2007

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

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Acknowledgments

Geology adapted from Conley (2004), Lambert (2004a-d), Mullins (2004), Mullins and Thompson (2004), Ashcraft (2006), Murphy (2006a, b), Petersen (2006), and Thompson (2006a, b). Thanks to Paul Howell, U.S. Department of Agriculture, Natural Resources Conservation Service, for pond construction illustration. Mapped sinkhole data from Paylor and others (2004). Thanks to Kim and Kent Anness, Kentucky Division of Geographic Information, for base-map data.

Metcalfe County Courthouse at Edmonton

Metcalfe County, an area of 291 square miles in the Mississippian Plateaus Region, was formed in 1860. The highest point in the county, 1,182 feet, is on a ridge on Ky. 163 about 1/3 mile north of Ky. 90. The lowest elevation, 560 feet, is where the Little Barren River leaves the county. The 2006 population, 10,219, was 1.8 percent greater than that of 2000. Photo by Dan Carey, Kentucky Geological Survey.

Edmonton–Metcalfe County Industrial Park

Transportation to and from the 7-acre Edmonton–Metcalfe County Industrial Park is provided by the Louie B. Nunn Parkway (below). Photos by Dan Carey, Kentucky Geological Survey.

EXPLANATION

- School
- Water wells
  - Domestic
  - Monitoring
  - Spring
  - Oil well
  - Gas well
  - Secondary recovery well
  - Severely eroded area
  - Mine or quarry
  - Rock outcrop
  - Wet area
  - Sinkhole
- Incorporated city boundary
- Public lands
- Source-water protection area[1], zone 1
- Wetlands > 1 acre (U.S. Fish and Wildlife Service, 2003)
- Watershed boundaries
- Quarry
- Mapped sinkhole

40-foot contour interval

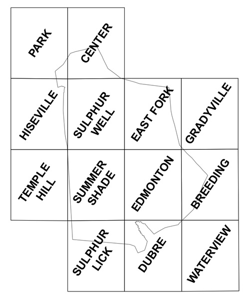
4 Photo location

[1]In source-water protection areas, activities are likely to affect the quality of the drinking-water source. For more information, see kgsweb.uky.edu/download/water/swapp/swapp.htm.

Energy Resources

Nearly 1 billion cubic feet from natural gas wells (above) and 3 million barrels from oil wells (below) have been produced in Metcalfe County. Photos by Dan Carey, Kentucky Geological Survey.

7.5-Minute Quadrangle Map Index



Radon Ventilation

Ventilation system removes radon from the basement area of this home on unit 5. Photo by Dan Carey, Kentucky Geological Survey.

Radon

Radon gas can be a local problem, in some areas exceeding the U.S. Environmental Protection Agency's maximum recommended limit of 4 picocuries per liter. The shales of unit 5 and limestones of unit 2, in particular, may contain high levels of uranium or radium, parent materials for radon gas. Homes in these areas should be tested for radon, but the homeowner should keep in mind that the threat to health results from relatively high levels of exposure over long periods, and the remedy may simply be additional ventilation of the home.

Radon Risk If You've Never Smoked (U.S. Environmental Protection Agency, 2005)

Radon Level	If 1,000 people who never smoked were exposed to this level over a lifetime*...	The risk of cancer from radon exposure compares to**...	WHAT TO DO:
20 pCi/L	About 36 people could get lung cancer	35 times the risk of drowning	Fix your home
10 pCi/L	About 18 people could get lung cancer	20 times the risk of dying in a home fire	Fix your home
8 pCi/L	About 15 people could get lung cancer	4 times the risk of dying in a fall	Fix your home
4 pCi/L	About 7 people could get lung cancer	The risk of dying in a car crash	Fix your home
2 pCi/L	About 4 people could get lung cancer	The risk of dying from poison	Consider fixing between 2 and 4 pCi/L
1.3 pCi/L	About 2 people could get lung cancer	(Average indoor radon level)	(Reducing radon levels below 2 pCi/L is difficult.)
0.4 pCi/L		(Average outdoor radon level)	

Note: If you are a former smoker, your risk may be higher.
* Lifetime risk of lung cancer deaths from EPA Assessment of Risks from Radon in Homes (EPA 402-R-03-003).
** Comparison data calculated using the Centers for Disease Control and Prevention's 1999-2001 National Center for Injury Prevention and Control Reports.

