



NORTH CAROLINA GEOLOGICAL SURVEY
DIVISION OF LAND RESOURCES
DEPARTMENT OF ENVIRONMENT AND NATURAL RESOURCES

MAP OF KNOWN AND POTENTIAL DEBRIS FLOW PATHWAYS IN WATAUGA COUNTY, NORTH CAROLINA

FOR SHALLOW TRANSLATIONAL SLOPE MOVEMENTS

By
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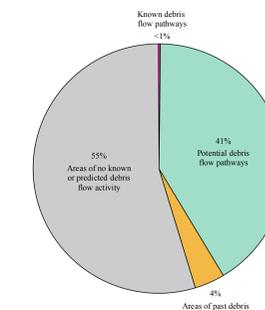
GEOLOGIC HAZARDS MAP SERIES 3
SLOPE MOVEMENT HAZARD MAPS OF WATAUGA COUNTY, NC
SHEET 3 OF 4, VERSION: MARCH 18, 2008

EXPLANATION

Map Symbols	Map Unit Designation	Description	OTHER MAP SYMBOLS
	Initiation zones of shallow, translational slope movements on unmodified slopes		
	Known debris flow pathways	Areas that lie within the pathways of mapped recent debris flows and other shallow, translational slope movements (those occurring in 1940 or later).	
	Potential debris flow pathways	Areas that lie within the predicted flow paths of debris flows and other shallow, translational slope movements that could potentially initiate within the unstable and upper threshold (high hazard) predicted stability zones of the Stability Index Map.	
	Areas of past debris flow activity	Areas of mapped slope movement deposits. Because slope movements have previously deposited material at these locations, future deposition of slope movement materials could occur in these areas again.	
	Areas of no known or predicted debris flow activity	Areas located outside of the predicted flow paths of potential debris flows and other shallow, translational slope movements, and outside of the mapped extents of slope movement deposits.	
		Slope movements may result from the modification of slopes in this map unit.	

Table 1. Definitions and explanation of map unit designations.

PERCENTAGE OF WATAUGA COUNTY WITHIN EACH MAP UNIT DESIGNATION



OVERVIEW OF THE POTENTIAL DEBRIS FLOW PATHWAYS MAP

Introduction
In response to the number of slope movements (landslides) and the destruction caused by the remnants of Hurricane Frances and Ivan in western North Carolina in September 2004, the North Carolina General Assembly authorized the North Carolina Geological Survey (NCGS) to produce landslide hazard maps for 19 western counties. Watauga County was selected as the second county to be mapped after Macon County because of the large number of landslides and the 14 landslide deaths associated with the August 13-14, 1940 storm, and the fast-growing population potentially at risk from slope movements. The intent of the landslide hazard mapping program is to provide the public, local government and local and state emergency agencies with a description and location of areas where slope movements have occurred, or are likely to occur, and the general areas at risk from these slope movements. The locations of previous slope movements are important because they often occur in the same general areas. This predictive mapping is not intended to be a substitute for a detailed, onsite analysis by a qualified geologist or engineer.

The slope movement hazard map series for Watauga County consists of four maps, Geologic Hazards Map Series 3 (GHMS-3) Sheets 1, 2, 3, and 4 designed to be used in conjunction with each other. This map is Sheet 3. The accompanying maps are: Sheet 1, Slope Movement and Slope Movement Deposit Map of Watauga County, North Carolina; Sheet 2, Stability Index Map of Watauga County North Carolina; and Sheet 4, Map Showing the Zone of Potential Rock Slope Instability with the Generalized Bedrock Geologic Compilation.

Map of Known and Potential Debris Flow Pathways (Geologic Hazards Map Series 3, Sheet 3).
This color-coded map portrays areas that could potentially be affected by debris flows or other shallow, translational slope movements such as debris-earth slides and flows. Designated units on this map are: known debris flow pathways, predicted debris flow pathways, areas of past debris flow activity, and areas of no known or predicted debris flow activity. The Stability Index Map shows areas where shallow translational slope movements are more likely to originate in response to a 3-inch (125-mm) or greater recharge event within a 24-hour period. The Map of Known and Potential Debris Flow Pathways delineate areas likely to be in the path of these slope movements should they occur, including areas significantly further downslope from where the slope movements originate. Table 2 shows the color codes used on the map with explanations that correspond to the map unit designations.

The Potential Debris Flow Pathways Map is intended to indicate the distribution of areas that could potentially be affected by debris flows or other shallow, translational slope movements. In these locations, further slope stability analysis, including field verification, is recommended prior to siting facilities or undertaking ground-disturbing activities.

