Kentucky Geological Survey
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UNIVERSITY OF KENTUCKY, LEXINGTON

MAP AND CHART 169
Series XII, 2007

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

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Acknowledgments

Geology adapted from Morris and Lambert (2005), Murphy and Lambert (2005a, b), Sparks and Lambert (2005), Sullivan and Lambert (2005a, b), Sullivan and others (2005), Andrews and others (2006), and Nelson and others (2006). Thanks to Brandon Nuttall, Kentucky Geological Survey, for oil production information. Thanks to Kim and Kent Anness, Kentucky Division of Geographic Information, for base-map data.

Lee County Courthouse at Beattyville

Lee County, 210 square miles on the western edge of the Eastern Kentucky Coal Field, was formed in 1870 and named after Gen. Robert E. Lee. The terrain is generally rugged except for ridgetops and stream valleys. The lowest elevation, 610 feet, is where the Kentucky River leaves the county. The highest elevation, 1,367 feet, is a ridge on the Owsley County line about 1 mile east of Ky. 708. The 2006 population of 7,775 was 1.8 percent smaller than that of 2000. Photo by Dan Carey, Kentucky Geological Survey.

Wildlife

Deer and quail (too shy for photo) greet the visitor to field and forest. Photos by Dan Carey, Kentucky Geological Survey.

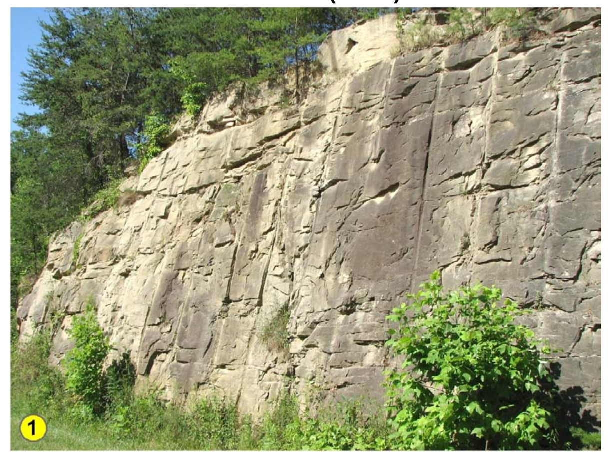
Oil

Pump jacks are a common sight in the county. On February 21, 1918, the No. 1 Ephraim ("Eph") Angel well was successfully completed and confirmed the discovery of a major oil resource: the Big Sinking Oil Field. The Big Sinking Oil Field, mostly within Lee County, is Kentucky's only giant oil field. Oil production in Lee County reached a peak of 2.6 million barrels in 1965 and remained above 1 million barrels per year from 1960 to 1975. Lee County has produced 87 million barrels of oil since 1918, second only to Henderson County. Currently, Lee County remains one of Kentucky's top five oil producing counties with more than 180,000 barrels per year. Secondary injection of air and water into wells has increased productivity. The oil is hauled by truck to the Catlettsburg Refinery operated by Marathon Petroleum near Ashland, Kentucky. Photo by Dan Carey, Kentucky Geological Survey.

Karst Geology

Some areas of the county are underlain by karst limestone. The term "karst" refers to a landscape characterized by sinkholes, springs, sinking streams (streams that disappear underground), and underground drainage through solution-enlarged conduits or caves. Karst landscapes form when slightly acidic water from rain and snowmelt seeps through soil cover into fractured and soluble bedrock (usually limestone, dolomite, or gypsum). Sinkholes are depressions on the land surface into which water drains underground. Usually circular and often funnel-shaped, they range in size from a few feet to hundreds of feet in diameter. Springs occur when water emerges from underground to become surface water. Caves are solution-enlarged fractures or conduits large enough for a person to enter.

Sandstone (Unit 7)

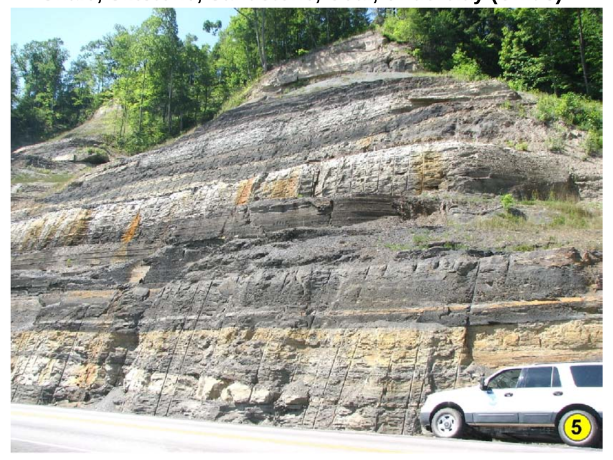


The thick, massive Corbin Sandstone (unit 7) is exposed along Ky. 11. Photo by Dan Carey, Kentucky Geological Survey.

