Kentucky Geological Survey
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UNIVERSITY OF KENTUCKY, LEXINGTON

MAP AND CHART 180
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Generalized Geologic Map for Land-Use Planning: Harlan County, Kentucky

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Acknowledgments

Geology adapted from Crawford (2003), Johnson (2003), Martin (2003), Mullins (2003a, b), Mullins and Murphy (2003), Sparks (2003a–f), Toth (2003),Toth and Sparks (2003). Petersen (2004), Morris and others (2005a, b). Thanks to Paul Howell, U.S. Department of Agriculture, Natural Resources Conservation Service, for photos. Thanks to Meg Smath, Kentucky Geological Survey, for editorial improvements. Thanks to Kim and Kent Anness, Kentucky Division of Geographic Information, for base-map data.

Harlan County Courthouse at Harlan

Harlan County, 467 square miles of the most rugged terrain in the Eastern Kentucky Coal Field, was formed in 1819. Great mountain ridges, including Pine Mountain, cross the county from southwest to northeast. All communities are in narrow, level valley bottoms. The highest elevation in Kentucky, 4,145 feet, is a peak on Black Mountain about 3 1/2 miles south-southeast of Lynch. The lowest elevation in the county, 1,070 feet, is where the Cumberland River leaves the county. The 2006 population of 31,257 was 5.6 percent smaller than that of 2000. Photo by Dan Carey, Kentucky Geological Survey.

Cumberland River at Loyall

The Cumberland River and its tributaries define the settlement patterns in the county. Flooding has been a historical problem. Cutoffs such as this one in Loyall, although preventing flooding, leave isolated meanders (below) that may create unanticipated secondary impacts. Photos by Dan Carey, Kentucky Geological Survey.

Natural Beauty

Harlan County is blessed with natural beauty, whether the sandstone formations like Log Rock in Kingdom Come State Park (above) or butterflies in the sunshine along the ridgetops (below). Photos by Dan Carey, Kentucky Geological Survey.

Nature's Playground

In an attempt to diversify its economy, eastern Kentucky is promoting itself as "nature's playground." Harlan County has miles of off-road sport vehicle and hiking trails, campsites, and spectacular ridgetop views. Photos by Dan Carey, Kentucky Geological Survey.

Kudzu

Kudzu, named after the area of its origin in Japan, grows to impressive displays throughout southeastern Kentucky. It can grow 12 inches in a day, or 60 feet in a season. The nonwoody parts are edible. Photo by Dan Carey, Kentucky Geological Survey.

Sandstone (Unit 9)

The difficulties of sandstone excavation can be imagined when looking at the 300-million-year-old Bee Rock Sandstone Member (unit 9) of the Lee Formation exposed along U.S. 421 near the base of Pine Mountain. Photo by Dan Carey, Kentucky Geological Survey.

Shale (Unit 7)

Shale (unit 7) weathers quickly and exhibits a characteristic crumbly appearance when exposed, as seen in this roadcut on Ky. 160. Photo by Dan Carey, Kentucky Geological Survey.

Construction on Slopes

Construction on slopes underlain by shale require additional support for stability. Photos by Dan Carey, Kentucky Geological Survey.

Landslides

Hillside construction can cause earth movements if not properly planned. Photos by Paul Howell, U.S. Department of Agriculture, Natural Resources Conservation Service.

