



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

FOR SHALLOW TRANSLATIONAL SLOPE MOVEMENTS

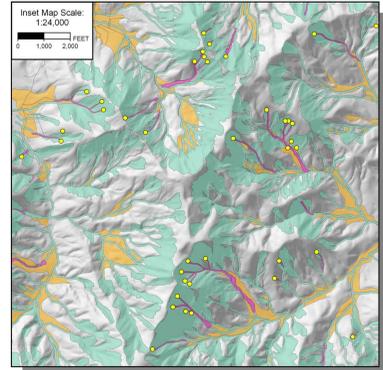
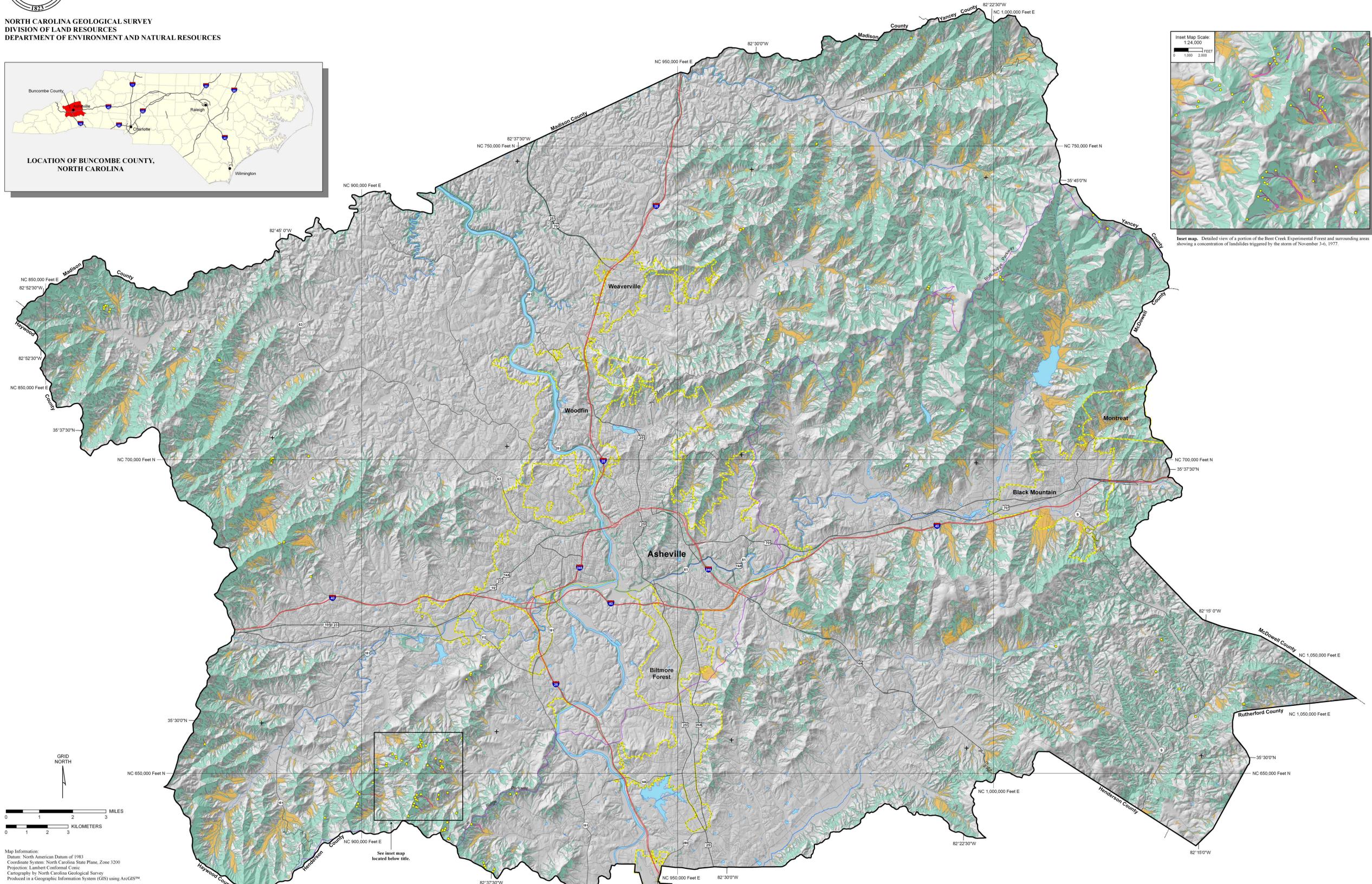
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NORTH CAROLINA GEOLOGICAL SURVEY
DIVISION OF LAND RESOURCES
DEPARTMENT OF ENVIRONMENT AND NATURAL RESOURCES

