1916 Lake Toxaway Dam Failure

Meeting and Field Trip to Gorges State Park,

Lake Toxaway, North Carolina

Talk by Tami Idol and Rick Wooten

Field Trip Led by Rick Wooten and Rebecca Latham

Talk and Dinner: October 8, 2004

Asheville, NC

Field Trip: October 9, 2004

Association of Engineering Geologists - Carolina Section

The Carolina Section of the Association of Engineering Geologists will hold a meeting and field trip in the beautiful North Carolina mountains on October 8 and 9, 2004. The speakers are Tami Idol, Asst. State Dam Safety Engineer, North Carolina Department of Environment and Natural Resources, and Rick Wooten, Senior Geologist for Geohazards and Engineering Geology, North Carolina Geological Survey. Rebecca Latham, Geologist for the NC Geological Survey, will assist Rick in leading the field trip.

Meeting:

Place:	Trevi Restaurant, 2 Hendersonville Rd., Asheville, NC
Date:	**Friday, October 8, 2004**
Time:	6pm social hour, 7pm dinner, 8pm speaker
Program:	1916 Lake Toxaway Dam Failure
Cost:	Member/Non-member $20, Student: $10

Field Trip:

Place: Meet in Asheville to caravan to the park at (see Directions at bottom of this email). It will take approximately one hour to get there.

High clearance vehicles will be necessary to drive on the gravel roads in the park. Please notify Jennifer Bauer when you register if you are willing to transport people into and out of the park.

Date:	**Saturday October 9, 2004**
Time:	9:00 am in Asheville
Program:	Field trip to Gorges State Park led by Rick Wooten and Rebecca Latham
Cost:	Member/Non-member: no charge, Student: no charge
Things to Bring:	Lunch will need to be brought by participants along with water. Bring raingear; this part of the state gets 82 inches of rain a year. This is peak leaf season in the Blue Ridge, so bring your camera.

Reservations: Please make reservations with Jennifer Bauer by Monday, October 4, 2004.
Phone: 919-831-8006
E-mail: jbbauer@mactec.com

Or you may also mail reservation to:
Jennifer Bauer
Mactec Engineering and Consulting, Inc.
3301 Atlantic Ave.
Raleigh, NC 27604

About the Speakers:

Tami Idol, E.I (NC) has been the Assistant State Dam Safety Engineer for the NC Department of Environment and Natural Resources Land Quality Section since April of 2001. Tami specializes in certification and inspection of dams in order to reduce the risk of failure of dams and to ensure maintenance of minimum stream flows of adequate quantity and quality below dams. From 1993 to 2001 Tami worked as a field geologist for the NC Department of Transportation conducting subsurface investigations and inspecting contractor sites. She graduated from NC State University with a B.S. in Geology in 1993.

Rebecca S. Latham has been a geologist at the N.C. Geological Survey in Asheville, NC specializing in slope stability studies and GIS since 2003. From 2002-2003 she worked as a Staff Geotechnical Engineer for QORE Property Sciences in Birmingham, AL monitoring and trouble shooting pile driving operations and conducting subsurface and slope stability analyses. While earning her M.E. from the Colorado School of Mines she worked as a U.S.G.S. Student Contract Worker in Golden CO working on remote, real-time monitoring of landslides. Her thesis topic was Remote Near Real-Time Monitoring of the DeBeque Canyon Landslide. Rebecca earned B.S in Geological Engineering from the University of Mississippi in 2000 and her M.E. in 2002.

Rick Wooten, L.G. (NC and OR) is a Senior Geologist for Geohazards and Engineering Geology for the N.C. Geological Survey in Asheville, NC. He specializes in geohazards studies (slope stability, mine collapse, sinkholes), geologic mapping, and low-level radioactive waste disposal. Before joining the Survey in 1990, Rick was with the U.S. Forest Service in Gifford Pinchot N.F., Washington in the Geotechnical Section. There he conducted geotechnical investigations

for slope stability, road design, bridge foundations, and quarry development and did geologic mapping and slope stability assessment for land-use planning. Rick earned his B.S. in 1973 and his M.S. in 1980 in Geology at the University of Georgia.

Rick was Chair of the AEG Carolina Section in 1995.

Abstracts:

The August 13, 1916 Lake Toxaway Dam Failure: A Retrospective from the Geologic Record in Gorges State Park, Transylvania County, North Carolina

Wooten, Richard M.[1], Rick.Wooten@ncmail.net
Latham, Rebecca S.[1], Rebecca.Latham@ncmail.net

Detailed geologic mapping of Gorges State Park by the North Carolina Geological Survey identified flood deposits along the Toxaway River attributed to the August 13, 1916 catastrophic failure of the Lake Toxaway dam. After withstanding two hurricanes in July 1916, the earthen dam failed following another hurricane that moved inland from the Gulf of Mexico. Rainfall from the third hurricane may have exceeded 500 mm (~20 in.) in the 24-hour period before the dam failed. The dam's failure mechanisms remain uncertain. Accounts of springs near the base of the dam suggest piping may have been a contributing factor. A report of a "four-foot tide" at the dam near the time of failure indicates floodwaters overtopped the dam.

