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Generalized Geologic Map for Land-Use Planning: Knott County, Kentucky

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Acknowledgments

Geology adapted from Conley (2004), Johnson (2004), Mullins (2004), Mullins and Murphy (2004), Murphy (2004a-c, 2005), Andrews and others (2005a, b), Morris and others (2005a-c), and Sparks and others (2005a, b). Thanks to Kim and Kent Anness, Kentucky Division of Geographic Information, for base-map data. Thanks to Dennis Cumbie, Loudon County Government, Leesburg, Va., for discussion of abandoned mine blowout.

Knott County Courthouse at Hindman

Knott County, 352 square miles in the Eastern Kentucky Coal Field, was formed in 1884. The highest point in the county, 2,360 feet, is at the head of Arnold Fork at the Knott-Letcher-Pike County junction. The lowest elevation, 675 feet, is the confluence of Jones Fork and the Right Fork of Beaver Creek. The 2006 population of 17,489 was 1 percent less than that of 2000. Photo by Dan Carey, Kentucky Geological Survey.

Carr Fork Lake

Carr Fork Lake, 710 acres and 24 miles of shoreline, provides swimming, fishing, boating, water sports, camping, hiking, and wildlife habitat (below) to visitors. Photos by Dan Carey, Kentucky Geological Survey.

Coal

Coal plays a central role in the Knott County economy; from 1921–2004, 330 million tons—212 underground and 118 surface and auger (below)—was mined. The 13.6 million tons in 2004 was the second highest annual production. Photos by Dan Carey, Kentucky Geological Survey.

Post-Mining Land Uses

Elk reintroduction and waterfowl habitat (below) are part of the creation of wildlife management areas for post-mining reclamation land use. Photos by Bart Davidson, Kentucky Geological Survey.

EXPLANATION

School
Water wells
- Commercial, industrial, mining
- Domestic
- Monitoring
- Public
- Livestock

Spring
Gas well
Oil well
Railroad
Abandoned railroad
Watershed boundary

Mined areas (may not include all mining)
- Deep
- Surface
- Unknown type

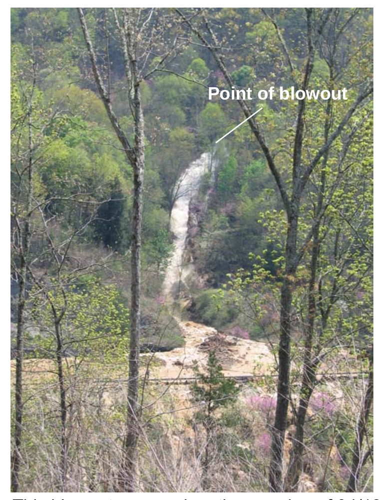
Designated flood zone* (FEMA, 2005)
Wetlands > 1 acre (U.S. Fish and Wildlife Service, 2003)
Public lands
Incorporated city boundaries
Artificial fill
Landslide deposits
Dump
200-foot contour interval
Photo location

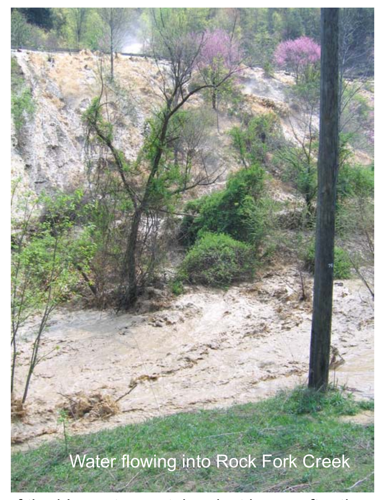
*Flood information is available from the Kentucky Division of Water, Flood Plain Management Branch, www.water.ky.gov/floods/.

Sandstone, Siltstone, Clay Shale, Coal, and Limestone

Coal, sandstone, and shale of unit 3 are exposed along Ky. 80 (right). A sea of humpbacked hills capped with sandstone of unit 2 (below) loom over narrow valleys. Photos by Dan Carey, Kentucky Geological Survey.