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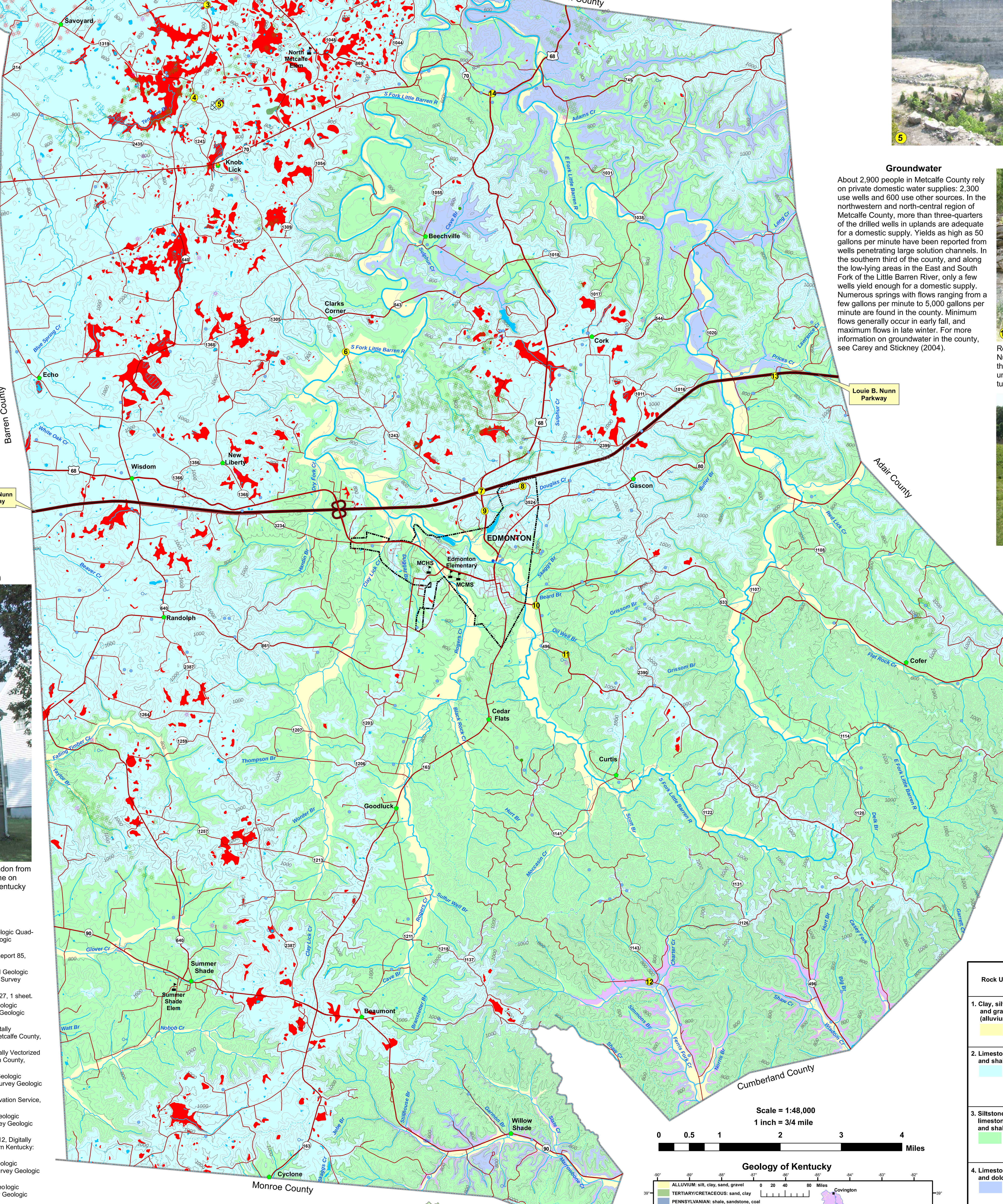
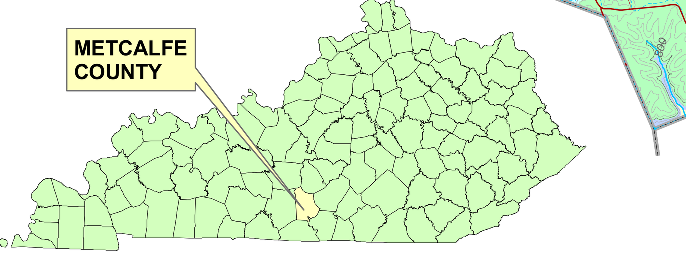