Landslides

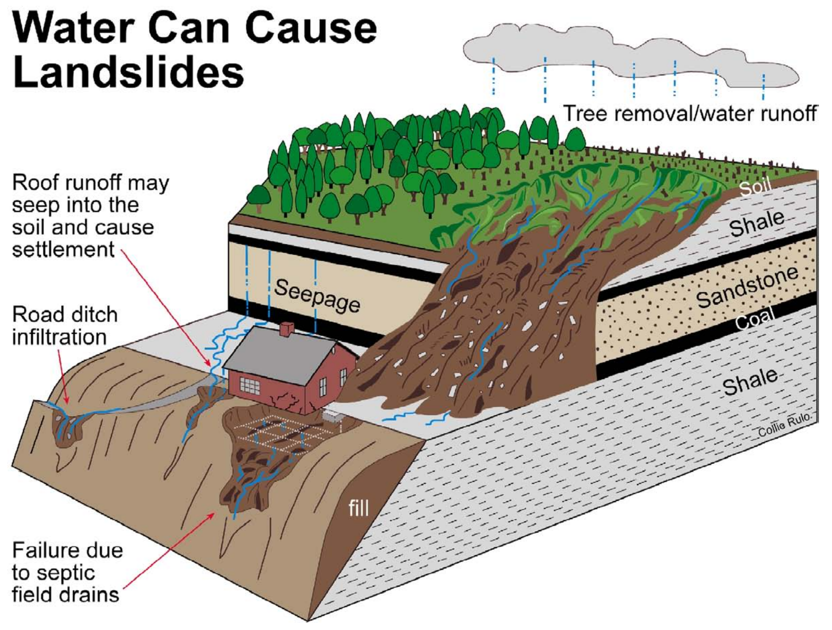
Virtually all units containing shale on slopes are subject to landslides. Shales will break down and weather rapidly when exposed to air and water. Gravity is the main driving force, but water nearly always plays a critical role by adding weight and lubricating the shale. Cutting into or overloading a slope with structures and fill can also be major contributing factors. The failure of the slope may be rapid, but more commonly is a slow, almost imperceptible movement, called creep, of a few inches per year. Whether rapid or slow, the end results and damage are similar and costly: broken plumbing, cracked walls and foundations, cracked streets and sidewalks, and commonly, total loss of the structures.

Precautions include taking care of all surface-water runoff by making certain that all runoff from roofs, gutters, patios, sidewalks, and driveways is carried well away from and not toward the house; diverting drainage from areas sloping toward the house; cutting into natural slopes as little as possible and avoiding the use of fill; and trying to place the foundation of the structure on undisturbed bedrock. When in doubt, consult an engineering geologist or a geotechnical engineer.

What Are the Factors That Cause Landslides?

Many factors contribute to landslides. The most common in eastern Kentucky are:

1. Steep slopes: Avoid when choosing a building site.
2. Water: Slope stability decreases as water moves into the soil. Springs, seeps, roof runoff, gutter downspouts, septic systems, and site grading that cause ponding or runoff are sources of water that often contribute to landslides.
3. Changing the natural slope by creating a level area where none previously existed.
4. Poor site selection for roads and driveways.
5. Improper placement of fill material.
6. Removal of trees and other vegetation: Site construction often results in the elimination of trees and other vegetation. Plants, especially trees, help remove water and stabilize the soil with their extensive root systems.