Dr. S. W. McCallie, Georgia state geologist at the time stated, "An estimated 5,376,548,571 gallons of water changed hands." Although there were no reported human fatalities from the dam failure, the flood destroyed several homes and permanently changed the nature of the Toxaway River gorge. With the lake gone, the resort on Lake Toxaway closed, hurting the local economy for many years to come. Rebuilt in 1960-1961 the present dam is very near the original dam site.

Floodwaters from the dam failure torrent scoured 3.5 km (2.2 mi) of the gorge down to bedrock from Lake Toxaway downstream to Wintergreen Falls. Below Wintergreen Falls discontinuous boulder levees and sheet deposits occur along a 6 km (3.7 mi) reach of the river. Individual boulders up to 18 m (60 ft) long, and imbricated boulders confirm the deposits' floodwater origin. Crests of boulder levees stand 2-10 m (~6-30 ft) above the present river level, recording minimum floodwater elevations. Some boulder levees have two subparallel crests, with the lower crest nearer the river, while others have a lower terraced surface, also on the river side of the crest. Pulsed flow caused by debris dams forming and bursting as the floodwaters progressed downstream may have produced these composite overbank deposits. Post-1916 floods also may have modified the original geometry of the levees. A valley-fill, cobble-gravel-sand facies of the flood deposit underlies Lake Jocassee, and extends into South Carolina over 11 km (6.8 mi) downstream from the original dam. The flood deposits attest to first-hand accounts that a "30-foot wall of water thundered down the valley, and rocks as large as train cars rolled and tumbled down the mountain."

Subsequent studies have focused on estimating the velocity and discharge of the dam failure torrent by examining relict geologic and hydrologic evidence. Estimates of the outflow velocity made at four locations downstream from the dam range from ~85 km/hr (~53 mi/hr) to ~48 km/hr (~30mi/hr). Estimates of outflow velocities were calculated using the superelevation angle of the flow around channel bends, along with the channel's radius curvature and gradient. At a location just below the dam the outflow discharge was calculated to be ~8,316 m^3/sec (~293,683 ft^3/sec). This contrasts with 65,129 m^3/sec (~2.3 million ft^3/sec) peak discharge from the 1976 Teton dam failure, and ~24 m^3/sec (~840 ft^3/sec) peak discharge from the 1977 Kelly Barnes dam failure in Toccoa, Georgia.

Other impacts of the flood torrent are still visible. Erosive floodwaters truncated colluvium and tributary alluvial fan deposits along toe slopes, triggering rockfall, debris slides, and a still-active 1.6-hectare (4 acre) weathered-rock slide. The 1916 boulder deposits locally constrict the channel of the Toxaway River and divert its tributaries. A 51,200 m^3 (67,000 yd^3) cobble-boulder deposit immediately upstream of the present confluence of Bearwallow Creek with the Toxaway River may have diverted the original confluence 60 m (200 ft) or more downstream along the Toxaway River.

Tree ring analyses of increment borings from Tsusga canadensis (eastern hemlock), Pinus strobus (white pine) and Pinus rigida (pitch pine) support a 1916 origin for the flood deposits. Of the five large trees sampled that were growing on the flood deposits, the oldest beginning growth year was 1917. Increment cores extracted from a curved Tsuga canadensis and an Acer rubrum (red maple) on the active 1.6 hectare (4 acre) weathered-rock slide, probably triggered by the flood torrent, indicate a period of slide movement from about 1965-1974. Tree rings show a decreased relative tree growth rate during the mid-1960's through the mid-1970's for both slide trees, but not in a nearby control tree (Tsusga canadensis) off the slide, suggesting a significant period of sliding occurred during this time. The slide trees record slide movement as a decrease in growth ring thickness due to a decrease in water and nutrient uptake caused by disruption of the root-soil interface during slide movement. Conversely, the increased relative tree growth rate in the control tree during the same time period corresponds to a period of above average precipitation that probably triggered this episode of slide movement.

The flood deposits and features preserved in Gorges State Park provide a modern analog for sedimentological and hydrologic studies of ancient catastrophic flood events in mountainous terrain. The N.C. Division of Parks and Recreation plan to incorporate some of these geologic and hydrologic features into the Park's interpretive programs to help illustrate man's impact on the landscape.