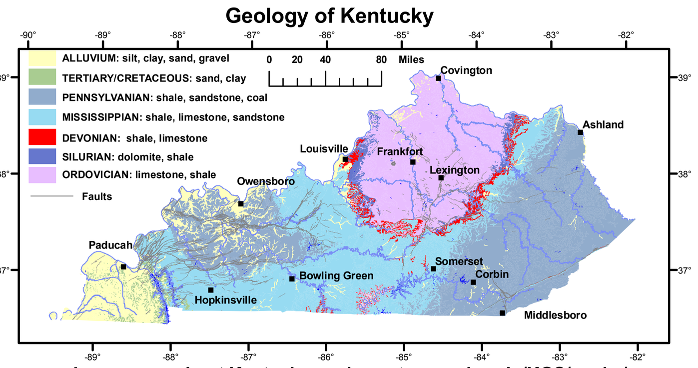
For Planning Use Only

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, and to make custom maps of your area, visit the KGS Land-Use Planning Internet Mapping Web Site at kgsmap.uky.edu/website/kyluplan/viewer.htm.



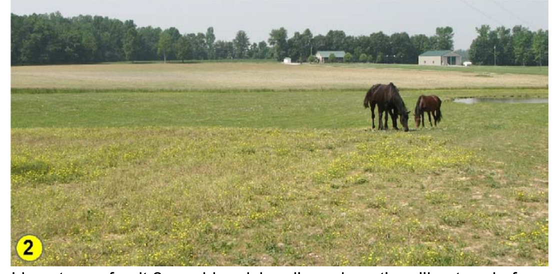
Scale = 1:48,000
1 inch = 3/4 mile
0 0.5 1 2 3 4 Miles

Geology of Kentucky



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

Limestone and Shale (Unit 2) Terrain

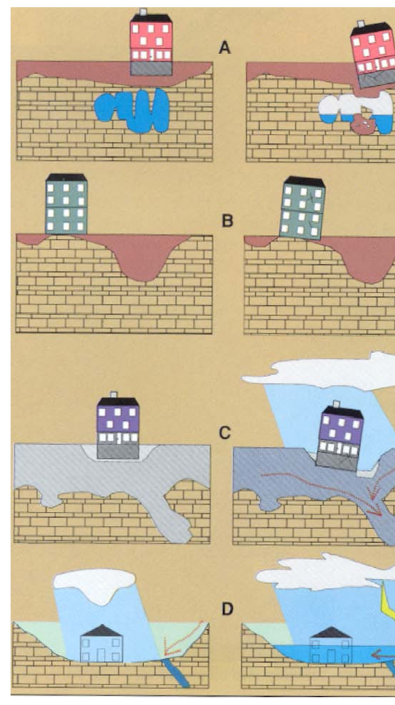


Limestone of unit 2 provides rich soils and gently rolling terrain for agriculture (above) and wetlands for wildlife (below). Photos by Dan Carey, Kentucky Geological Survey.

Limestone and Shale (Unit 2)

The 350-million-year-old limestone and shale of unit 2 is seen at this roadcut (above) along U.S. 68 north of Edmonton. Percolating water dissolves the limestone, forming underground flow channels and creating a karst terrain with numerous sinkholes. The Montgomery Rock Quarry (below) on Ky. 1243 produced construction aggregate and agricultural lime from unit 2. Photo by Dan Carey, Kentucky Geological Survey.