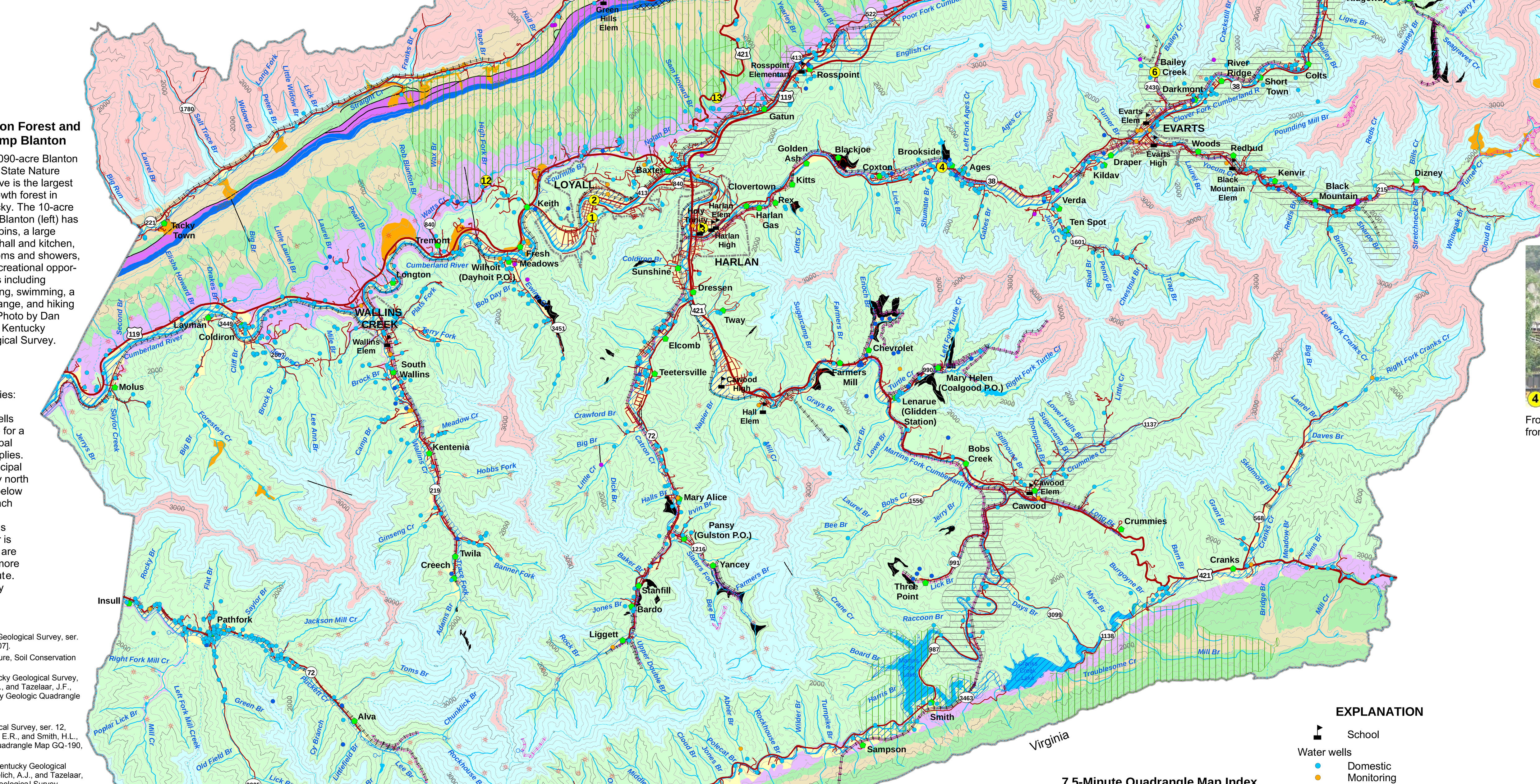
What Are Some Ways to Prevent Landslides?