Map Production
The Map of Known and Potential Debris Flow Pathways is derived from two sources:
1. Outlines of debris flow tracks and slope movement deposits from the Slope Movements and Slope Movement Deposit Locations Map; and
2. High hazard areas of the Stability Index Map.

The following sequential steps outline the method used to reduce the areas of predicted debris flow pathways using a 20 ft (6 m) LIDAR-derived DEM.
1. High hazard areas from the Stability Index Map greater than 0.25 acres (10,893 ft² or 1,012 m²) were designated as the most likely source areas for slope movements that could affect areas downslope.

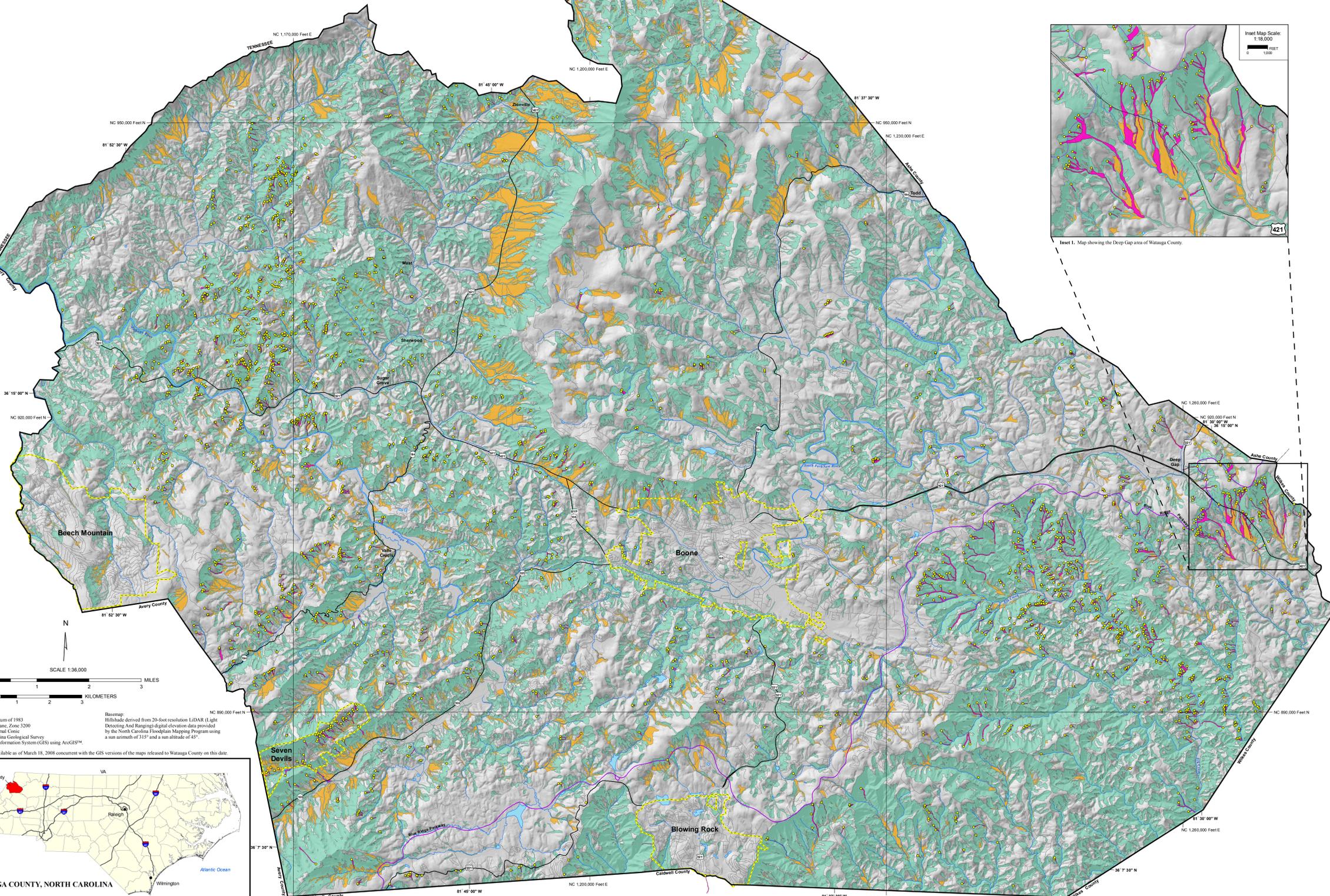
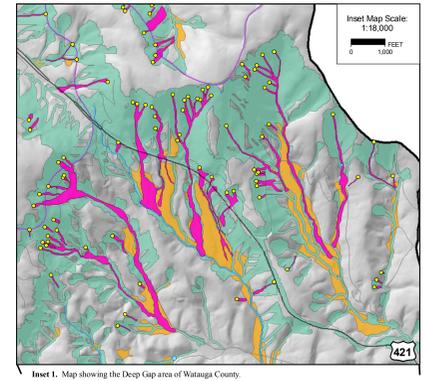
2. Hydrologic flow paths based on topographic gradients and streams mapped by the North Carolina Stream Mapping Project were then created in ArcGIS™ from points placed on a 20 ft (6 m) grid constructed from the high hazard areas on the Stability Index Map.
3. Flow paths were terminated once they encountered slope gradients less than three degrees for contiguous areas >0.25 acres (10,893 ft² or 1,012 m²). Three degrees was selected as a nominal gradient consistent with the lowest downslope extent of most slope movement deposits and tracks delineated in the accompanying Slope Movements and Slope Movement Deposits Location Map.
4. These flow paths were then buffered to 33 ft (10 m) on all sides to delineate the predicted debris flow pathways. This buffer approximates the average track width of mapped debris flows in Watauga County. Note: In some cases the automated 33-ft (10m) buffering routine may extend the predicted debris flow pathways slightly upslope and over ridge tops above debris flow source areas.