Construction on Karst



Limestone terrain can be subject to subsidence hazards, which usually can be overcome by prior planning and site evaluation. "A" shows construction above an open cavern, which later collapses. This is one of the most difficult situations to detect, and the possibility of this situation beneath a structure warrants insurance protection for homes built on karst terrain. In "B," a heavy structure presumed to lie above solid bedrock actually is partially supported on soft, residual clay soils that subside gradually, resulting in damage to the structure. This occurs where inadequate site evaluation can be traced to lack of geophysical studies and inadequate core sampling. "C" and "D" show the close relationship between hydrology and subsidence hazards in limestone terrain. In "C," the house is situated on porous fill (light shading) at a site where surface- and groundwater drainage move supporting soil (darker shading) into voids in limestone (blocks) below. The natural process is then accelerated by infiltration through fill around the home. "D" shows a karst site where normal rainfall is absorbed by subsurface conduits, but water from infrequent heavy storms cannot be carried away quickly enough to prevent flooding of low-lying areas. Adapted from AIPG (1993).

Alluvium (Unit 1)

Wide alluvial valleys (unit 1) along scenic streams in unit 3 like the South Fork of the Little Barren River (below right) provide flat land for agriculture and other uses if drainage and flooding are properly managed. Photos by Dan Carey, Kentucky Geological Survey.

Groundwater

About 2,900 people in Metcalfe County rely on private domestic water supplies: 2,300 use wells and 600 use other sources. In the northwestern and north-central region of Metcalfe County, more than three-quarters of the drilled wells in uplands are adequate for a domestic supply. Yields as high as 50 gallons per minute have been reported from wells penetrating large solution channels. In the southern third of the county, and along the low-lying areas in the East and South Fork of the Little Barren River, only a few wells yield enough for a domestic supply. Numerous springs with flows ranging from a few gallons per minute to 5,000 gallons per minute are found in the county. Minimum flows generally occur in early fall, and maximum flows in late winter. For more information on groundwater in the county, see Carey and Stickney (2004).

Siltstone, Limestone, and Shale (Unit 3)

Rocks of unit 3 (above) are exposed in this roadcut near the Louie B. Nunn Parkway. A water-loving sycamore feeds from the shale layer that impedes percolating water. The erosion-resistant siltstone in unit 3 creates a rugged terrain (below). Photos by Dan Carey, Kentucky Geological Survey.

Limestone and Dolomite (Unit 4)

Slabs of limestone (unit 4) are exposed near the intersection of Ky. 70 and U.S. 68. Photo by Dan Carey, Kentucky Geological Survey.

Shale (Unit 5)

The Chattanooga Shale (unit 5) makes a poor foundation. 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)

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

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Additional Resources

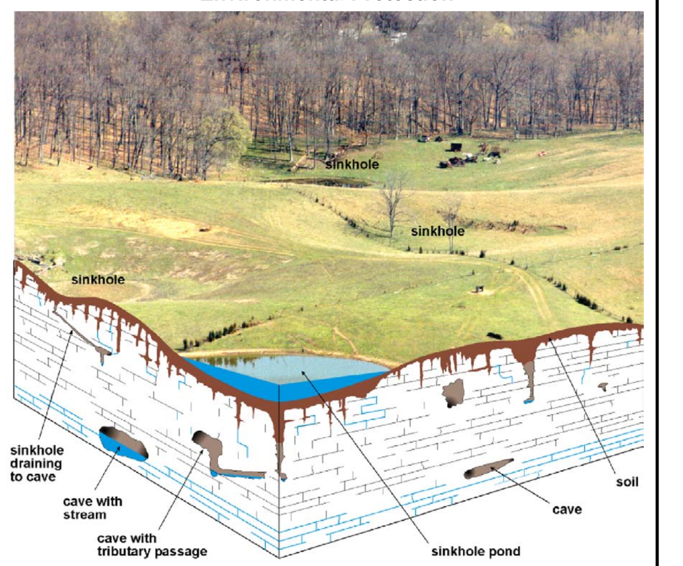
Listed below are Web sites for several agencies and organizations that may be of assistance with land-use planning issues in Metcalfe County:

