2007

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

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https://doi.org/10.13023/kgs.mc168.12
KGS MAP AND CHART 168
Series XII, 2007

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Acknowledgments

Geology adapted from Conley (2004), Johnson (2004a, b), Lambert (2004a-e), Mullins (2004), Mullins and Thompson (2004), and Thompson (2004). 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. Thanks to Rick Sergeant, Kentucky Geological Survey, for photo assistance.

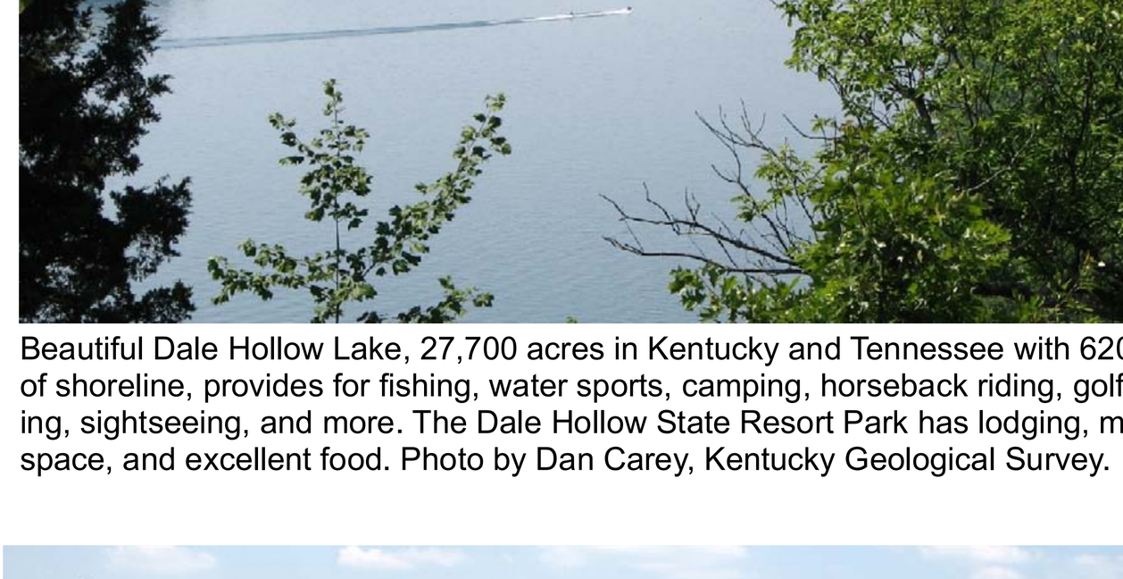
Cumberland County Courthouse at Burkesville

Cumberland County, an area of 306 square miles in the Mississippian Plateaus Region, was formed in 1799. The lowest elevation, 505 feet, is where the Cumberland River leaves the county. The highest elevation, 1,126 feet, is on a ridge at the Tennessee border about 5/8 mile southeast of Ashlock. The 2006 population of 7,211 was 0.9 percent greater than that of 2000. Photo by Dan Carey, Kentucky Geological Survey.

Cumberland River

The Cumberland River crosses the county from northeast to southwest in broad, sweeping, meandering loops and intervening large spurs. It is one of the finest cool-water fishing streams in the eastern United States, with striped bass (40 pounds), brown trout (20 pounds), and rainbow trout. Spring droughts and hot weather can bring reduced flow (above) and warmer water that threatens the fish. Managed releases from the upstream Lake Cumberland Dam mitigate the impacts. Photo by Dan Carey, Kentucky Geological Survey.