[1]North Carolina Geological Survey, 2090 U.S. Hwy. 70, Swannanoa, N.C., 28778
tel. 828-296-4500

Tami Idol will supplement the above talk with modeling a worst case failure by using the present Toxaway Dam to calculate the failure outflow. She will then compare her results to Rick's estimate of the velocity and volume of water that caused such extreme erosion in the Toxaway gorge.

Field trip to Gorges State Park, Transylvania County, North Carolina

The field trip to Gorges State Park will highlight some the surficial deposits, and active geologic processes recently mapped in the Park by the North Carolina Geological Survey. Encompassing 15 square miles within the steep, dissected terrain of the Blue Ridge Escarpment, the Park sits astride the Brevard fault zone. The scenic Toxaway River Gorge cuts through the Park from Toxaway Falls, downstream to Lake Jocassee.

The field trip will include a stop at Toxaway Falls just below the Lake Toxaway dam. Here we will examine an exposure of the Toxaway Gneiss, and discuss estimates of the outflow velocity and discharge from the August 13, 1916 catastrophic failure of the Lake Toxaway. Inside the Park we will see flood torrent deposits from the dam failure, and an active, 4-acre landslide along the Toxaway River. Many features along the Toxaway River's course through the Park can be attributed to the flood torrent. The scoured bedrock channel of the upper Toxaway River Gorge, and the boulder levees mapped downstream attest to first-hand accounts that a "30-foot wall of

water thundered down the valley, and rocks as large as train cars rolled and tumbled down the mountain."

The field trip will be in two, roughly half-day, parts. For the first part we will travel by vehicle to Toxaway Falls, and then through the Park to the Toxaway River. At the river we will see imbricate boulder deposits from the 1916 dam failure flood**. *** Those not wishing to take part in the second half of the trip can depart by vehicle and drive back to the Park entrance. For the second half we will hike upstream along the Toxaway River to Wintergreen Falls. The round trip hike will take about three hours, mostly along a trail, but with one short section of scrambling along a steep slope. Hikers should wear good hiking boots and bring raingear, just in case.

Along the way to Wintergreen Falls we will stop at an active landslide (weathered-rock slide) that was probably triggered by the dam failure torrent. Detailed mapping of the landslide, along with tree-ring studies, helped to assess its extent, and its movement rate and history. Mylonitic rocks, exposed at the slide, delineate the fault contact between 1.2 billion year-old Toxaway Gneiss, and the 500-600 million year old metasedimentary rocks of the Tallulah Falls Formation. From the landslide we will proceed upstream to Wintergreen Falls. Near the falls we will see a 20-foot high boulder levee deposited by the 1916 flood.

If time and interest allows, on the return trip out of the Park, we can stop at an exposure of the Rosman fault. Brecciated phyllonites along the fault separate the Brevard zone rocks from the Tallulah Falls Formation. The side trip to the Rosman fault is a quarter-mile hike along a steep trail, past two waterfalls, with a short stretch of stream-hopping.

***Note:** This would be a good place to have lunch. Folks who want to lunch during the field trip should bring their food and water.

Other Important Info:

Hotels: There are several hotels and campgrounds near the restaurant and Saturday meeting A few suggestions:

Holiday Inn Express, 234 Hendersonville Rd. 800-465-4329
Baymont Inn, 204 Hendersonville Rd. (828) 274-2022
Sleep Inn, 117 Hendersonville Rd. (828)277-1800
Howard Johnson, 190 Hendersonville Rd. (828)274-2300
Days Inn Asheville Mall, 201 Tunnel Rd (828)252-4000

Campgrounds:

North Mills River, Pisgah District, Asheville (828)890-3284
Davidson River, Pisgah District, Brevard (828) 862-5960

Please make your accommodation reservations early as this is a busy time in Asheville.

Directions:

Trevi Restaurant

2 Hendersonville Road.
Asheville, NC 28803

From the East:

Take I-40 to exit 50b (US 25 N). Turn right (north) onto Hendersonville Road. Continue 0.6 miles, Trevi is on the right.

From the West:

From I-40 take Exit 50 (US 25 North). Turn left (north) onto Hendersonville Road. Continue 0.7 miles, Trevi will be on the right.

Meeting place for field trip Saturday morning:

We will meet at the Waffle House off of I-26 near the Asheville Airport. Take I-26 to the Asheville Regional Airport exit, Exit 40. At the ramp, go west onto Airport Rd (hwy 280) away from the airport. Continue on Airport Road approximately 2 miles, Waffle House is at the intersection of Hwy 25 and Airport Rd.

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Association of Engineering Geologists - Carolina Section

Registration Deadline is Monday October 4, 2004

Name:_____

Organization:_____

Address:_____

Phone: _____

Email:_____

Please mail your registration to Jennifer Bauer, 3301 Atlantic Ave. Raleigh, NC 27604. Questions? Call Jennifer at (919) 831-8006 or email at jbbauer@mactec.com