www.metcalfecounty.com/ Metcalfe County
www.metcalfechamber.com/ Edmonton–Metcalfe County Chamber of Commerce
ces.ca.uky.edu/metcalfe/ UK Cooperative Extension Service
www.bradd.org/ Barren River Area Development District
www.thinkkentucky.com/EDIS/cmnty/index.aspx?cw=038 Kentucky Economic Development Information System
www.uky.edu/KentuckyAtlas/21169.html Kentucky Atlas and Gazetteer
quickfacts.census.gov/qfd/states/21/21169.html U.S. Census data
www.bae.uky.edu/ext/Residential/Radon/QandA.htm Radon in the home
kgsweb.uky.edu/download/misc/landuse/mainkyluplan.htm Planning information from the Kentucky Geological Survey

Karst Geology

Karst areas are indicated by sinkholes. 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.

Environmental Protection



- Never use sinkholes as dumps. All waste, but especially pesticides, paints, household chemicals, automobile batteries, and used motor oil, should be taken to an appropriate recycling center or landfill.
- Make sure runoff from parking lots, streets, and other urban areas is routed through a detention basin and sediment trap to filter it before it flows into a sinkhole.
- Make sure your home septic system is working properly and that it's not discharging sewage into a crevice or sinkhole.
- Keep cattle and other livestock out of sinkholes and sinking streams. There are other methods of providing water to livestock.
- See to it that sinkholes near or in crop fields are bordered with trees, shrubs, or grass buffer strips. This will filter runoff flowing into sinkholes and also keep tilled areas away from sinkholes.
- Construct waste-holding lagoons in karst areas carefully, to prevent the bottom of the lagoon from collapsing, which would result in a catastrophic emptying of waste into the groundwater.
- If required, develop a groundwater protection plan (410KAR5:037) or an agricultural water-quality plan (KRS224.71) for your land use.

(From Currens, 2001)

Pond Construction

Successful pond construction must prevent water from seeping through structured soils into limestone solution channels below. A compacted clay liner or artificial liner may prevent pond failure. Getting the basin filled with water as soon as possible after construction prevents drying and cracking, and possible leakage, of the clayey soil liner. Ponds constructed in dry weather are more apt to leak than ponds constructed in wet weather. A geotechnical engineer or geologist should be consulted regarding the requirements of a specific site. Other leakage prevention measures include synthetic liners, bentonite, and asphaltic emulsions. The U.S. Department of Agriculture–Natural Resources Conservation Service can provide guidance on the application of these liners to new construction, and for treatment of existing leaking ponds.

Dams should be constructed of compacted clayey soils at slopes flatter than three units horizontal to one unit vertical. Ponds with dam heights exceeding 25 feet, or pond volumes exceeding 50 acre-feet, require permits. Contact the Kentucky Division of Water, 14 Reilly Rd., Frankfort, KY 40601, telephone: 502.564.3410. Illustration by Paul Howell, U.S. Department of Agriculture–Natural Resources Conservation Service.