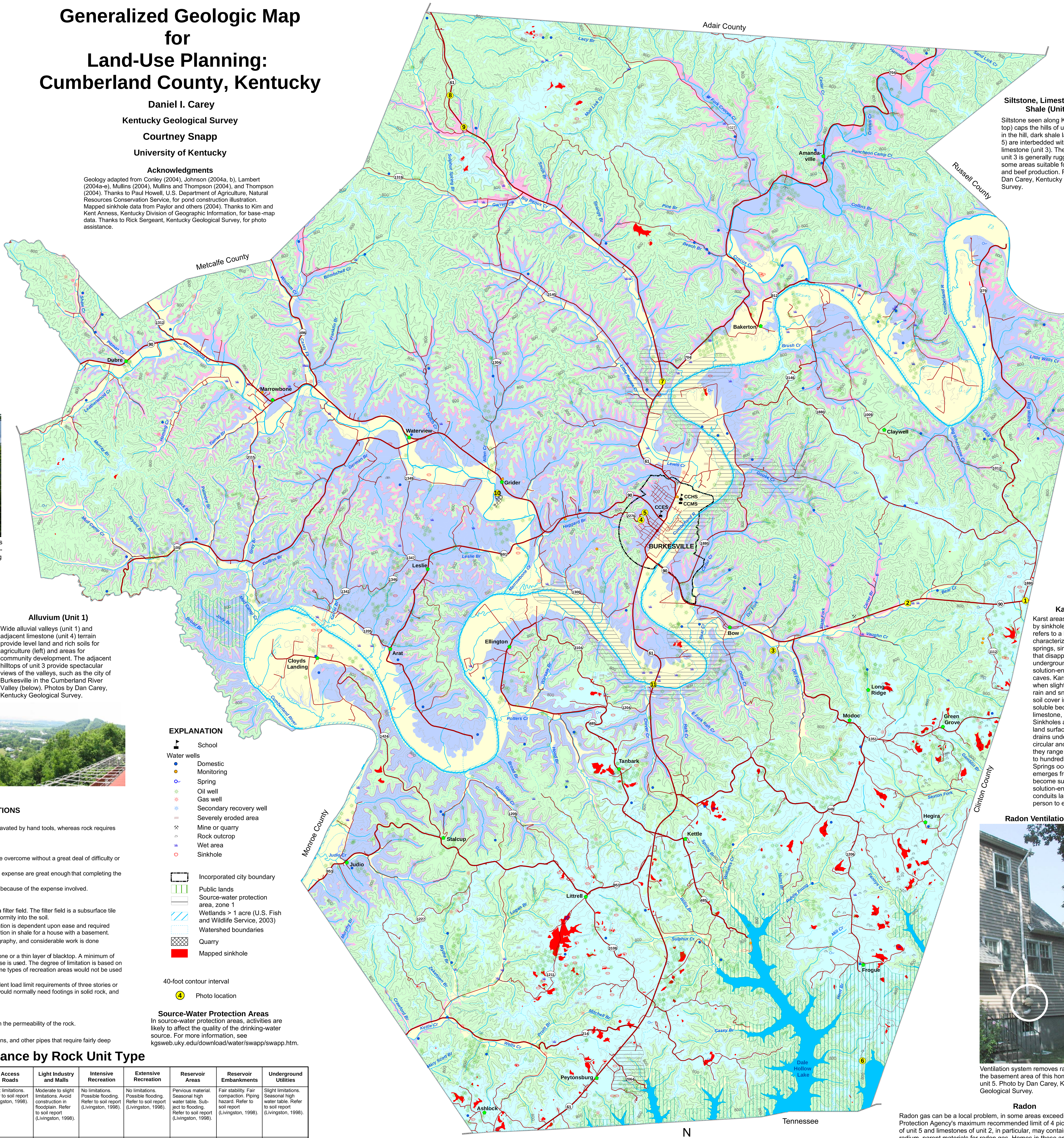
Dale Hollow Lake



Beautiful Dale Hollow Lake, 27,700 acres in Kentucky and Tennessee with 620 miles of shoreline, provides for fishing, water sports, camping, horseback riding, golf, hunting, sightseeing, and more. The Dale Hollow State Resort Park has lodging, meeting space, and excellent food. Photo by Dan Carey, Kentucky Geological Survey.

Alluvium (Unit 1)

Wide alluvial valleys (unit 1) and adjacent limestone (unit 4) terrain provide level land and rich soils for agriculture (left) and areas for community development. The adjacent hilltops of unit 3 provide spectacular views of the valleys, such as the city of Burkesville in the Cumberland River Valley (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, zone 1
- Wetlands > 1 acre (U.S. Fish and Wildlife Service, 2003)
- Watershed boundaries
- Quarry
- Mapped sinkhole

40-foot contour interval

(4) Photo location

Source-Water Protection Areas

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.