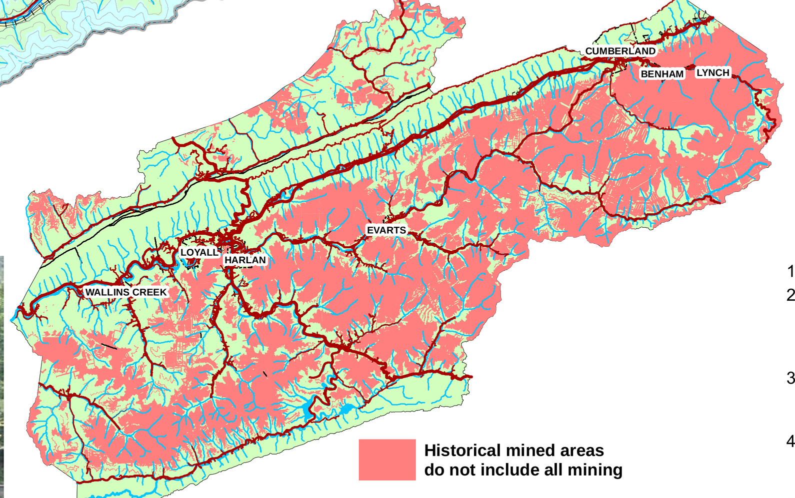
1. Seek professional assistance prior to construction.
2. Proper site selection: Some sloping areas are naturally prone to landslides. Inspect the site for springs, seeps, and other wet areas that might indicate water problems. Take note of unusual cracks or bulges at the soil surface. These are typical signs of soil movement that may lead to slope failure. Also be aware of geologically sensitive areas where landslides are more likely to occur.
3. Alter the natural slope of the building site as little as possible during construction. Never remove soil from the toe or bottom of the slope or add soil to the top of the slope. Landslides are less likely to occur on sites where disturbance has been minimized. Seek professional assistance before earth-moving begins.
4. Remove as few trees and other vegetation as possible. Trees develop extensive root systems that are very useful in slope stabilization. Trees also remove large amounts of groundwater. Trees and other permanent vegetative covers should be established as rapidly as possible and maintained to reduce soil erosion and landslide potential.
5. Household water disposal system: Seek professional assistance in selecting the appropriate type and location of your septic system. Septic systems located in fill material can saturate soil and contribute to landslides.
6. Proper water disposal: Allowing surface waters to saturate the sloping soil is the most common cause of landslides in eastern Kentucky. Properly located diversion channels are helpful in redirecting runoff away from areas disturbed during construction. Runoff should be channeled and water from roofs and downspouts piped to stable areas at the bottom of the slope.

(From U.S. Department of Agriculture, Natural Resources Conservation Service, no date)

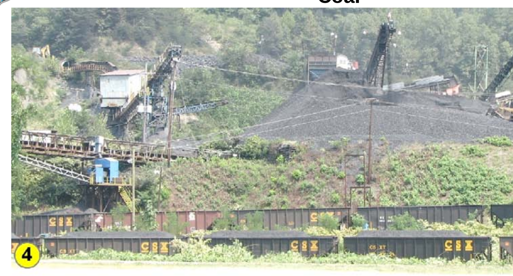
For Planning Use Only

This map is not intended to be used for selecting individual sites. Its purpose is to inform land-use planners, government officials, and the public in a general way about geologic bedrock conditions that affect the selection of sites for various purposes. The properties of thick soils may supersede those of the underlying bedrock and should be considered on a site-to-site basis. At any site, it is important to understand the characteristics of both the soils and the underlying rock. For further assistance, contact the Kentucky Geological Survey, 859.257.5500. For more information, visit the KGS Community Development Planning Web Site at kgsweb.uky.edu/download/kgsplanning.htm.





Coal



From 1910 to 2004, Harlan County produced over 917 million tons of coal, 823 million from underground mines. Photo by Dan Carey, Kentucky Geological Survey.

Limestone

The 350-million-year-old Newman Limestone is quarried off U.S. 421 (right) for construction aggregate and agricultural lime. Photo by Dan Carey, Kentucky Geological Survey.

Blanton Forest and Camp Blanton

The 3,090-acre Blanton Forest State Nature Preserve is the largest old-growth forest in Kentucky. The 10-acre Camp Blanton (left) has five cabins, a large dining hall and kitchen, restrooms and showers, and recreational opportunities including canoeing, swimming, a firing range, and hiking trails. Photo by Dan Carey, Kentucky Geological Survey.

Groundwater

About 16,800 people in Harlan County rely on private domestic water supplies: 14,000 use wells and 2,800 use other sources. Most wells drilled in valley bottoms are adequate for a domestic supply. About three-quarters of the wells drilled on hillsides and one-third of the wells drilled on hilltops are adequate for a domestic supply. Wells drilled 200 feet or more below the level of the principal valley bottoms may yield enough water for small municipal or industrial supplies. Few wells in this county drilled less than 300 feet below the level of the principal valley bottoms will yield salty water, except in the small corner of the county north of Pine Mountain, where salty water can be found in the range of 200 feet below the principal valley bottoms. Wells drilled in the Pine Mountain area that reach limestone may yield as much as several hundred gallons per minute. Groundwater obtained from most drilled wells in this area is soft but contains noticeable amounts of iron, except north of Pine Mountain, where the water is moderately hard. Some of the most productive springs in eastern Kentucky are found along Pine Mountain in Harlan County. Limestone springs can yield more than 50 gallons per minute but generally yield less than 10 gallons per minute. For more information on groundwater in the county, see Carey and Stickney (2005).