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.	Severe limitations. Failed septic systems can contaminate groundwater. Refer to soil report (Latham and Barton, 1967).	Water in alluvium may be in direct contact with basements. Refer to soil report (Latham and Barton, 1967).	Slight limitations. Refer to soil report (Latham and Barton, 1967).	Slight to moderate limitations. Refer to soil report (Latham and Barton, 1967).	Slight to moderate limitations. Avoid construction in floodplain. Refer to soil report (Latham and Barton, 1967).	Refer to soil report (Latham and Barton, 1967).	Refer to soil report (Latham and Barton, 1967).	Refer to soil report (Latham and Barton, 1967).	Not recommended. Refer to soil report (Latham and Barton, 1967).	Not recommended. Refer to soil report (Latham and Barton, 1967).
2. Limestone and shale	Excellent foundation material; difficult to excavate.	Severe limitations. Impermeable rock. Locally fast drainage through fractures and sinks. Danger of groundwater contamination.	Severe to moderate limitations. Rock excavation; locally, upper few feet may be rippable. Sinks common. Drainage required.	Slight to moderate limitations. Rock excavation; locally, upper few feet may be rippable. Sinks possible. Drainage required.	Slight limitations. Local drainage problems from seeps or springs. Sinks possible.	Slight to moderate limitations, depending on topography. Rock excavation; locally, upper few feet may be rippable. Sinks common. Local drainage problems.	Slight to moderate limitations, depending on activity and topography.	Slight to moderate limitations, depending on activity and topography.	Severe limitations. Leaky reservoir rock; locally, conditions may be favorable. Sinks possible.	Severe limitations. Leaky rock. Locally, conditions may be favorable.	Severe limitations. Rock excavation.
3. Siltstone, limestone, and shale*	Fair to good foundation material; easy to moderately difficult to excavate. Possible expansion of shales.	Severe limitations. Low permeability.	Moderate to severe limitations. Rock excavation; locally, upper few feet may be rippable. Possible expansion of shales.	Severe limitations. Rock excavation; locally, upper few feet may be rippable. Steep slopes. Possible expansion of shales.	Moderate limitations. Rock excavation. Steep slopes.	Severe limitations. Rock excavation; locally, upper few feet may be rippable. Steep slopes. Possible expansion of shales.	Severe limitations. Steep slopes.	Slight to moderate limitations, depending on activity and topography.	Slight limitations. Reservoir may leak where rocks are fractured.	Severe limitations. Steep slopes.	Moderate limitations. Highly variable amount of rock and earth excavation.
4. Limestone and dolomite	Good to excellent foundation material; difficult to excavate.	Severe limitations. Impermeable rock. Danger of groundwater contamination.	Severe limitations. Rock excavation may be required.	Severe limitations. Rock excavation. Possible steep slopes.	Severe to moderate limitations. Rock excavation. Possible steep slopes.	Slight to moderate limitations, depending on topography. Rock excavation. Local drainage problems.	Slight to severe limitations, depending on activity and topography.	Slight to severe limitations, depending on activity and topography.	Moderate to severe limitations. Reservoir may leak where rocks are fractured.	Moderate to severe limitations. Reservoir may leak where rocks are fractured.	Severe limitations. Rock excavation.
5. Shale*	Fair to poor foundation material; easy to moderately difficult to excavate. Possible expansion of shales. Plastic clay is particularly poor foundation.	Severe limitations. Low permeability.	Severe limitations. Low strength, slumping, and seepage problems. Possible shrinking and swelling of shales.	Moderate to severe limitations, depending on slopes. Strength, slumping, and seepage problems.	Moderate to severe limitations, depending on slopes. Strength, slumping, and seepage problems.	Moderate to severe limitations, depending on slopes. Strength, slumping, and seepage problems.	Severe to slight limitations, depending on activity and topography. Strength, slumping, and seepage problems.	Moderate to slight limitations, depending on activity and topography.	Slight limitations. Reservoir may leak where rocks are fractured. Most ponds on shale are successful.	Severe limitations. Poor strength and stability.	Moderate limitations. Poor strength, wetness.
6. Sandstone	Fair to good foundation material; difficult to excavate.	Severe limitations. Impermeable rock.	Severe to moderate limitations. Difficult excavation; locally, upper few feet may be rippable.	Severe to moderate limitations. Difficult excavation; locally, upper few feet may be rippable.	Moderate limitations. Difficult excavation; locally, upper few feet may be rippable.	Moderate to severe limitations. Rock excavation may be required. Possible steep slopes.	Moderate to severe limitations, depending on activity and topography.	Slight to moderate limitations, depending on activity and topography.	Moderate limitations. Reservoir may leak where rocks are fractured.	Slight limitations. Reservoir may leak where rocks are fractured.	Severe to moderate limitations. Highly variable amount of rockand earth 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.