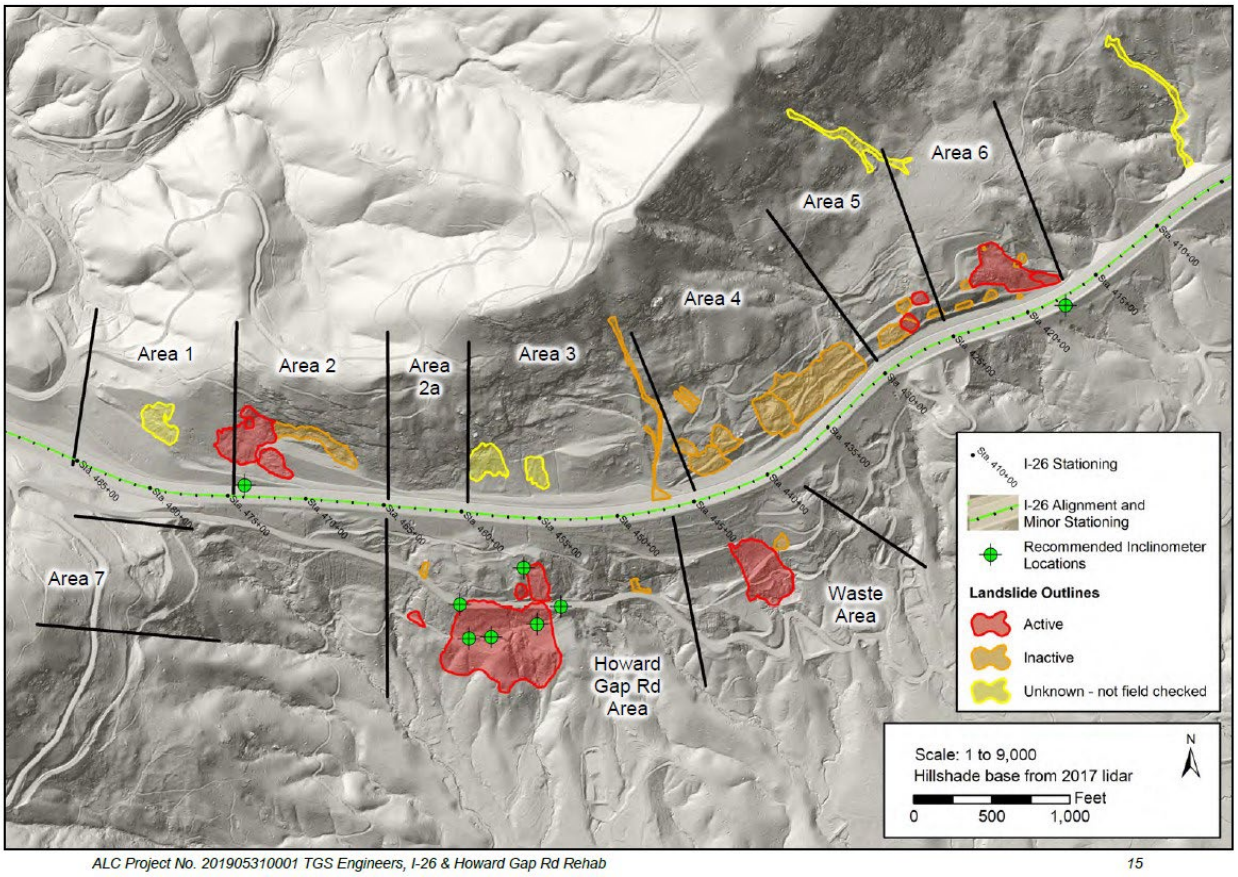
Theorized to be as high, or higher than the Rockies at formation, 200 million years of rifted erosion leave us with an exposed look at deep orogenic roots of multiple thrust events.

Precipitation of 60-100" per year, deep ancient colluvial deposits, complex mineralization and weathering profiles, and non-linear/planar discontinuities make for distinct issues within the state. Deep foundations rarely present problems.

Travel to Stop 1 will traverse 20 miles of I-26 E, which is currently under a widening project to 6 and 8 lanes. The project involves major structure replacement, a new exit, extensive retaining walls and engineered embankments to deal with impact on the French Broad River valley and Historic Biltmore Estate property.

The trip will take you over the tallest bridge in the state at I-26 MM 55 in the morning, and the second tallest at I-26 MM 2.5 in the afternoon.