GEOLOGIC HAZARDS MAP SERIES 4
SLOPE MOVEMENT HAZARD MAPS OF BUNCOMBE COUNTY, NORTH CAROLINA
SHEET 3 OF 3, VERSION: AUGUST 24, 2009



LOCATION OF BUNCOMBE COUNTY, NORTH CAROLINA



Inset map. Detailed view of a portion of the Bent Creek Experimental Forest and surrounding areas showing a concentration of landslides triggered by the storm of November 3-6, 1977.

EXPLANATION

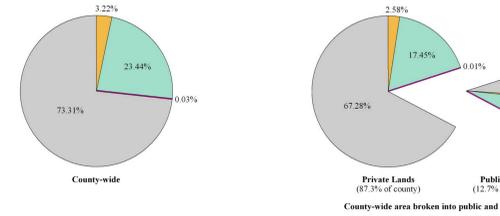
Map Unit Designation	Description
Known debris flow pathways	Areas within the pathways of known mapped recent debris flows (those occurring circa 1951 or later).
Potential debris flow pathways	Areas within the potential flow paths of debris flows and other shallow, translational slope movements that could potentially initiate within the unstable and upper threshold (high hazard) stability zones predicted on 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 outside the areas of potential 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 also affect these areas.
Areas of no known or potential debris flow activity	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-steeped by stream erosion.
	Areas that are outside of the known and potential debris flow pathways as well as outside the mapped extents of past debris flow activity. Damage is unlikely in these areas from natural slope movements that originate from within the other map units.
	While these areas are unlikely to be damaged by debris flows or other shallow, translational slope movements, modification or alteration of slopes in this map unit could result in slope movement activity.

Table 1. Definitions and explanation of map unit designations.

OTHER MAP FEATURES

- Selected slope movement initiation zones
- Interstates
- Primary Roads
- Secondary Roads
- Blue Ridge Parkway
- Rivers
- Major Rivers
- Minor Rivers
- Lakes
- Municipal boundaries
- Buncombe County boundary

RELATIVE PERCENTAGES OF PUBLIC AND PRIVATE LANDS WITHIN EACH MAP UNIT DESIGNATION



OVERVIEW OF THE POTENTIAL DEBRIS FLOW PATHWAYS MAP

Introduction
The North Carolina General Assembly authorized the North Carolina Geological Survey (NCGS) to produce landslide hazard maps for 19 western counties in response to the number of slope movements (landslides) and destruction caused by the remnants of Hurricanes Frances and Ivan in western North Carolina in September 2004. The intent of the Landslide Hazard Mapping program is to provide the public, local government, and local and state emergency agencies with a planning tool that describes and locates areas where slope movements have occurred, or are likely to occur, and the general areas at risk from these slope movements. The location of previous slope movements are important because slope movements often recur in the same general areas. This mapping is not intended to be a substitute for a detailed, onsite analysis by a qualified geologist or engineer.

Map of Known and Potential Debris Flow Pathways (Geologic Hazards Map Series 4, Sheet 3)
This color-coded map portrays areas that potentially could be affected by debris flows or other shallow, translational slope movements. The Stability Index Map (Sheet 2) shows areas where shallow translational slope movements are more likely to originate in response to a rain event producing recharge to the shallow groundwater system of at least 1 inches (approx. 25 millimeters) in a 24-hour period. The Map of Known and Potential Debris Flow Pathways delineates areas likely to be in the path of these slope movements if they do occur. The pathways include areas significantly further downslope from where the slope movements may initiate. Designated units on this map are: known debris flow pathways, potential debris flow pathways, areas of past debris flow activity, and areas of no known or potential debris flow activity. Table 1 shows the color codes used on the map with explanations that correspond to the map unit designations.