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. Silt, clay, sand, and gravel (alluvial deposits)	Fair foundation material; easy to excavate. Seasonal high water table. Subject to flooding.	Severe limitations. Seasonal high water table subject to flooding. Refer to soil report (Livingston, 1998).	Water in alluvium may be in direct contact with basements. Seasonal high water table subject to flooding. Refer to soil report (Livingston, 1998).	Slight limitations. Refer to soil report (Livingston, 1998).	Slight limitations. Refer to soil report (Livingston, 1998).	Moderate to slight limitations. Avoid construction in floodplain. Refer to soil report (Livingston, 1998).	No limitations. Possible flooding. Refer to soil report (Livingston, 1998).	No limitations. Possible flooding. Refer to soil report (Livingston, 1998).	Pervious material. Seasonal high water table. Subject to flooding. Refer to soil report (Livingston, 1998).	Fair stability. Fair compaction. Piping hazard. Refer to soil report (Livingston, 1998).	Slight limitations. Seasonal high water table. Refer to soil report (Livingston, 1998).
2. Limestone, siltstone, and shale	Good to excellent foundation material; moderately difficult to difficult to excavate.	Severe limitations. Impermeable rock. Locally fast drainage through fractures; danger of groundwater contamination.	Severe to moderate limitations. Rock excavation; locally, upper few feet may be rippable. Sinks possible; drainage required.	Slight to moderate limitations. Rock excavation; locally, upper few feet may be rippable. Sinks possible; local drainage problems.	Moderate limitations. Rock excavation. Local drainage problems.	Slight to moderate limitations, depending on topography. Rock excavation; locally, upper few feet may be rippable. Sinks possible; 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 reservoir rock; locally, conditions may be favorable.	Moderate to severe limitations. Rock excavation.
3. Siltstone, limestone, and shale*	Fair to good foundation material; difficult to excavate. Possible expansive shales.	Severe limitations. Impermeable rock. Thin soils.	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.	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	Excellent foundation material; difficult to excavate.	Severe limitations. Impermeable rock. Locally fast drainage through fractures; danger of groundwater contamination.	Severe to moderate limitations. Rock excavation; locally, upper few feet may be rippable.	Slight to moderate limitations. Rock excavation; locally, upper few feet may be rippable. Local drainage problems.	Moderate limitations. Rock excavation.	Slight to moderate limitations, depending on topography. Rock excavation; locally, upper few feet may be rippable.	Slight limitations.	Moderate to slight limitations. Steep wooded slopes. Potential for forest reserve or natural history park.	Severe limitations. Leaky reservoir rock; locally, conditions may be favorable.	Severe limitations. Leaky reservoir rock; locally, conditions may be favorable.	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.

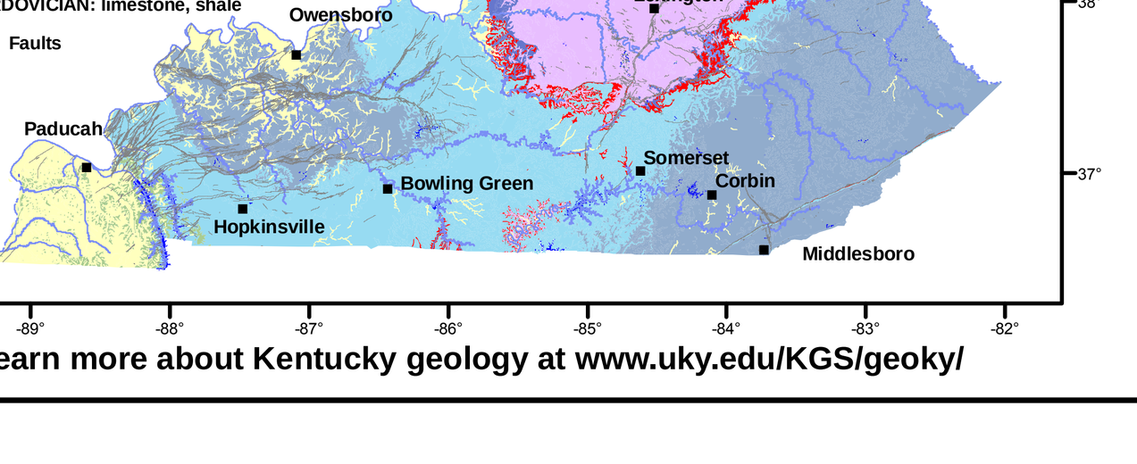
*Shales and clays in these units may shrink during dry periods and swell during wet periods, and cause cracking of foundations. On hillsides, especially where seeps and springs are present, they can also be susceptible to landslides. See discussions of swelling shales and soils and slope stability.