Unit 3 Terrain

The terrain of unit 3 is generally rugged, with steep wooded hillsides, and some level land on ridgetops. Photo by Dan Carey, Kentucky Geological Survey.

Shale, Siltstone, Sandstone, Coal, Underclay (Unit 3)



Layers of shale, siltstone, and sandstone (unit 3) are exposed along Ky. 52 east of Beattyville. Photo by Dan Carey, Kentucky Geological Survey.

Slope Stability

Roadbeds cut into shale often require additional support to reduce pavement failure, as seen in this section along Ky. 708 in unit 3. Photo by Dan Carey, Kentucky Geological Survey.

Landslides

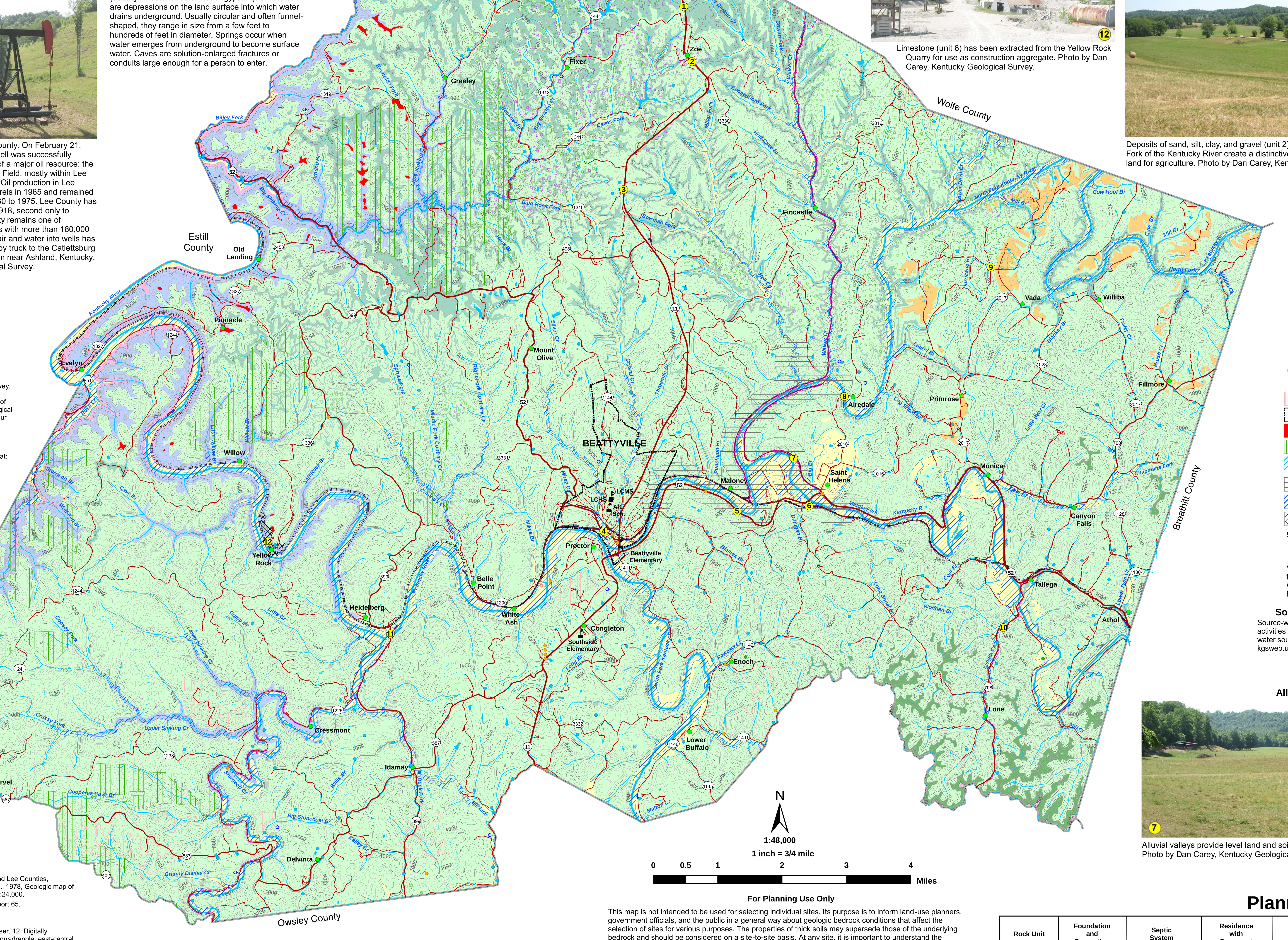
Hillside construction can cause earth movements if not properly planned. Photos by Paul Howell, U.S. Department of Agriculture, Natural Resources Conservation Service.