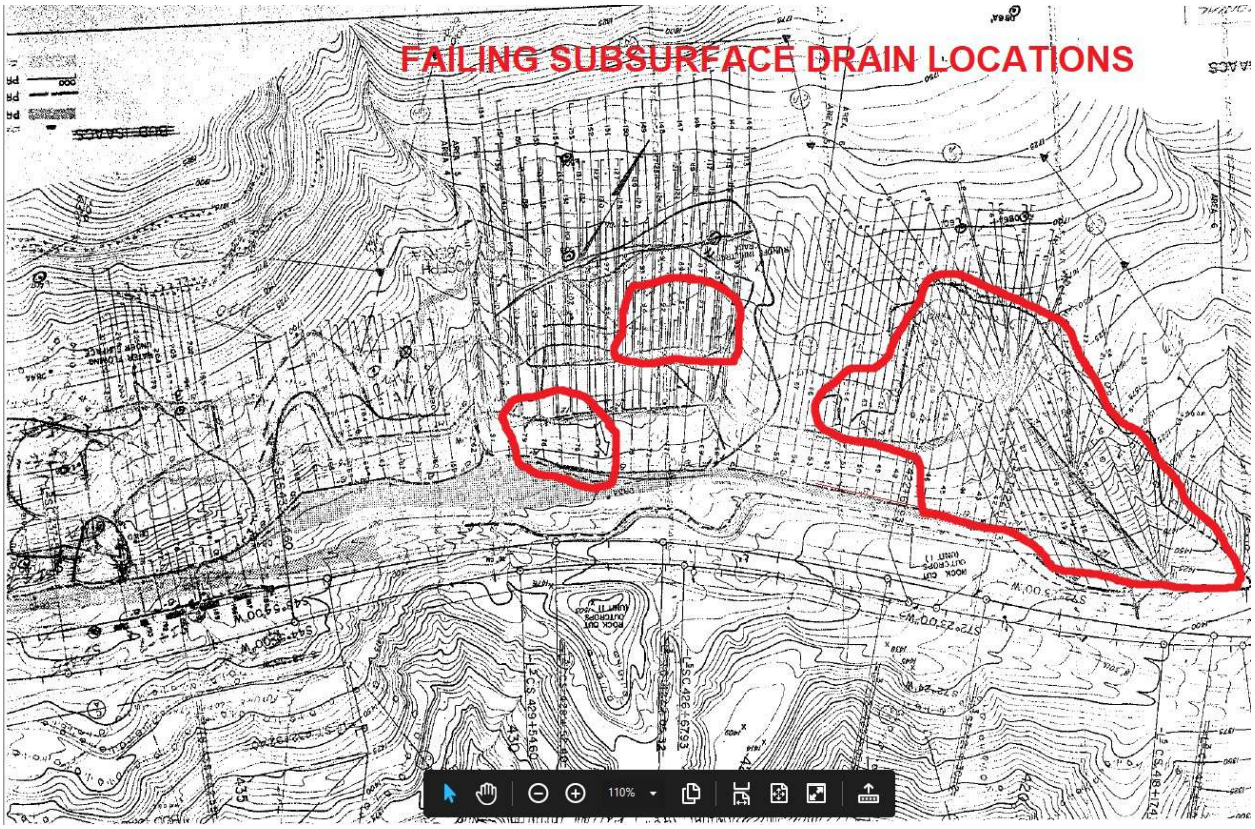
Appalachian Landslide Consultants, PLLC
www.appalachianlandslide.com
PO Box 5516
Asheville, NC 28813
(828) 209-8642



I-26, MM 60, Blue Ridge Escarpment Figure 1

I-26 on Saluda grade had stability issues during construction resulting in a 4 year delay.

2019 mapping by Appalachian Landslide Consultants recorded areas for movement, monitoring, horizontal drain condition and other information necessary for a future Interstate Maintenance effort.



I-26, Blue Ridge Escarpment, Figure 2

This rather fuzzy plan view shows the enormity and complexity of the original horizontal drain installation. This is Area 6 as seen in “I-26, Blue Ridge Escarpment, Figure 1”, previous.

Much of this is now active slide with a failed collection system, access, and drains.