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

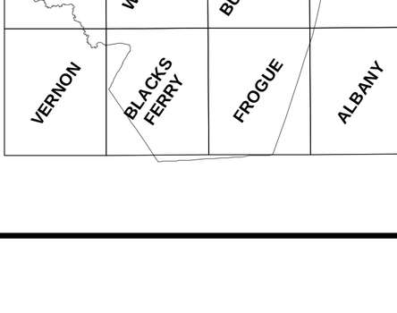
Scale = 1: 48,000
1 inch = 3/4 mile

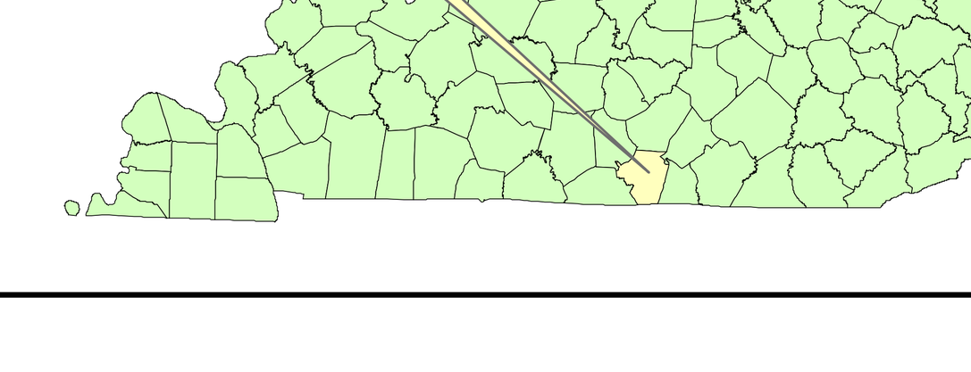
Geology of Kentucky



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

7.5-Minute Quadrangle Map Index

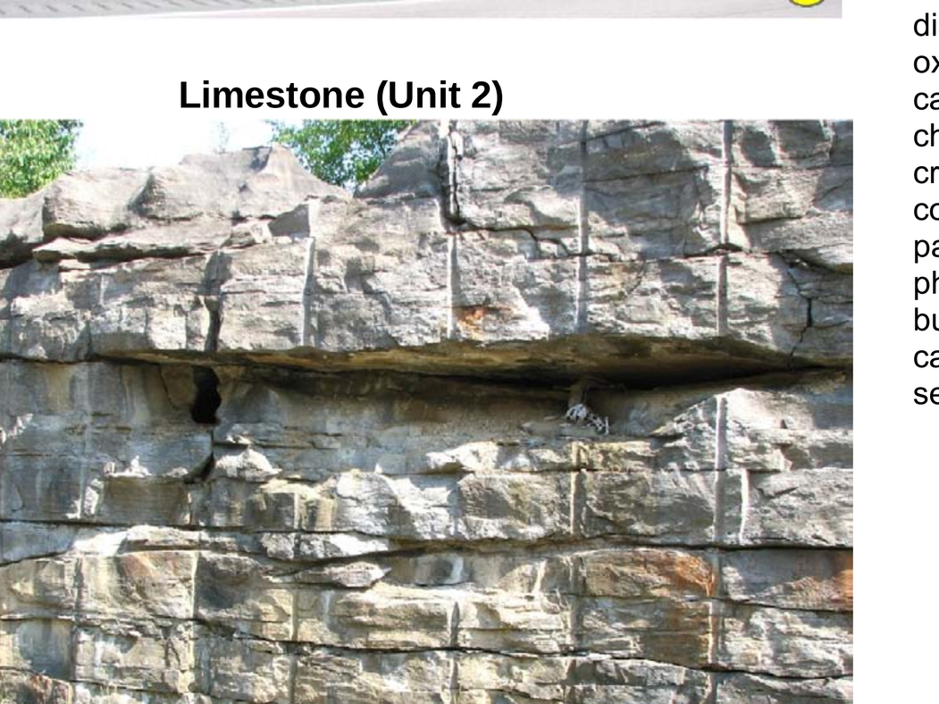




Siltstone, Limestone, and Shale (Unit 3)