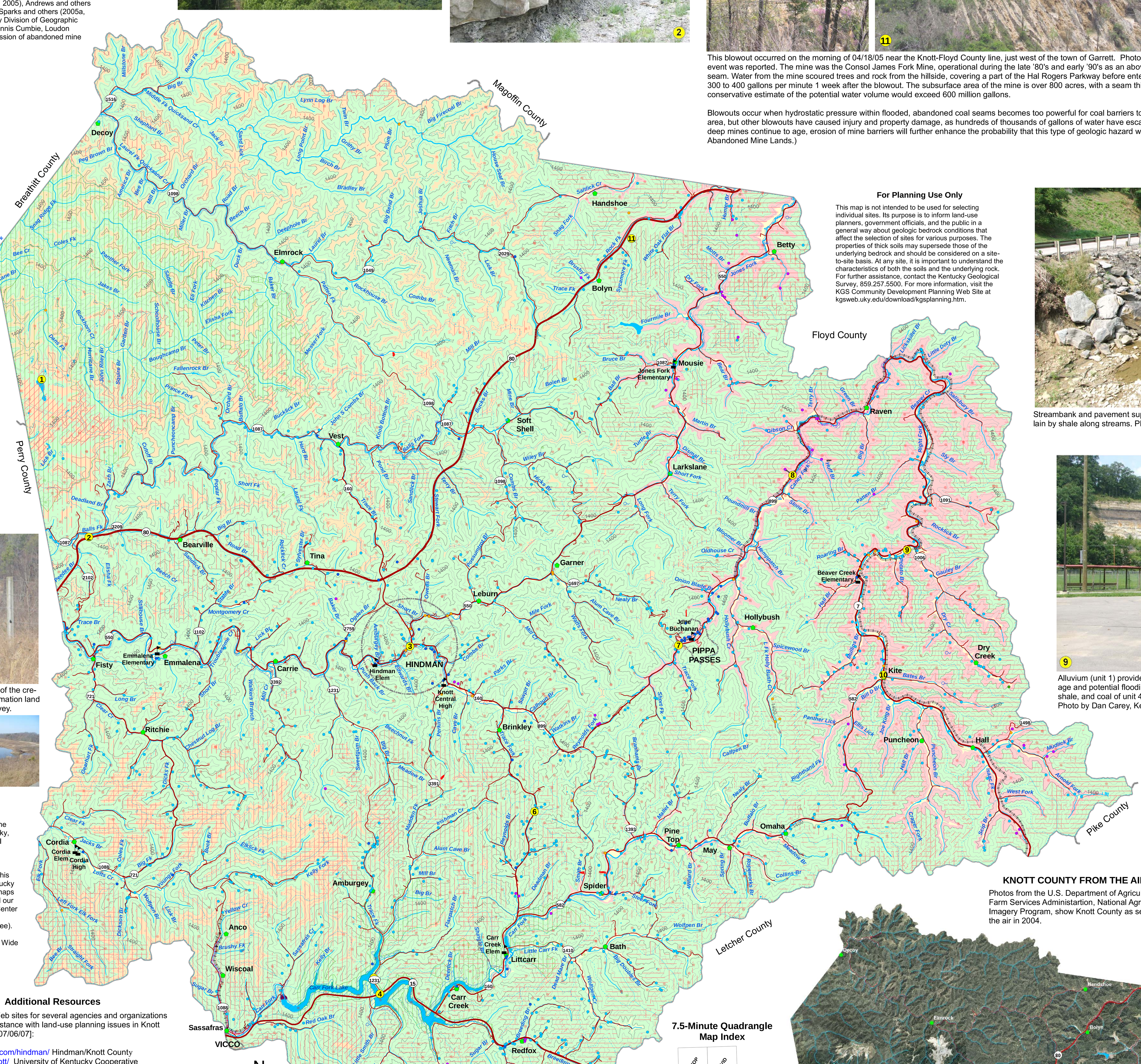
Abandoned Mine Blowout





This blowout occurred on the morning of 04/18/05 near the Knott-Floyd County line, just west of the town of Garrett. Photographs of the blowout were taken just hours after the event was reported. The mine was the Consol James Fork Mine, operational during the late '80s and early '90s as an above-drainage room-and-pillar mine in the Hazard No. 4 seam. Water from the mine scoured trees and rock from the hillside, covering a part of the Hal Rogers Parkway before entering Rock Fork. Water was still flowing at a rate of 300 to 400 gallons per minute 1 week after the blowout. The subsurface area of the mine is over 800 acres, with a seam thickness near 5 feet. If the mine were fully flooded, a conservative estimate of the potential water volume would exceed 600 million gallons.

Blowouts occur when hydrostatic pressure within flooded, abandoned coal seams becomes too powerful for coal barriers to endure. This event happened in an unpopulated area, but other blowouts have caused injury and property damage, as hundreds of thousands of gallons of water have escaped the mine with great velocity. As abandoned deep mines continue to age, erosion of mine barriers will further enhance the probability that this type of geologic hazard will happen. (Photos courtesy of Kentucky Division of Abandoned Mine Lands.)



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.

N

Scale = 1:63,360

1 inch = 1 mile

0 0.5 1 2 3 4 Miles

Slope Failure

Mass movements or landslides of surficial materials are frequent and costly geologic hazards in eastern Kentucky. 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.

Virtually all units containing shale on slopes are subject to landslides.