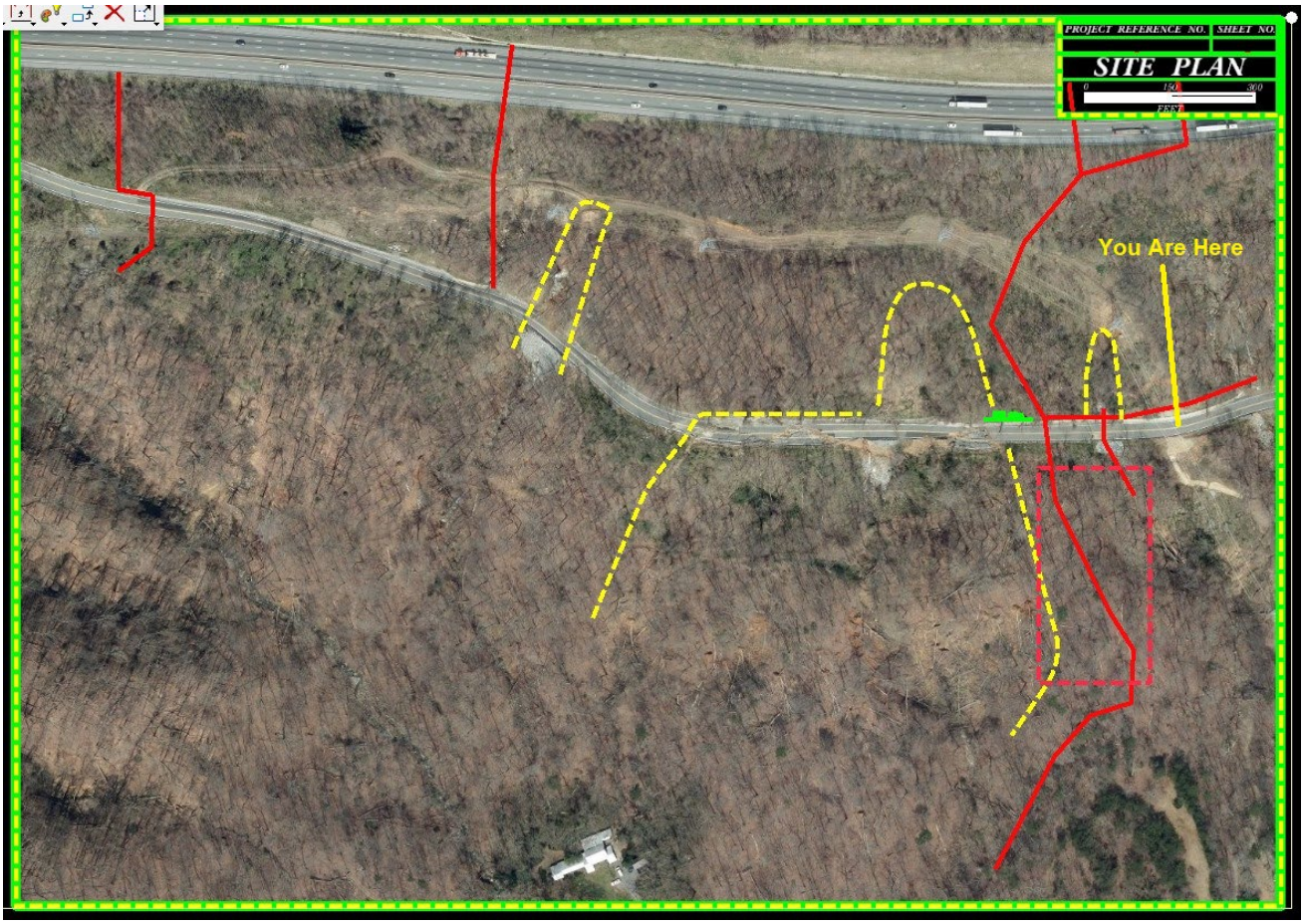
Stop 1: Old Howard Gap Slide Area

2018 was a record rainfall year for the area. Old Howard Gap Road is a secondary route that was relocated to the toe of Interstate 26 embankments and required wall, buttress and horizontal drain stabilization during initial construction. Due to its location along the escarpment; concentrated precipitation and hurricane runout produce intense events. Sections of the embankment and cuts have failed and been repaired many times.