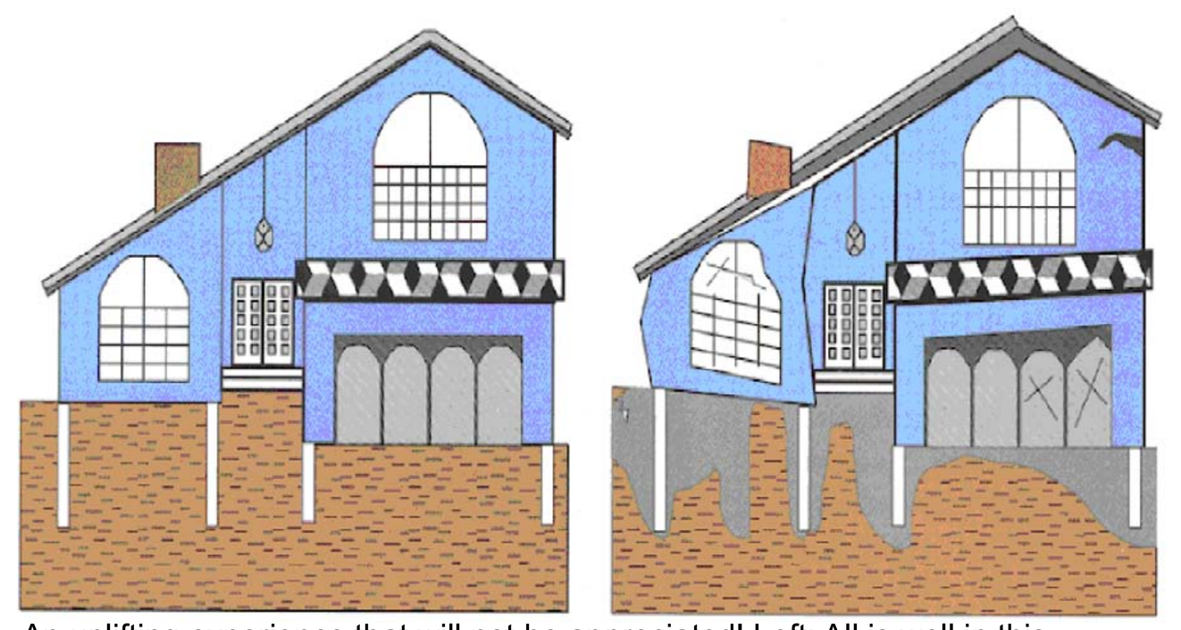
Siltstone seen along Ky. 61 (right, top) caps the hills of unit 3. Lower in the hill, dark shale layers (unit 5) are interbedded with the limestone (unit 3). The terrain of unit 3 is generally rugged, with some areas suitable for forage and beef production. Photos by Dan Carey, Kentucky Geological Survey.

Limestone (Unit 2)



The St. Louis Limestone (unit 2) along Ky. 90. Percolating water penetrates cracks, dissolving the rock and creating sinkholes and underground flow conduits. Water may be quickly contaminated if sinkholes are used for waste disposal. Photo by Dan Carey, Kentucky Geological Survey.