Siltstone, Limestone, Dolomite, and Shale (Unit 6)

Limestone (unit 6) has been extracted from the Yellow Rock Quarry for use as construction aggregate. Photo by Dan Carey, Kentucky Geological Survey.

Sand, Silt, Clay, and Gravel (Unit 2)

Deposits of sand, silt, clay, and gravel (unit 2) carried by an ancient North Fork of the Kentucky River create a distinctive terrain and provide level land for agriculture. Photo by Dan Carey, Kentucky Geological Survey.



N
1:48,000
1 inch = 3/4 mile
0 0.5 1 2 3 4 Miles

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

EXPLANATION

- School
- Gas well
- Oil well
- Enhanced recovery well
- Water wells
  - Domestic
  - Industrial
  - Monitoring
  - Public
  - Livestock
- Spring
- County line
- Watershed boundary
- Railroad
- Abandoned railroad
- Mined area
- Incorporated city boundaries
- Mapped sinkhole
- Daniel Boone National Forest
- Wetlands > 1 acre (U.S. Fish and Wildlife Service, 2003)
- Source-water protection area, zone 1
- Designated flood zone* (FEMA, 2005)
- Quarry
- 50-foot contour interval
- Photo location

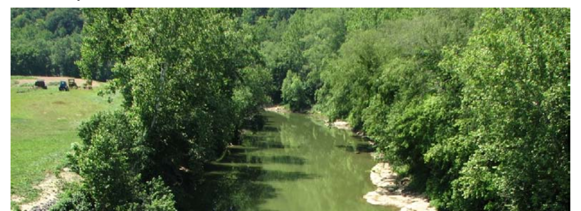
*Flood information is available from the Kentucky Division of Water, Flood Plain Management Branch, www.water.ky.gov/floods/.

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.

Kentucky River

Lee County is blessed with an abundance of water. The North, South, and Middle Forks of the Kentucky River meet upstream of Heidelberg, the site of Lock and Dam 14. The dam (seen from the Albert Updyke Ky. 399 bridge) was completed in 1917 as the last in the system from Heidelberg to the Ohio River. The North Fork of the Kentucky River, seen below from the Ky. 2016 bridge near Airedale, provides water to the Beattyville Water Plant. Photos by Dan Carey, Kentucky Geological Survey.



What Are the Factors That Cause Landslides?

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

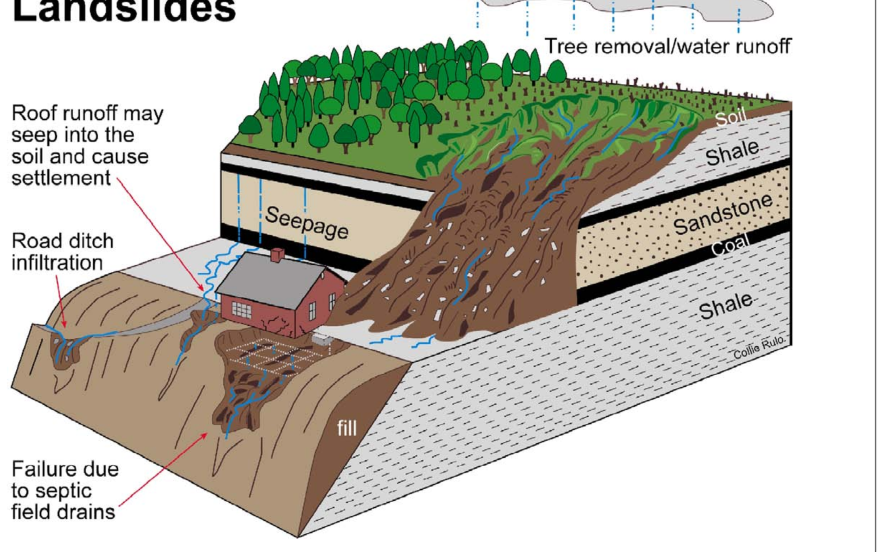
1. Steep slopes: Avoid when choosing a building site.
2. Water: Slope stability decreases as water moves into the soil. Springs, seeps, roof runoff, gutter downspouts, septic systems, and site grading that cause ponding or runoff are sources of water that often contribute to landslides.
3. Changing the 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 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)