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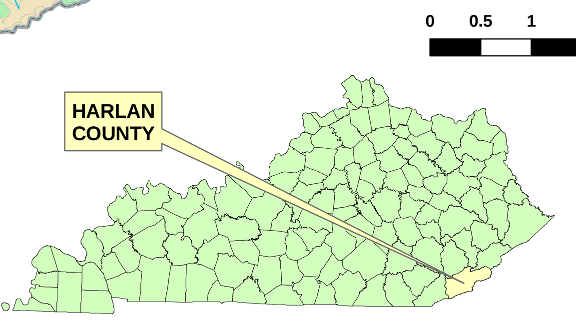
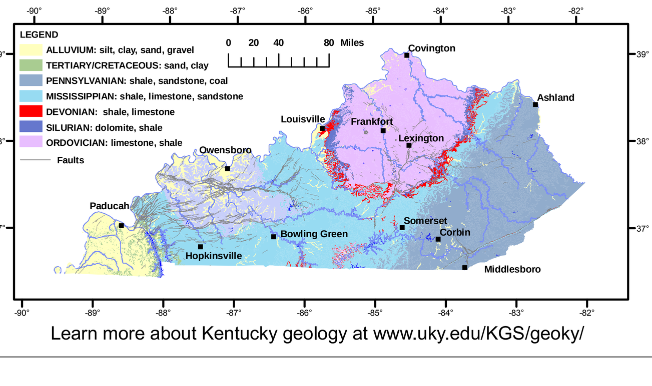


Additional Resources

Listed below are Web sites for several agencies and organizations that may be of assistance with land-use planning issues in Harlan County:

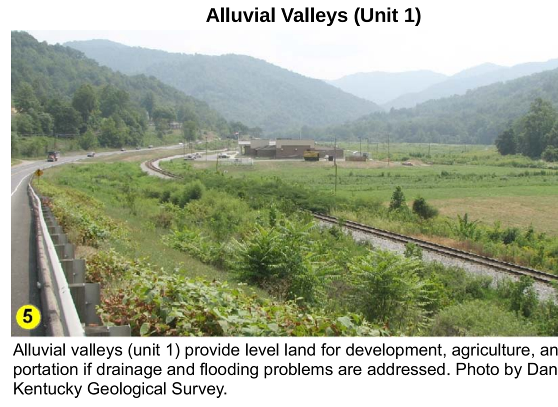
www.harlancounty.com Harlan County
www.kyhometown.com/harlan/ Harlan and Harlan County
www.harlancountychamber.com Harlan County Chamber of Commerce
harlancountytourism.com Harlan County Tourism Commission
www.harlancountytrails.com Kentucky Mountain Trails of Harlan County
www.harlandaily.com Harlan Daily Enterprise
ces.ca.uky.edu/Harlan/ University of Kentucky Cooperative Extension Service
www.cvadd.org/ Cumberland Valley Area Development District
www.thinkkentucky.com/edis/cmnty/index.aspx?cw=075 Kentucky Economic Development Information System
www.uky.edu/KentuckyAtlas/21095.html Kentucky Atlas and Gazetteer, Harlan County
quickfacts.census.gov/qfd/states/21/21095.html U.S. Census data
kgsweb.uky.edu/download/kgsplanning.htm Planning information from the Kentucky Geological Survey

Geology of Kentucky



Learn more about Kentucky geology at www.uky.edu/KGS/geoky/

Alluvial Valleys (Unit 1)



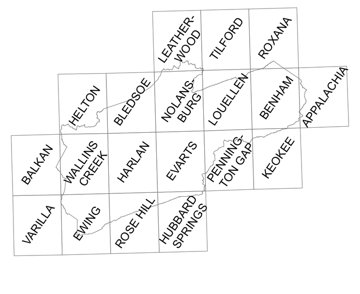
Alluvial valleys (unit 1) provide level land for development, agriculture, and transportation if drainage and flooding problems are addressed. Photo by Dan Carey, Kentucky Geological Survey.