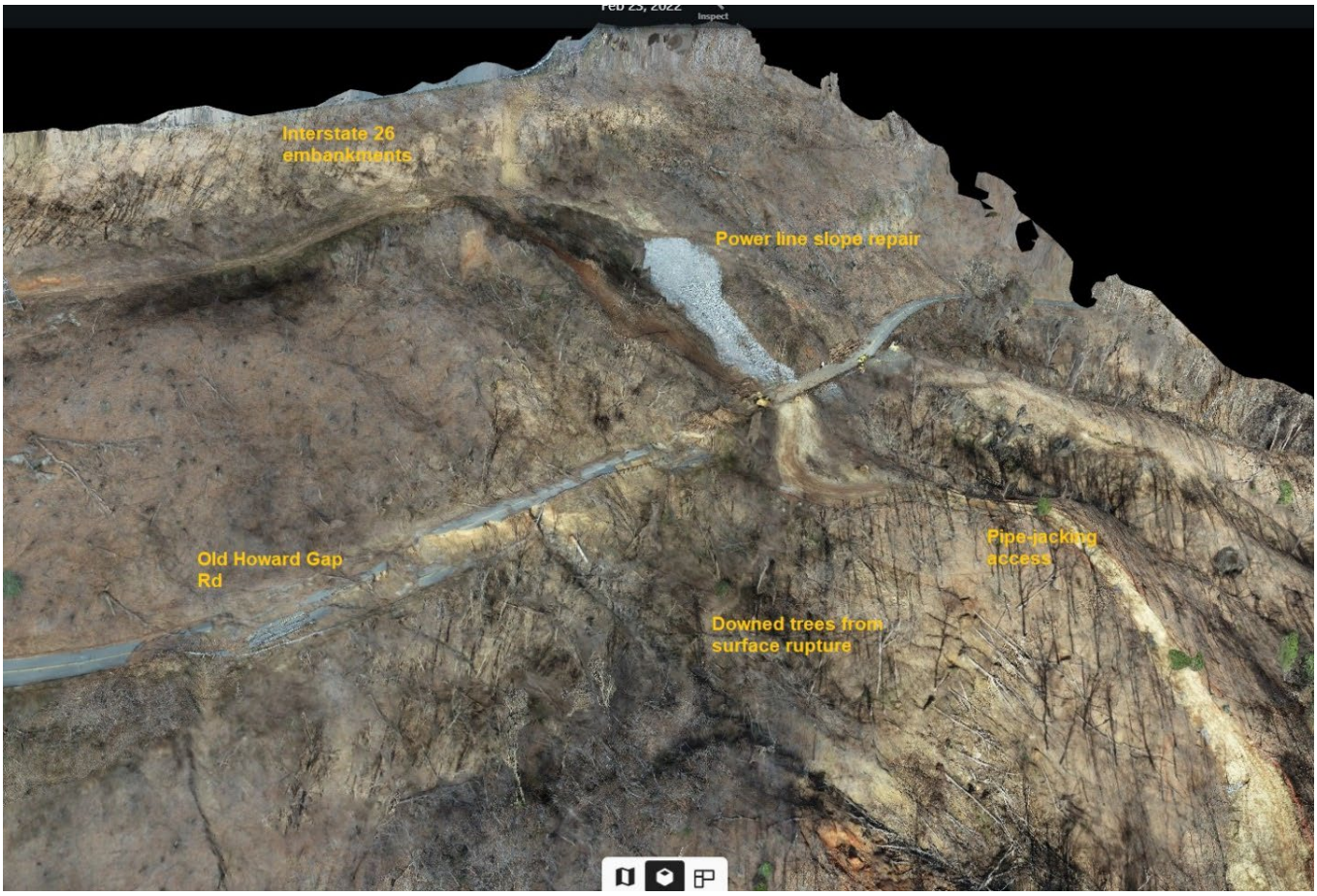
2018 resulted in overwhelming of the I-26 surface drainage system, with a river/wall of water dumped on the secondary road. The Geotechnical Unit was geared up for another round of investigation and recommendations when the largest embankment area morphed into a 15-acre big slow mover.

OHG Road on YouTube: Erik Olsen, ErikOlsenPictures.com.

According to the rating algorithm in the NCDOT Geotechnical Asset Management program, the detour for this is not overly long and is the interstate. This has taken the pressure off to initiate an expensive unexpected repair; good news since this failure area has been expanding beyond what an initial investigation would have discovered!



Overview: Yellow are slide areas, solid red is new drainage for the interstate. Dashed red box is location of pipe-jacking section under rare and endangered plant locations. It was vital to map out slide areas, for routing new drainage in stable locations.



Orthophoto overview by NCDOT Div. 14 Loc and Surveys.

The field trip continues through Tryon, NC, parallel to the Pacolet River and I-26, and climbs up the Blue Ridge Escarpment to Saluda.