Water Can Cause Landslides



Alluvium (Unit 1)

Alluvial valleys provide level land and soils for agriculture, sports fields, and other compatible uses. Photo by Dan Carey, Kentucky Geological Survey.

Slope Failure

Mass movements or landslides of surficial materials are frequent and costly geologic hazards in the eastern Kentucky area. 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 unit 5 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 onto the hillside, and tilted and cracked sidewalks, streets, and retaining walls.

Swelling and Shrinking Shales

A problem of some concern in this area is the swelling of some clays and shales. Expanding shale can cause backfill to swell, and concrete to crack and crumble. It can heave the foundation, the slab, and interior partitions resting on it, and damage upper floors and interior partitions. This phenomenon has been responsible for extensive damage to schools, homes, and businesses in Kentucky. During times of drought, these same shales may shrink, causing foundations to drop. Anyone planning construction on these shales should seek professional advice from a geologist or engineer familiar with the problem.

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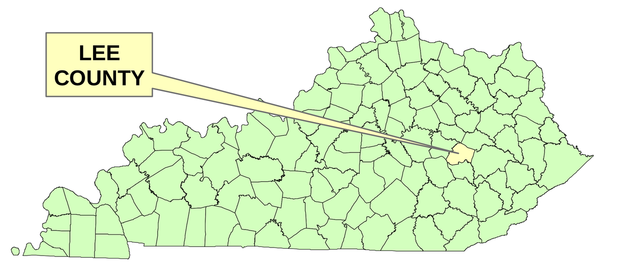
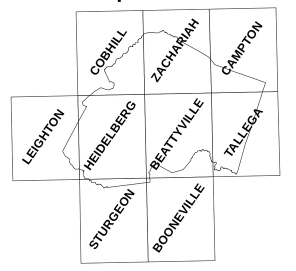
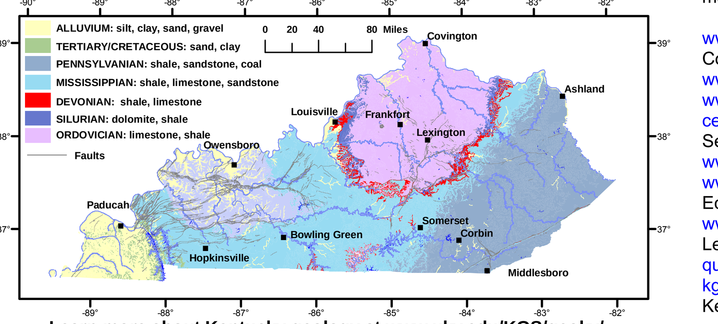


7.5-Minute Quadrangle Map Index



Geology of Kentucky



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

Groundwater

Almost 2,000 people in Lee County rely on private domestic water supplies: 1,300 use wells and 700 use other sources. Throughout most of the county, wells drilled in valley bottoms are adequate for domestic use. Yields to wells become progressively less on hillsides and ridges, although some wells drilled on ridges produce enough water for domestic use. Generally, wells on broad ridges produce more water than wells on narrow ridges or hilltops. Most wells drilled in the valley bottoms are completed in limestone and produce hard water, often with noticeable amounts of iron. On hillsides and ridges wells are often completed in sandstone and contain soft to moderately hard water, with noticeable amounts of iron. Salty water may be found at depths greater than 100 feet below the level of the Kentucky River. A few springs supply enough water for domestic use. Most springs yield less than 5 gallons per minute, except limestone springs that occur near stream level often produce 100 gallons per minute or greater.

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

Coal

Coal is trucked to the Sturgeon Mining facility east of Beattyville for processing. Photo by Dan Carey, Kentucky Geological Survey.