For information on obtaining copies of this map and other Kentucky Geological Survey maps and publications call our Public Information Center at 859.257.3896 or 877.778.7827 (toll free).

Visit the KGS World Wide Web site at: www.uky.edu/kgs

Scale 1:63,360
1 inch = 1 mile

7.5-Minute Quadrangle Map Index



EXPLANATION

School
Water wells
Domestic
Monitoring
Public
Mining, industrial
Spring
Wet area
Mine or quarry
Alluvial fan
Gas well
Oil well
Railroad
Abandoned railroad
County line
Watershed boundary
Geologic fault
Concealed geologic fault
Scarp
Artificial fill
Boulders, gravel, and sand
Dump or mine spoil
Designated flood zone* (FEMA, 2005)
Source-water protection area, zone 1
Wetlands > 1 acre (U.S. Fish and Wildlife Service, 2003)
Incorporated city boundaries
Quarry
Public lands
200-foot contour interval
Photo location

Source-Water Protection Areas

Source-water protection areas are those in which activities are likely to affect the quality of the drinking-water source. For more information, see kgsweb.uky.edu/download/water/swapp/swapp.htm.

*Flood information is available from the Kentucky Division of Water, Flood Plain Management Branch, www.water.ky.gov/floods/.

LAND-USE PLANNING TABLE DEFINITIONS

FOUNDATION AND EXCAVATION

The terms "earth" and "rock" excavation are used in the engineering sense; earth can be excavated by hand tools, whereas rock requires heavy equipment or blasting to remove.

LIMITATIONS

Slight—A slight limitation is one that commonly requires some corrective measure but can be overcome without a great deal of difficulty or expense.

Moderate—A moderate limitation is one that can normally be overcome but the difficulty and expense are great enough that completing the project is commonly a question of feasibility.

Severe—A severe limitation is one that is difficult to overcome and commonly is not feasible because of the expense involved.

LAND USES

Septic tank disposal system—A septic tank disposal system consists of a septic tank and a filter field. The filter field is a subsurface tile system laid in such a way that effluent from the septic tank is distributed with reasonable uniformity into the soil.

Residences—Ratings are made for residences with basements because the degree of limitation is dependent upon ease and required depth of excavation. For example, excavation in limestone has greater limitation than excavation in shale for a house with a basement.

Highways and streets—Refers to paved roads in which cuts and fills are made in hilly topography, and considerable work is done preparing subgrades and bases before the surface is applied.

Access roads—These are low-cost roads, driveways, etc., usually surfaced with crushed stone or a thin layer of blacktop. A minimum of cuts and fills are made, little work is done preparing a subgrade, and generally only a thin base is used. The degree of limitation is based on year-around use and would be less severe if not used during the winter and early spring. Some types of recreation areas would not be used during these seasons.

Light industry and malls—Ratings are based on developments having structures or equivalent load limit requirements of three stories or less, and large paved areas for parking lots. Structures with greater load limit requirements would normally need footings in solid rock, and the rock would need to be core drilled to determine the presence of caverns, cracks, etc.

Intensive recreation—Athletic fields, stadiums, etc.

Extensive recreation—Camp sites, picnic areas, parks, etc.

Reservoir areas—The floor of the area where the water is impounded. Ratings are based on the permeability of the rock.

Reservoir embankments—The rocks are rated on limitations for embankment material.

Underground utilities—Included in this group are sanitary sewers, storm sewers, water mains, and other pipes that require fairly deep trenches.