Clay shales of units 3 and 4 become plastic when wet and present particularly difficult problems for excavations and foundations. An engineering geologist or a geotechnical engineer should be consulted when clay shales are present.

Gravity is the main driving force, but water nearly always plays a critical role by adding weight and lubricating the particles in the weathered shale. Cutting into or overloading a slope with structures and fill can also be major contributing factors.

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. Relict landslides can also be easily reactivated. Look for unusual bulges or cracks in the slope, tilted or curved trees, springs coming out into the hillside, and tilted and cracked sidewalks, streets, and retaining walls.

What Are the Factors That Cause Landslides?

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

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 in 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 slope 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)

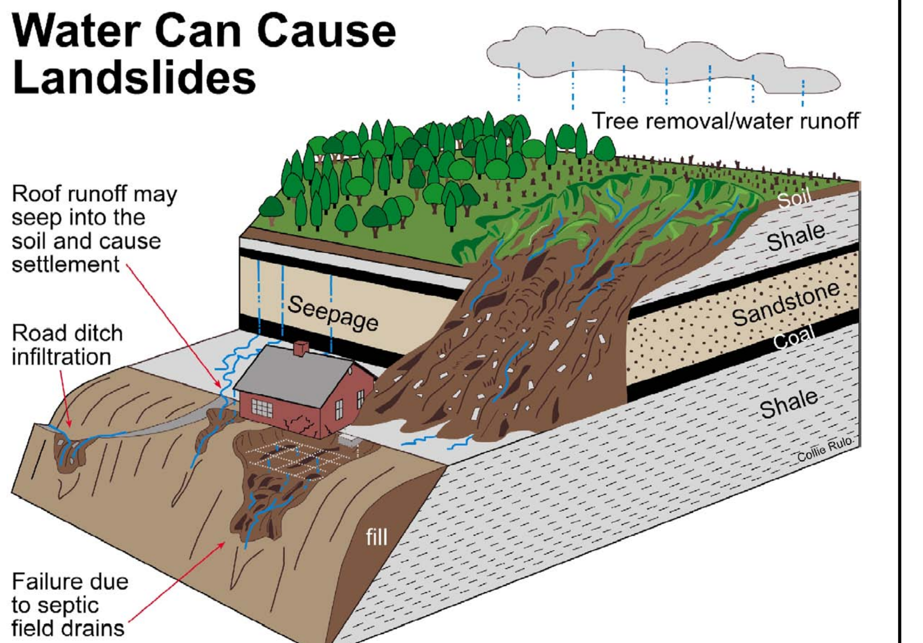
Slope Stability

Streambank and pavement support are required for roadbeds cut into slopes underlain by shale along streams. Photo by Dan Carey, Kentucky Geological Survey.

Alluvium (Unit 1)

Alluvium (unit 1) provides level land suitable for recreation and other uses if drainage and potential flooding are properly considered. Siltstone, sandstone, clay shale, and coal of unit 4 are exposed in the roadcut on Ky. 7 in the background. Photo by Dan Carey, Kentucky Geological Survey.

Water Can Cause Landslides



Site Preparation

Cut-and-fill foundation preparation is common in steep-sloping areas. Slope stability and proper drainage must be considered, particularly where shales are present. See diagram above. Photo by Dan Carey, Kentucky Geological Survey.

Groundwater

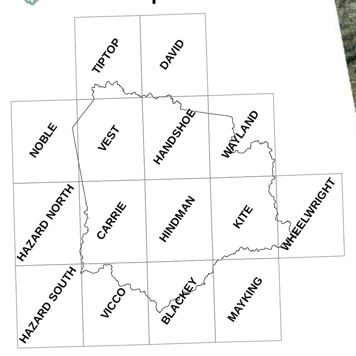
About 15,100 people, or six of seven households, in Knott County rely on private domestic water systems: 14,100 use wells and 1,000 use other sources. Of those on private systems, about 84 percent rely on drilled wells, 9 percent on dug wells, and 7 percent on cisterns and other sources. The primary problems with private wells in Knott County are high levels of sulfur or iron. Most wells drilled in valley bottoms and on hillsides are adequate for a modern domestic supply; however, on ridgetops, only some wells produce enough for a modern domestic supply. Wells drilled in valleys to depths greater than 200 feet may yield enough water for small municipal or industrial supplies. Groundwater from most wells is considered moderately hard and contains noticeable amounts of iron. In the drainage basin of the Right Fork of Beaver Creek, salty water may be found at depths less than 100 feet below the level of the valley bottom. In the rest of Knott County, salty water in wells probably will not be found less than 200 feet below the level of the principal valley bottoms. A few springs supply sufficient quantities of water for domestic use, usually less than 5 gallons per minute.

