

Building sustainably – it starts with the land

□ BY JENNIFER BAUER □

Meet Mr. and Mrs. Green (not their real names). They are a loving couple in their early 70s who bought their dream retirement home in the mountains of Western North Carolina a few years ago. They poured their savings into moving from the muggy summers of Florida into the crisp cool mountain air year-round. Their two-story home with a nice deck and mountain views sits atop a steep gravel driveway. They didn't want much landscaping maintenance, so were fine with having a steep slope as their front yard. Despite some unexpected health problems for Mr. Green, they were enjoying their retirement in WNC.

Then came the rains of 2013, the wettest year on record. Mrs. Green started noticing cracks in their driveway, which then became scarps, as the outer edge of the fill slope started dropping down. After every rain, more and more of the edge would slide down and away, preventing them from using the parking area near their garage. They even started noticing cracks in their basement garage and foundation (see photo, right).

Fortunately, one of their neighbors had an excavator and volunteered to help them repair the slope. As he dug down into the failing fill material, he found trash and actual car parts buried within the slope. The Greens had bought the place under the assumption that it had been constructed soundly. Unfortunately, they were wrong.

The right site

Many times, when people mention "sustainable building," what comes to mind are solar panels, energy efficiency, and recycled materials. What many don't realize is that sustainability starts with the suitability of the land on which the home is built. The Green's story is only one of many homes, driveways, and roads that have been con-

structed in a place and/or manner that doesn't take this into account.

One of the things that makes building in the mountains unique from building elsewhere is our need to consider the natural processes constantly reshaping our mountain landscape. Landslides have been a dominant force in the evolution of the Appalachian Mountains for millions of years, and will continue to be until there are no mountains left. As inhabitants of this naturally shifting landscape, we must make ourselves aware of these potential hazards and strive to live here safely and sustainably.

As in the case of the Greens, most of the landslides that happen in WNC are triggered by an abundance of water on the slope. Typically this is from long periods of wet weather causing high antecedent moisture conditions, followed by intense bursts of rain, similar to the rains in January, May, and July of 2013. Other times, it is back-to-back large storm systems that drop many inches of rain at a time. In September 2004, the remnants of Hurricanes Frances and Ivan passed over WNC, creating up to 22 inches of rain in a 10-day period, and triggering hundreds of landslides. Landslides can also be triggered from severe thunderstorms with extremely heavy rainfall. Other times, the water is from a human-caused situation, like a broken water line, or poor storm water management. In all cases, the soil or rock is oversaturated with water, and it slides or flows down the slope.

In North Carolina, we know of over 3,500 landslides that have happened since 1916 (from database inventories at Appalachian Landslide Consultants, PLLC (ALC), and the North Carolina Geological Survey (NCGS), as of July 2015). The majority of these (approximately 70 percent) started on natural slopes, or slopes that had not been modified by construction activities (see photo).

Over 2,000 of these happened in Watauga County in August 1940, when the remnants of an Atlantic



Cracks in the home foundation. Photo by Appalachian Landslide Consultants, PLLC

A home can have the highest LEED certification and be as green as possible, but if the house or its driveway slides off of the mountain all the painstaking efforts to reduce its environmental impact will be negated.



Left: Long Branch natural debris flow, Maggie Valley, Jan. 15-16, 2013. Above: Road embankment failure/debris flow, Maggie Valley, Jan. 15-16, 2013. Photos by Appalachian Landslide Consultants, PLLC

Learn more:

- The NCGS Landslide Hazard Maps are available for Macon, Watauga, Buncombe, and Henderson Counties on the NCGS's website www.portal.ncdenr.org/web/lr/landslides-information.
- You can view a web map version of the Buncombe County maps on the county's GIS site www.gis.buncombecounty.org/buncomap/Map_All.html.
- ALC has mapped sub-watersheds in Haywood and Jackson counties with grant funding from area non-profits. An online map viewer of these areas is available on ALC's website www.appalachianlandslide.com.

hurricane brought an average of 12 to 13 inches of rain to the area in a week. Watauga County is one of the four counties that was completed during the NCGS landslide hazard mapping program from 2005-2011. Had the surrounding counties also been mapped, the number of landslides would certainly be much higher.

Since the 1940 storms and the recent population growth in WNC, we have seen a shift from the majority of landslides starting on natural, unmodified slopes, to the majority of landslides (67 percent) starting on modified, constructed slopes. We are seeing that the amount of rainfall it takes to trigger landslides on marginally stable constructed slopes is less, sometimes much less, than the amount of rain it takes to trigger natural landslides.

Of landslides from the 2013 rains, 133 out of 135 landslides that ALC mapped in were on modified slopes. Many were fill slopes or road embankments built on steep slopes near natural drainages. Often times these fill slope failures send debris directly into streams, filling them with sediment and impacting water quality (see photo,

above). A typical road embankment failure moves about 400 cubic yards of soil, or the equivalent of 20 dump truck loads.

These modified slope failures are the landslides that can be prevented with thorough evaluation of the property before development, proper design and construction of the slopes, and continued maintenance of stormwater drainage systems. In the past several years, some mountain counties have taken steps to help minimize or prevent modified slope failures with slope development ordinances which establish minimum requirements for designing and constructing on steep slopes. While these ordinances will help, they are not present in much of WNC and they only apply to new construction.

Check it out

WNC will continue to be a place where people want to live, and development will continue. We know that the potential for landslides exists in the mountains, and that they don't happen everywhere. An evaluation of property by a licensed

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geologist or other professional familiar with landslides in the mountains will help with siting new homes and roadways in places less likely to be impacted by natural landslides. These evaluations can also identify areas that are marginally stable in their natural condition and will need proper engineering design before construction to prevent a constructed slope failure. If purchasing an existing home in the mountains, it is wise to have it evaluated as well to ensure it was not built in harm's way and it is not showing signs of instability.

To help the public with identifying the areas with a higher potential for landslides, the NCGS (during the landslide mapping program) and ALC have created landslide susceptibility maps for some areas of WNC. These maps can be used to screen properties or pick out certain portions of a property that might be safer than others. If the property you wish to purchase is in a landslide prone area, which indicates the need for a site specific evaluation.

A home can have the highest LEED certification rating, and be as green as possible, but if the house or its driveway slides off of the mountain, all the painstaking efforts to reduce its environmental impact will be negated. It is in everyone's best interest to consider that sustainability starts with the suitability of the land. Mr. and Mrs. Green would agree with that.

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