Planning Guidance by Rock Unit Type

Rock Unit	Foundation and Excavation	Septic System	Residence with Basement	Highways and Streets	Access Roads	Light Industry and Malls	Intensive Recreation	Extensive Recreation	Reservoir Areas	Reservoir Embankments	Underground Utilities
1. Clay, silt, sand, and gravel (alluvium)	Fair foundation material; easy to excavate. Seasonal high water table. Subject to flooding. Refer to soil report (Childress, 1992).	Severe limitations. Seasonal high water table. Subject to flooding. Refer to soil report (Childress, 1992).	Severe limitations. Seasonal high water table. Subject to flooding. Refer to soil report (Childress, 1992).	Severe limitations. Seasonal high water table. Subject to flooding. Refer to soil report (Childress, 1992).	Severe limitations. Seasonal high water table. Subject to flooding. Refer to soil report (Childress, 1992).	Severe limitations. Seasonal high water table. Subject to flooding. Refer to soil report (Childress, 1992).	Slight to severe limitations, depending on type of activity and topography. Subject to flooding. Refer to soil report (Childress, 1992).	Slight to severe limitations, depending on type of activity and topography. Subject to flooding. Refer to soil report (Childress, 1992).	Pervious material. Seasonal high water table. Subject to flooding. Refer to soil report (Childress, 1992).	Fair stability. Fair compaction characteristics. Piping hazard. Refer to soil report (Childress, 1992).	Seasonal high water table. Subject to flooding. Refer to soil report (Childress, 1992).
2. Black, red, and green shales	Poor foundation material; easy to moderately difficult to excavate. Low strength and stability. May contain plastic clays.	Severe limitations. Thin soils and low permeability.	Severe to moderate limitations. Low strength, slumping, and seepage problems.	Severe to moderate limitations. Low strength, slumping, and seepage problems.	Severe to moderate limitations. Low strength, slumping, and seepage problems.	Not recommended.	Moderate to severe limitations, depending on activity and topography.	Severe to slight limitations, depending on activity and topography.	Slight limitations for small ponds.	Severe limitations. Poor strength and stability.	Moderate limitations. Poor strength. Wetness.
3. Shale*, siltstone, sandstone, thin coal, underclay	Fair to good foundation material; difficult to excavate. Possible low strength associated with shales, sparse coals, and underclays.	Severe limitations. Thin soils and impermeable rock associated with shales.	Severe to moderate limitations. Rock excavation may be required. Possible steep slopes.	Moderate to severe limitations. Rock excavation may be required. Possible steep slopes.	Moderate to severe limitations. Rock excavation may be required. Possible steep slopes.	Moderate to severe limitations. Rock excavation may be required. Possible steep slopes.	Moderate to severe limitations. Rock excavation may be required.	Slight to severe limitations, depending on activity and topography. Possible steep wooded slopes. Slight limitations for forest or nature preserve.	Slight limitations. Reservoir may leak where rocks are jointed or fractured.	Slight limitations. Reservoir may leak where rocks are fractured.	Severe to moderate limitations. Thin soils. Possible rock excavation.
4. Limestone, shale, chert	Good to excellent foundation material; difficult to excavate.	Moderate to severe limitations. Thin soils and impermeable rock associated with shales.	Severe to moderate limitations. Rock excavation may be required. Steep slopes.	Severe limitations. Rock excavation. Steep slopes.	Severe limitations. Rock excavation. Steep slopes.	Severe limitations. Rock excavation. Steep slopes.	Severe limitations. Rock excavation. Steep slopes.	Slight to moderate limitations, depending on activity and topography. Slight limitations for forest or nature preserve.	Severe limitations. Reservoir may leak where rocks are fractured.	Severe limitations. Reservoir may leak where rocks are fractured.	Severe limitations. Rock excavation. Thin soils.