Manual editing of the digital map was required to adjust the downstream extents of the predicted debris flow pathways in order to terminate unrealistic flow paths where warranted. These adjustment procedures are outlined as follows:
1. Flow paths that originated on man-made cut slopes were terminated near the base of the cut.
2. Flow paths were terminated before flowing over dams.
3. In some instances, errors in the LIDAR data did not represent "bare-earth" topography. Flow paths that originated from these features were removed.

Map Unit Designations
Known debris flow pathways. Areas that lie within the pathways of mapped recent debris flows (those occurring in 1940 or later).
Potential debris flow pathways. Areas that lie within the predicted flow paths of debris-earth slides and flows that potentially initiate in the unstable and upper threshold predicted stability zones of the Stability Index Map. Slope movements that initiate on slopes destabilized by modification within these high hazard zones may also follow similar flow paths.
Areas of past debris flow activity. Areas mapped as slope movement deposits (Slope Movements and Slope Movement Deposits Map) outside the areas of predicted flow paths are designated as areas of past debris flow activity. Debris flows and other slope movements have previously deposited material at these locations. For this reason future slope movements could occur in these areas; however, it is more likely that future debris flows will affect areas of known and predicted debris flow pathways. Additionally, a potential hazard exists for slope movement deposits because they typically consist of deep, unconsolidated accumulations of clay- to boulder-sized material that can be unstable in high, steep-sided excavations, and in areas over-stepped by stream erosion.
Areas of no known or predicted debris flow activity. Areas outside of the predicted flow paths of potential debris-earth slides and flows, and mapped slope movement deposits. There is a low likelihood of damage in this area from slope movements that originate from outside of this area. Slope movements may result from the modification of slopes in these areas.

ACKNOWLEDGEMENTS

The North Carolina Geological Survey gratefully acknowledges assistance and information furnished by local government agencies in Watauga County. Special thanks go to the residents of Watauga County for their willingness to provide information and property access. The North Carolina Department of Transportation - Geotechnical Engineering Unit, the North Carolina Floodplain Mapping Program, the U.S.D.A. Forest Service, and the U.S. Geological Survey supplied much useful data and assistance. Reviews and comments on the draft maps and on the field by Louis Acker, Andy Bobrovich, Bert Cattanach, Jack Callahan, Carl Mensch, Hugh Mills, Loren Raymond, Katherine Scherer, Keith Scribner, Jim Simons and Kenneth Taylor greatly improved the product. Mike Medina and John Nickerson contributed GIS and cartographic support, and the North Carolina Center for Geographic Information and Analysis, Department of Environment and Natural Resources provided contractual assistance.



Map Information:
Datum: North American Datum of 1983
Projection: Lambert Conformal Conic
Coordinate System: State Plane, Zone 3200
Cartography by North Carolina Geological Survey
Produced in a Geographic Information System (GIS) using ArcGIS™

Based on information and data available as of March 18, 2008 concurrent with the GIS versions of the maps related to Watauga County on this date.

Backsight: Hillshade derived from 20-foot resolution LIDAR (Light Detecting And Ranging) digital elevation data provided by the North Carolina Floodplain Mapping Program using a sun azimuth of 315° and a sun altitude of 45°