Impact of 2018 concentrated rainfall on nearby escarpment:

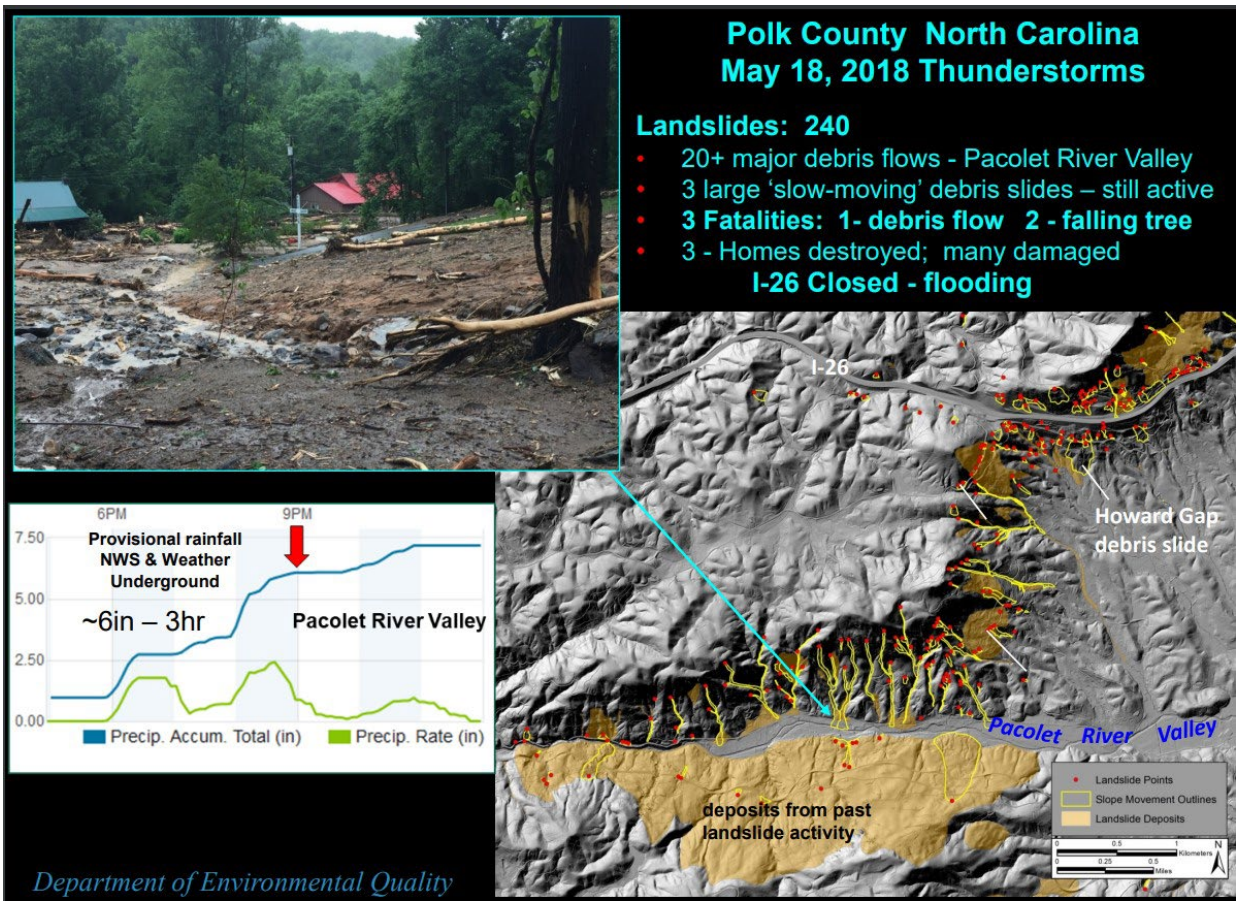


Image slide from NCDEQ and NCGS by Rick Wooten, PG

Associated with the rainfall event at Old Howard Gap, the debris flows to the south along US 176/Pacolet River covered the highway in several places and resulted in one homeowner death.

We continue our trip through Hendersonville to east on US 64 to the Bat Cave/Lake Lure area.

Stop 2: US 74, Gerton Slide

2017 Streetview showing minor ditchline creep. Generally stable for decades. After record rainfall in 2018 this developed into a slow rotational colluvial slide with continuous water and pavement uplift.

Slide mobilized and now consuming the road…Required multiple maintenance cleanups over a year.