Site Drainage

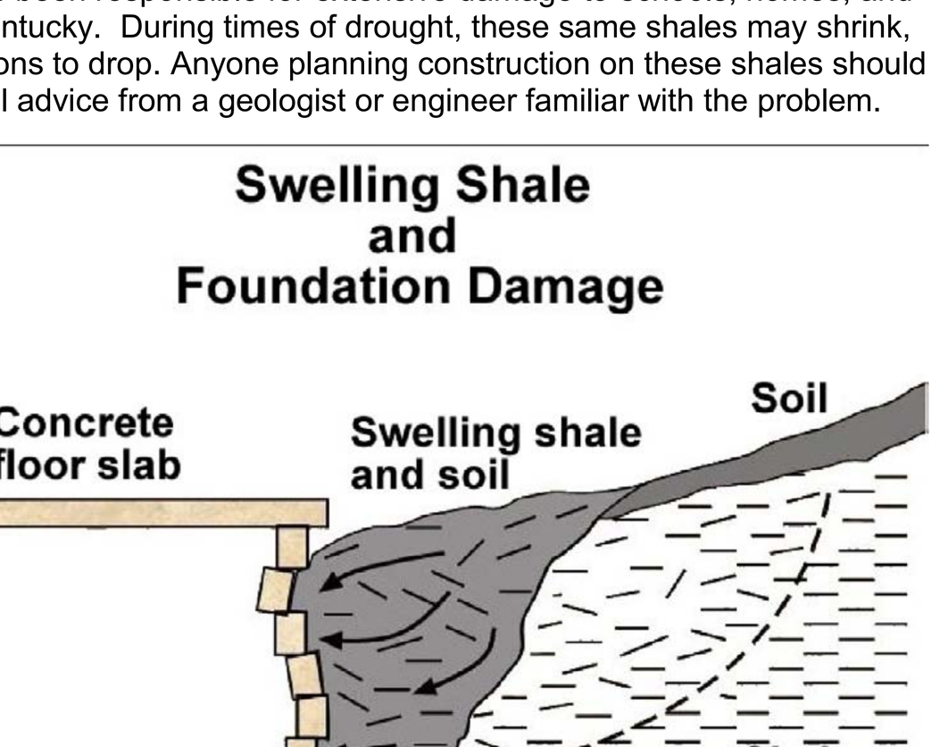


An uplifting experience that will not be appreciated! Left: All is well in this newly built home until water from percolation, drains, lawn sprinklers, leaking sewers, or water mains soaks swelling soil beneath the foundation.

Right: With time, expanding soils exert several tons per square foot of pressure on the foundation and shallow pilings. Without remedial measures, the house will actually become deformed, and shatter masonry and windows. Remedies vary from mere maintenance that keeps drainage away from the house to expensive reconstruction of foundations. Prior site planning that takes geology into account is always preferable to dealing with problems after a structure is built. From AIPG (1993).

Swelling and Shrinking Shales

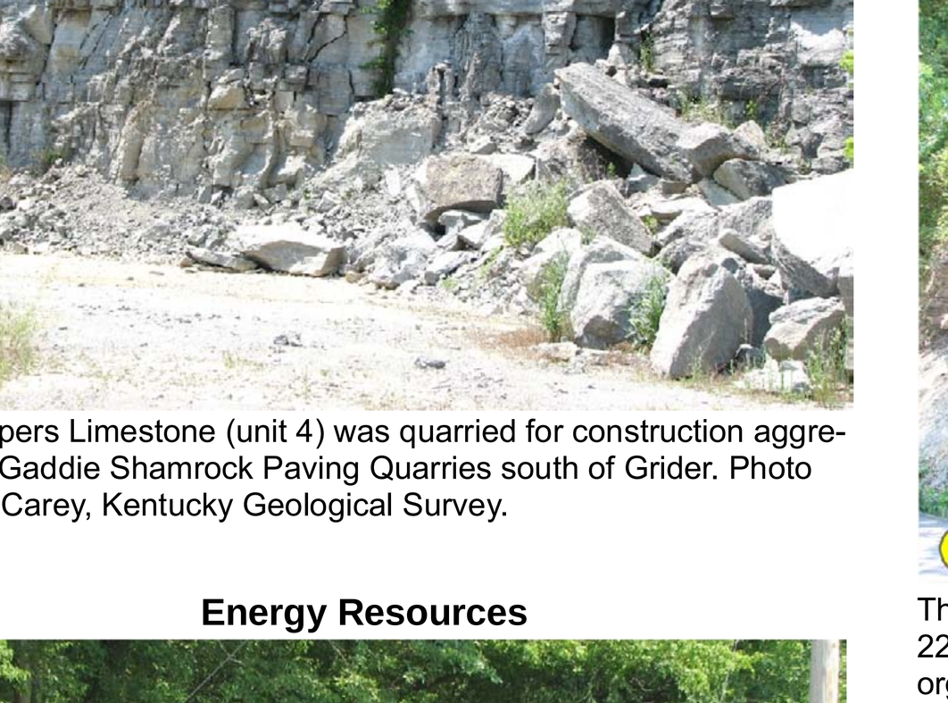
A problem of some concern in Cumberland County is the swelling of some of the clay minerals in shale units 3 and 5. The process is exacerbated when the shale contains the mineral pyrite (fool's gold). Pyrite is a common mineral and can be found distributed throughout the black shale, although it is not always present and may be discontinuous both vertically and horizontally. In the presence of moisture and oxygen, pyrite oxidizes and produces sulfuric acid. The acid reacts with calcium carbonates found in water, the rock itself, crushed limestone, and concrete. This chemical reaction produces sulfate and can form the mineral gypsum, whose crystallization can cause layers of shale to expand and burst, 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.