The Map of Known and Potential Debris Flow Pathways indicates the distribution of areas that could potentially be affected by debris flows or other shallow, translational slope movements given the conditions on the ground at the time the map was made. Changes in the landscape as a result of human activity and future debris flows and other types of landslides can alter the potential pathways of subsequent debris flows; therefore, the map represents the general areas that could potentially be affected by debris flows and other shallow translational slope movements. In these locations of known, potential, and past debris flow activity, further slope stability analysis, including onsite field investigation, is recommended prior to siting facilities or undertaking ground-disturbing activities.

The slope movement hazard map series for Buncombe County consists of three maps (Geologic Hazards Map Series 4 (GHMS-4, Sheets 1, 2, and 3) designed to be used in conjunction with each other. This map is Sheet 3. The accompanying maps are: Sheet 1, Slope Movements and Slope Movement Deposits Map of Buncombe County; and, Sheet 2, Stability Index Map of Buncombe County, North Carolina.

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 Deposits Map
2. High hazard areas of the Stability Index Map
The following sequential steps outline the method used to produce the areas of potential debris flow pathways using a 20-foot (6-meter) LIDAR-derived DEM.
1. High hazard zones from the Stability Index Map with areas greater than 0.25 acres (approx. 10,900 feet² or 1,000 meters²) were assumed to be the probable source areas for slope movements that could affect areas downslope (i.e., high hazard areas less than 0.25 acres were eliminated as source areas).
2. Hydrologic flow paths, based on topographic gradients and streams mapped by the North Carolina Stream Mapping Project, were created in ArcGIS[®] from points placed on a 20-foot (6-meter) square 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 (approx. 10,900 feet² or 1,000 meters²)). Three degrees was selected as a nominal slope gradient consistent with the lowestmost downslope extent of most slope movement deposits and tracks delineated in the accompanying Slope Movements and Slope Movement Deposits Map.
4. Flow paths were buffered to 33 feet (10 meters) on all sides to delineate the potential debris flow pathways. This buffer approximates the average track width of mapped debris flows in Buncombe County. Note: In some cases the automated 33-foot (10-meter) buffering routine may extend the potential 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 potential debris flow pathways to arbitrarily terminate flow paths deemed to be unrealistic in most cases. Adjustments included:
1. Terminating flow paths when they encountered the 500-year floodplain boundary as mapped by the North Carolina Floodplain Mapping Program.
2. Terminating flow paths that originated on man-made cut slopes near the base of the cut.
3. Removing flow paths that originated on dams or aggregate stockpiles.
4. Terminating flow paths where they encountered water bodies such as ponds and lakes.

ACKNOWLEDGEMENTS

The North Carolina Geological Survey would like to thank Buncombe County Government for their assistance and cooperation. Special thanks go to the residents of Buncombe County for their willingness to provide information and property access. The North Carolina Department of Transportation - Geotechnical Engineering and Materials and Tests Units, the U.S.D.A. Forest Service and Natural Resources Conservation Service provided much useful data and assistance. Brooks Engineering Associates, P.A., provided valuable information on soil types and hydraulic conductivity for sites in Buncombe County. Field and map reviews and comments by Nick Bozdog, Ted Campbell, Juan Cattanach, James Conner, Landon Davidson, Dave Kinner, Brett Laverty, Carl Mersch, J.W. Miller, William Miller, Hugh Mills, Kate Scherer, James Simons, Chip Smith, Kenneth Taylor, Cheryl Waters-Torney, and Leonard Wiener greatly improved the maps. The North Carolina Center for Geographic Information and Analysis provided contractual assistance.

Map Information:
Datum: North American Datum of 1983
Coordinate System: North Carolina State Plane, Zone 2200
Projection: Lambert Conformal Conic
Cartography by: North Carolina Geological Survey
Produced in a Geographic Information System (GIS) using ArcGIS[®].

Basemap:
Hillshade derived from 30-foot resolution LIDAR Light Detecting and Ranging digital elevation data provided by the North Carolina Floodplain Mapping Program using an artificial sun azimuth of 315° and a sun altitude of 45°.

Based on information and data available as of August 24, 2009; concurrent with the GIS versions of the maps released to Buncombe County on this date.