Due to the size of colluvial deposit and steepness; design decisions were rock buttress, shear key, subsurface drainage and generous catchment bench with cleanout access.

Finished product with scarps developing above.

Depart Stop 2, travel up across Hickory Nut Gap to Asheville. Lunch in the River Arts District with BBQ from 12 Bones at the Wedge Brewery (Stop 3) Lunch

1:15: Depart the Wedge and head east on I-40, down and back up the Blue Ridge Escarpment.

As you head west on I-40 you reach Swannanoa Gap, the top of the Blue Ridge Escarpment. Nearly continuous cut sections expose rocks of the Brevard Fault Zone. At the orogen scale the escarpment is a nearly linear landform stretching from Northern Georgia to central Virginia, separating the mountains from the lower relief Piedmont physiographic province to the east (Scheip, 2022). Rock cuts consist of high-grade metamorphic foliated Proterozoic to Paleozoic crystalline bedrock.

The nature of the development and evolution of BRE topography remain enigmatic and debated. The highway traverses steep terrain (ground slopes often exceed 20^{o}) for 5 roadway miles, dropping 1,300' in the process. (Scheip, 2022)

Stop 4: Shallow landslide barrier at MM 68 on I-40 W.

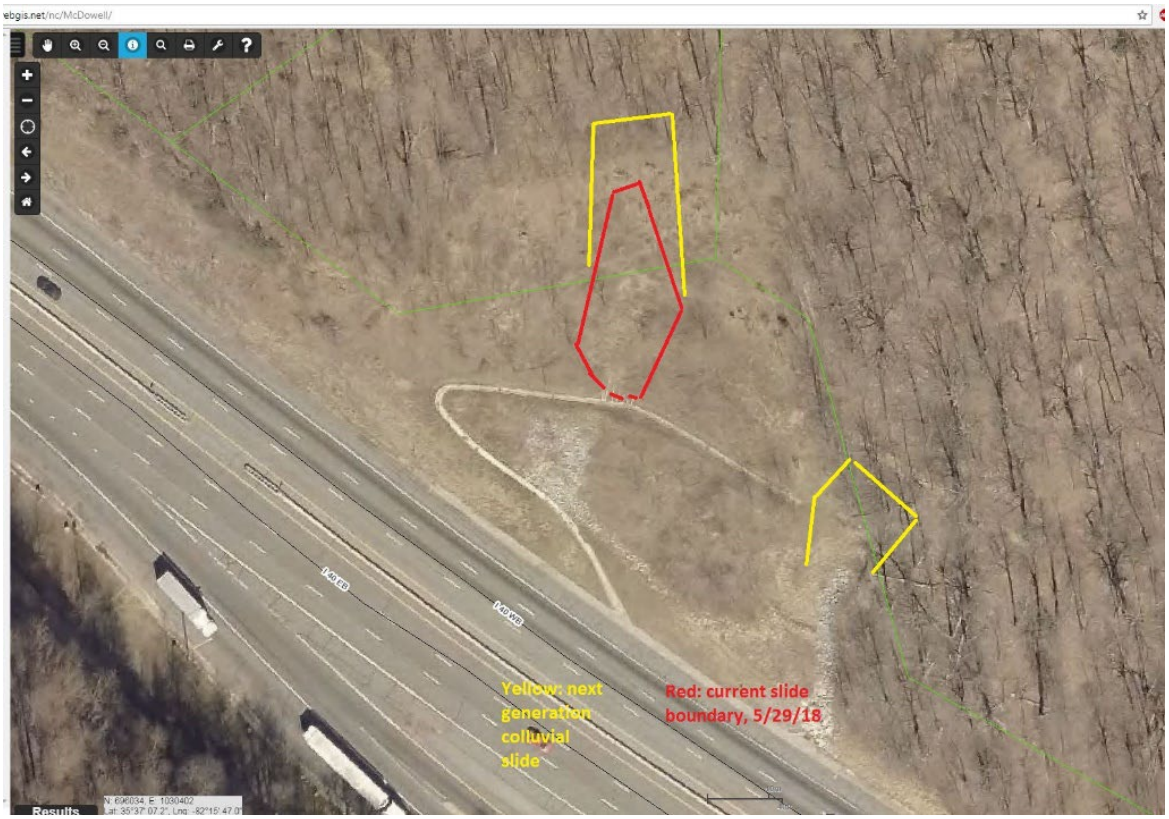


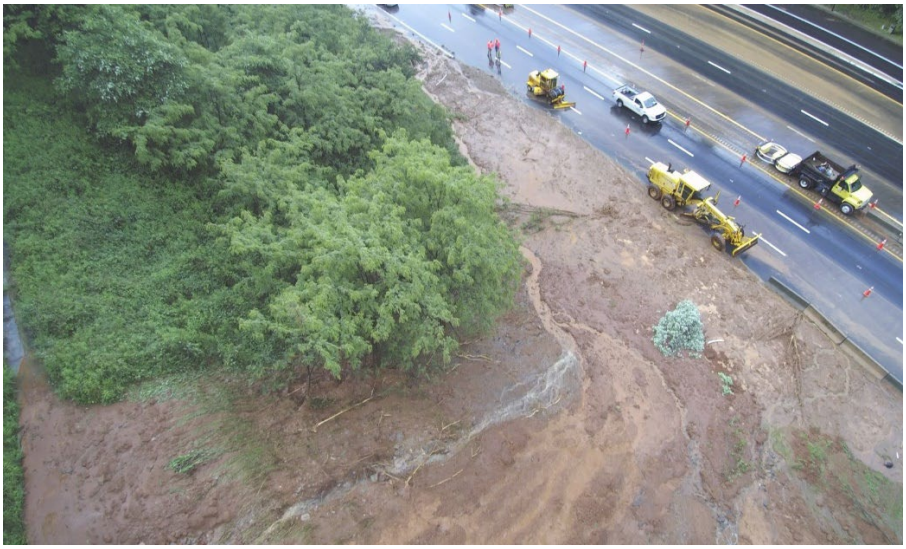
Image: Buncombe County, NC GIS

This steep slope is the site of numerous failures. The presence of perched colluvium indicates groundwater and the location at the top of the escarpment results in precipitation concentration. The failures take the form of short debris flows and extremely saturated saprolite/weathered rock material that flows and blocks half or all of the interstate with a shallow deposit. Fortunately, the nature of this deposit has not resulted in death or injury but has allowed for some car surfing. The pre-2018 image above shows excavated slopes and a drainage swale that captures flow from rows of horizontal drains.

There are widely used trails on USFS land above, NCDOT is only allowed to mitigate 100' of ROW at this location. Due the nature of the failure creeping up the slope it was determined the future failure would have to be mitigated by an attenuator/catchment scheme. NCDOT was not