Karst Geology

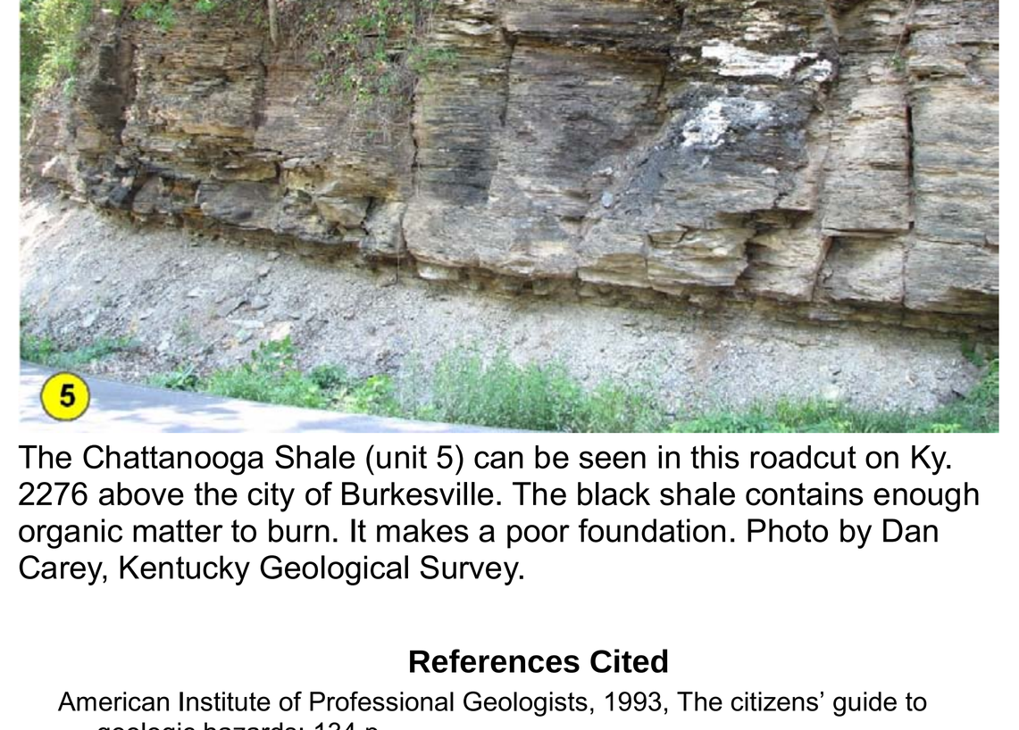
Karst areas (unit 2) are indicated by sinkholes. The term "karst" refers to a landscape characterized by sinkholes, springs, sinking streams (streams that disappear underground), and underground drainage through solution-enlarged conduits or caves. Karst landscapes form when slightly acidic water from 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.