Additional Resources

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

www.geocities.com/beattyvilleky/ Beattyville–Lee County Chamber of Commerce
www.beattyville.org/ City of Beattyville
www.kyhometown.com/beattyville/ Beattyville–Lee County
ces.ca.uky.edu/Lee/ University of Kentucky Cooperative Extension Service
www.kradd.org/ Kentucky River Area Development District
www.thinkkentucky.com/edis/cmnty/index.aspx?cw=095 Kentucky Economic Development Information System
www.uky.edu/KentuckyAtlas/21129.html Kentucky Atlas and Gazetteer, Lee County
quickfacts.census.gov/qfd/states/21/21129.html U.S. Census data
kgsweb.uky.edu/download/kgsplanning.htm Planning information from the Kentucky Geological Survey

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.

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 (Newton and others, 1974).	Severe limitations. Seasonal high water table. Subject to flooding. Refer to soil report (Newton and others, 1974).	Severe limitations. Seasonal high water table. Subject to flooding. Refer to soil report (Newton and others, 1974).	Severe limitations. Seasonal high water table. Subject to flooding. Refer to soil report (Newton and others, 1974).	Severe limitations. Seasonal high water table. Subject to flooding. Refer to soil report (Newton and others, 1974).	Severe limitations. Seasonal high water table. Subject to flooding. Refer to soil report (Newton and others, 1974).	Slight to severe limitations, depending on type of activity and topography. Subject to flooding. Refer to soil report (Newton and others, 1974).	Slight to severe limitations, depending on type of activity and topography. Subject to flooding. Refer to soil report (Newton and others, 1974).	Pervious material. Seasonal high water table. Subject to flooding. Refer to soil report (Newton and others, 1974).	Fair stability. Fair compaction characteristics. Piping hazard. Refer to soil report (Newton and others, 1974).	Seasonal high water table. Subject to flooding. Refer to soil report (Newton and others, 1974).
2. Sand, silt, clay, and gravel (ancient river deposits)	Fair foundation material; easy to excavate.	Severe to slight limitations, depending on amount of soil cover.	Moderate to slight limitations, depending on slope.	Slight limitations.	Slight limitations, depending on slope.	Slight limitations, depending on slope.	Moderate to slight limitations, depending on activity and topography.	Moderate to slight limitations, depending on activity and topography.	Pervious material. Not recommended.	Severe to slight limitations. Unstable steep slopes.	Slight limitations.
3. Shale*, siltstone, sandstone, coal, underclay	Fair to good foundation material; difficult to excavate. Possible low strength associated with shales, coals, and underclays. Possibility of old mine works.	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. Sandstone, siltstone, shale*, 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.	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.	Severe limitations. Steep 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.
5. Shale*	Poor foundation material; difficult to excavate. Slumps when wet. Avoid steep slopes. May contain plastic clays.	Severe limitations.	Severe to moderate limitations. Rock excavation may be required. Slumps when wet. Avoid steep slopes. Possible shrinking and swelling shales.	Severe to moderate limitations. Rock excavation may be required. Slumps when wet. Avoid steep slopes.	Severe to moderate limitations. Rock excavation may be required. Slumps when wet. Avoid steep slopes.	Moderate to severe limitations, depending on topography. Rock excavation. Local drainage problems. Susceptible to landslides.	Moderate to severe limitations, depending on activity and topography. Possible steep wooded slopes.	Moderate limitations, depending on activity and topography. Possible steep wooded slopes. Slight limitations for forest or nature preserve.	Moderate to slight limitations. Reservoir may leak where rocks are fractured.	Slight to moderate limitations. Reservoir may leak where rocks are fractured.	Moderate limitations. Poor strength, wetness.
6. Siltstone, limestone, dolomite, and shale*	Good to excellent foundation material; difficult to excavate. See unit 5 for shale.	Severe limitations. Fast drainage to groundwater; danger of contamination.	Severe limitations. Rock excavation. Sinks possible. See unit 5 for shale.	Severe limitations. Rock excavation. Sinks possible. See unit 5 for shale.	Severe limitations. Rock excavation. Sinks possible. See unit 5 for shale.	Moderate to severe limitations. Rock excavation. Sinks possible. See unit 5 for shale.	Moderate to severe limitations, depending on activity and slope.	Slight to severe limitations, depending on activity. Slight limitations for forest or nature preserve.	Severe limitations. Leaky reservoir rock. Sinks possible.	Severe limitations. Leaky reservoir rock. Sinks possible.	Severe limitations. Rock excavation.
7. Sandstone	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 to moderate limitations. Reservoir may leak where rocks are fractured.	Slight to moderate limitations. Reservoir may leak where rocks are fractured.	Severe 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.