going to be able to reinforce the slope above, and it is a potentially huge area with multiple failure locations.

May 30, 2018. Top of current scarp. Slide blocked WB lanes and jumped barrier to EB lanes.



Slide runout with groundwater, mud, and weathered rock.

1990 Incident

Mitigation design called for double landslide debris barriers with fixed shoulder barrier and access for cleanout.

June 22, 2020. Final installation of elements

Field trip continues back to Asheville and north on I-26 W toward Tennessee.

Interstate 26 traverses directly across the Blue Ridge; climbing the escarpment from the foothills of North and South Carolina, north through the French Broad River Valley, veering off to cross the peak of the Blue Ridge at 3,800’ and down across the back of the thrust faults that built the range.

North of Mars Hill, NC, NCDOT constructed 10 miles of new alignment Interstate 26 as part of the Appalachian Development Highway System. At the time, 2007, this was the largest single contract and excavation project in the State highway system. The project involved 40 million cubic yards of excavation, 3 million yards of unsuitable colluvial waste, single-slope rock cuts with catchment and rockfall fence, steepened rock fills and buttresses, rock bolting, dowelling, scaling, shotcrete, and a vast horizontal drain system for embankment stability.

Rock slope design was based on oriented core drilling in 10 large cut areas, yielding 17,000 discontinuity measurements. An additional 5,000 measurements were taken from rock outcrops including persistence, water, roughness and other design stability inputs. Investigation included nearly 1,500 borings and 2 miles of refractive seismic.

I-26 Looking West at Buckner Gap, Madison County, NC, 2008. By Rob Amberg

Stop 5: Buckner Gap Cut

This cut section is the largest single excavation by NCDOT at nearly 4 million cubic yards. Investigation involved difficult roadbuilding access with surface mapping and multiple oriented core holes. Originally intended as a probabilistic design, ultimately deterministic was used yielding 1:1 on the west and 0.5:1 on the east. 70 tensioned rock anchors and an entire anchored shotcrete bench add stability on the east slope.

Top lift of Buckner Gap cut construction, looking South toward Asheville.