5. Sandstone, siltstone, shale*, limestone, coal, underclay	Fair to good foundation material; difficult to excavate. Possible low strength associated with shales, sparse coals, and underclays. Possibility of underground coal-mine voids.	Severe limitations. Thin soils and impermeable rock associated with shales.	Severe limitations. Rock excavation. Steep slopes.	Severe limitations. Rock excavation. Steep slopes.	Severe limitations. Rock excavation. Steep slopes.	Severe limitations. Rock excavation. Steep slopes.	Moderate to severe limitations. Rock excavation may be required. Steep slopes.	Moderate to severe limitations, depending on activity. Steep slopes. Slight limitations for forest or nature preserve.	Severe limitations. Reservoir may leak where rocks are jointed or fractured.	Slight limitations. Reservoir may leak where rocks are fractured.	Severe limitations. Thin soils. Rock excavation.
6. Shale*, siltstone, sandstone, coal	Fair to poor foundation material; difficult to excavate. Possible low strength associated with shales, sparse coals, and underclays. Possibility of underground coal-mine voids.	Severe limitations. Thin soils and impermeable rock associated with shales.	Severe limitations. Rock excavation. Unstable slopes.	Severe limitations. Rock excavation. Unstable slopes.	Severe limitations. Rock excavation. Unstable slopes.	Severe limitations. Rock excavation. Unstable slopes.	Severe limitations. Rock excavation. Unstable slopes.	Slight limitations for forest or nature preserve.	Slight limitations. Reservoir may leak where rocks are jointed or fractured.	Severe limitations. Reservoir may leak where rocks are fractured.	Severe limitations. Rock excavation. Unstable slopes.
7. Siltstone, shale*, sandstone, thin coal	Fair to good foundation material; difficult to excavate. Possible low strength associated with shales, coals, and underclays. Possibility of underground coal-mine voids.	Severe limitations. Thin soils and impermeable rock associated with shales.	Severe to moderate limitations. Rock excavation may be required. Possible steep slopes.	Moderate to severe limitations. Rock excavation may be required. Possible steep slopes.	Moderate to severe limitations. Rock excavation may be required. Possible steep slopes.	Moderate to severe limitations. Rock excavation may be required. Possible steep slopes.	Moderate to severe limitations. Rock excavation may be required.	Slight to severe limitations, depending on activity and topography. Possible steep wooded slopes. Slight limitations for forest or nature preserve.	Slight limitations. Reservoir may leak where rocks are fractured.	Slight limitations. Reservoir may leak where rocks are fractured.	Severe to moderate limitations. Thin soils. Possible rock excavation.
8. Sandstone, siltstone, shale*, limestone	Fair to good foundation material; difficult to excavate. Possible low strength associated with shales.	Severe limitations. Thin soils and impermeable rock associated with shales.	Severe to moderate limitations. Rock excavation may be required. Possible steep slopes.	Moderate to severe limitations. Rock excavation may be required. Possible steep slopes.	Moderate to severe limitations. Rock excavation may be required. Possible steep slopes.	Moderate to severe limitations. Rock excavation may be required. Possible steep slopes.	Moderate to severe limitations. Rock excavation may be required.	Slight to severe limitations, depending on activity and topography. Possible steep wooded slopes. Slight limitations for forest or nature preserve.	Slight limitations. Reservoir may leak where rocks are fractured.	Slight limitations. Reservoir may leak where rocks are fractured.	Severe to moderate limitations. Thin soils. Possible rock excavation.
9. Sandstone, siltstone, shale*, minor coal	Excellent foundation material; difficult to excavate.	Severe limitations. Thin soils.	Severe to moderate limitations. Rock excavation. Steep slopes.	Severe to moderate limitations. Rock excavation. Steep slopes.	Severe to moderate limitations. Rock excavation. Steep slopes.	Severe to moderate limitations. Rock excavation. Steep slopes.	Moderate to severe limitations, depending on activity and slope.	Slight to severe limitations, depending on activity. Slight limitations for forest or nature preserve.	Slight limitations. Reservoir may leak where rocks are fractured.	Slight to moderate limitations. Reservoir may leak where rocks are fractured.	Severe to moderate limitations. Rock excavation.

*Shales and clays in these units may shrink during dry periods and swell during wet periods and cause cracking of foundations. On hillsides, especially where seeps and springs are present, they can also be susceptible to landslides.