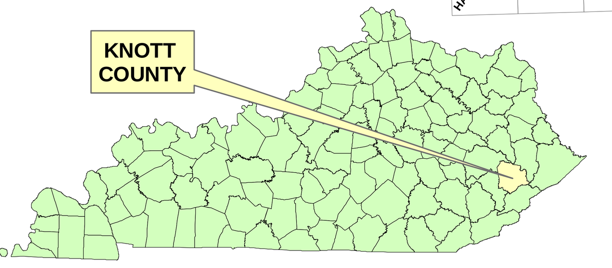
For more information on groundwater in the county, see Carey and Stickney (2005).

KNOTT COUNTY FROM THE AIR

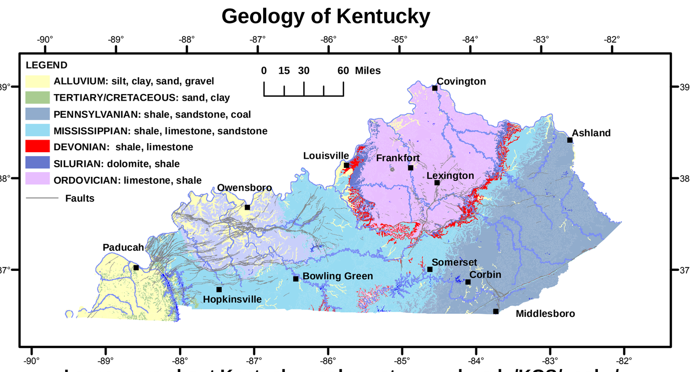
Photos from the U.S. Department of Agriculture, Farm Services Administration, National Agricultural Imagery Program, show Knott County as seen from the air in 2004.

7.5-Minute Quadrangle Map Index





Geology of Kentucky



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

Alice Lloyd College

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.

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

Additional Resources

Listed below are Web sites for several agencies and organizations that may be of assistance with land-use planning issues in Knott County [accessed 07/06/07]:

www.kyhometown.com/hindman/ Hindman/Knott County
ces.ca.uky.edu/Knott/ University of Kentucky Cooperative Extension Service
www.kradd.org/ Kentucky River Area Development District
courts.ky.gov/counties/Knott/ Knott County government information
www.thinkkentucky.com/EDIS/cmnty/index.aspx?cw=088 Kentucky Economic Development Information System
www.uky.edu/KentuckyAtlas/21119.html Kentucky Atlas and Gazetteer, Knott County
quickfacts.census.gov/qfd/states/21/21119.html U.S. Census data
kgsweb.uky.edu/download/kgsplanning.htm Planning information from the Kentucky Geological Survey

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 (McIntosh, 2004).	Severe limitations. Seasonal high water table. Subject to flooding. Refer to soil report (McIntosh, 2004).	Severe limitations. Seasonal high water table. Subject to flooding. Refer to soil report (McIntosh, 2004).	Severe limitations. Seasonal high water table. Subject to flooding. Refer to soil report (McIntosh, 2004).	Severe limitations. Seasonal high water table. Subject to flooding. Refer to soil report (McIntosh, 2004).	Severe limitations. Seasonal high water table. Subject to flooding. Refer to soil report (McIntosh, 2004).	Slight to severe limitations, depending on type of activity and topography. Subject to flooding. Refer to soil report (McIntosh, 2004).	Slight to severe limitations, depending on type of activity and topography. Subject to flooding. Refer to soil report (McIntosh, 2004).	Pervious material. Seasonal high water table. Subject to flooding. Refer to soil report (McIntosh, 2004).	Fair stability. Fair compaction characteristics. Piping hazard. Refer to soil report (McIntosh, 2004).	Slight limitations, in general, except for seasonal high water table. Subject to flooding. Refer to soil report (McIntosh, 2004).
2. Sandstone, shale, claystone, coal, and limestone	Fair to good foundation material; difficult to excavate. Possible low strength associated with coals and underclays. Possibility of underground coal-mine voids.	Severe limitations. Thin soils and impermeable rock.	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, including coal, are jointed or fractured.	Severe limitations. Reservoir may leak where rocks are fractured.	Severe to moderate limitations. Thin soils. Possible rock excavation.
3. Sandstone, siltstone, clay shale, coal, and limestone	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, including coal, are jointed or fractured.	Severe limitations. Reservoir may leak where rocks are fractured.	Severe to moderate limitations. Thin soils. Possible rock excavation.
4. Siltstone, sandstone, clay shale, coal, and limestone	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.	Moderate to severe limitations. Rock excavation may be required.	Moderate to severe limitations. Rock excavation may be required.	Moderate to severe limitations. Rock excavation may be required.	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, including coal, are jointed or fractured.	Severe limitations. Reservoir may leak where rocks are fractured.	Severe to moderate limitations. Thin soils. Possible rock excavation.

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