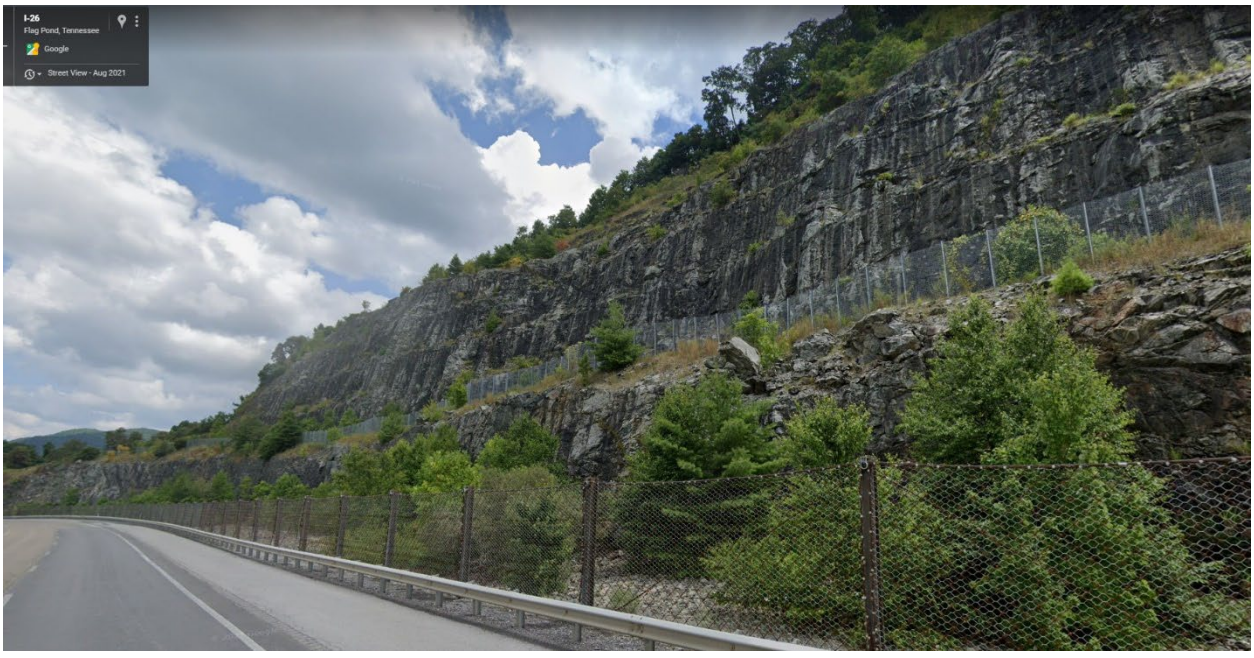
Looking toward Buckner Gap from the north. Cleared gap in distance. Large rock buttresses visible for soil slope support between rock cuts.

Buckner Gap, east face. Anchor and shotcrete stabilization.

During construction holes were drilled across the benches to provide future rope access points, such as this Lidar study in 2020.

Russell Glass looks over final paving of I-26, Madison Co.

-Field trip continues to NC/TN state line with a turnaround 5 miles into TN at Flag Pond.



The Tennessee section of I-26 was completed 4 years before NC. Notable difference is the use of benched slopes and stacked rockfall fences.

1,000’ south of the turnaround at Flag Pond (back toward Asheville) is good exposure of a thrust fault on the left side large cut. Iron sulfates at the base of the hanging wall required treatment and encapsulation within the Flag Pond exit embankment (Harry Moore).

Flag Pond Cut (East face). Well exposed Blue Ridge thrusting within gneissic unit.

Stop 6: NC Welcome Center

From the Welcome Center and trail above you get an expansive look at the inner Blue Ridge from the Craggy range east of Asheville to Mount Mitchell, highest point east of the Mississippi at 6,684'.

References

The Geologic Map of North Carolina, 1985, NCGS

Bauer, Jennifer and Fuemmeler, Stephen, 2019, *Report for Geologic Evaluation for Slope Stability, Interstate 26 and Howard Gap Road Rehab.* NCDOT Report.

Bobyarchick, Andy, April 1999, *The history of investigation of the Brevard Fault Zone and evolving concepts in tectonics. Southeastern Geology*

Moore, Harry, Spring 2022, Personal communication

Scheip, Corey, Spring 2022, Personal communication

Wooten, Rick, 2018 Webinar, *Updates on the NCGS's Landslide Mapping and Response Program; Lidar, Drones and Boots on the Ground*