Mineral Resources



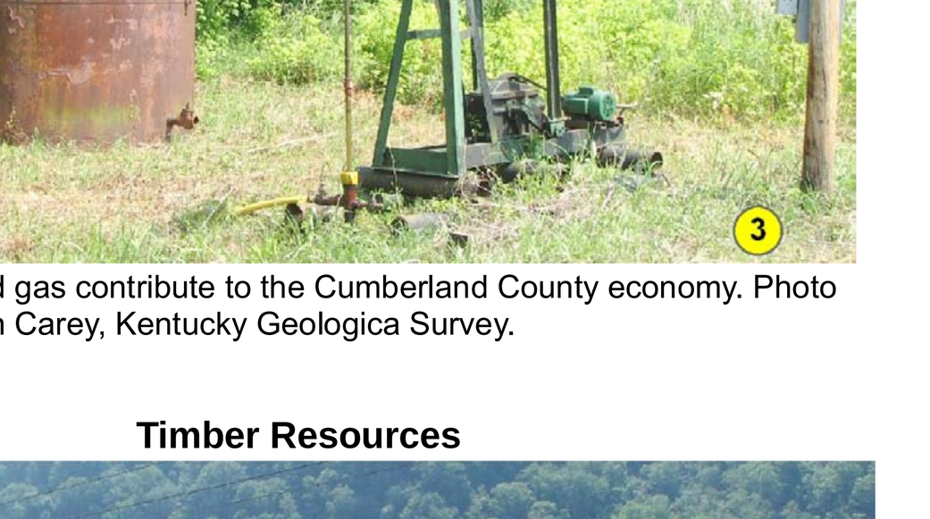
The Leipers Limestone (unit 4) was quarried for construction aggregate at Gaddie Shamrock Paving Quarries south of Grider. Photo by Dan Carey, Kentucky Geological Survey.

Black Shale (Unit 5)



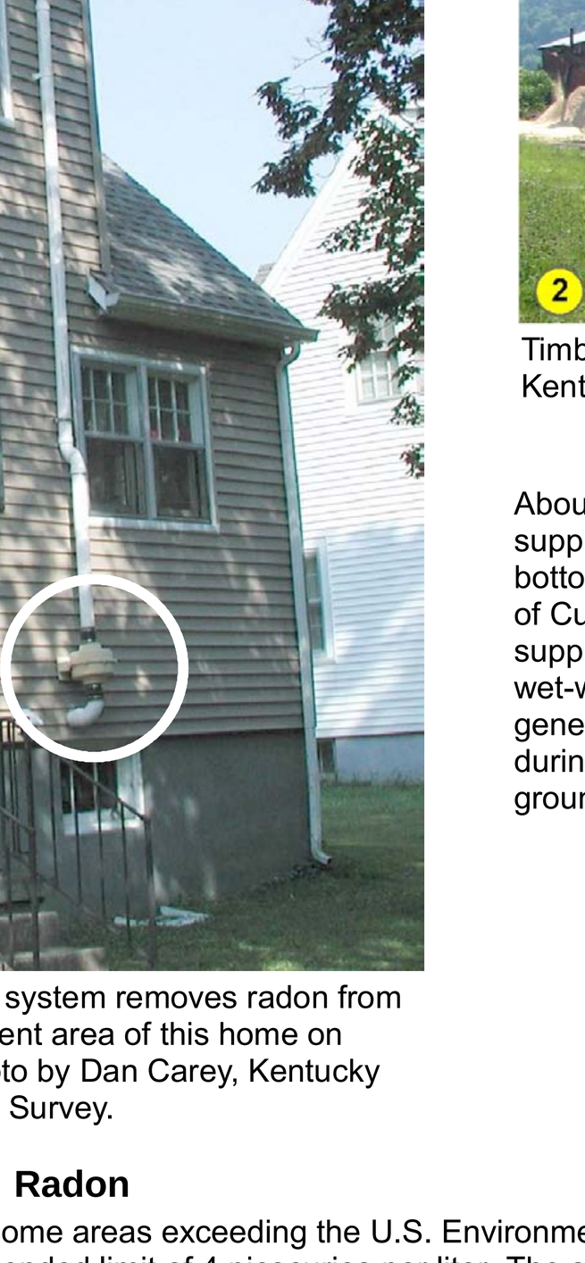
The Chattanooga Shale (unit 5) can be seen in this roadcut on Ky. 2276 above the city of Burkesville. The black shale contains enough organic matter to burn. It makes a poor foundation. Photo by Dan Carey, Kentucky Geological Survey.

Energy Resources



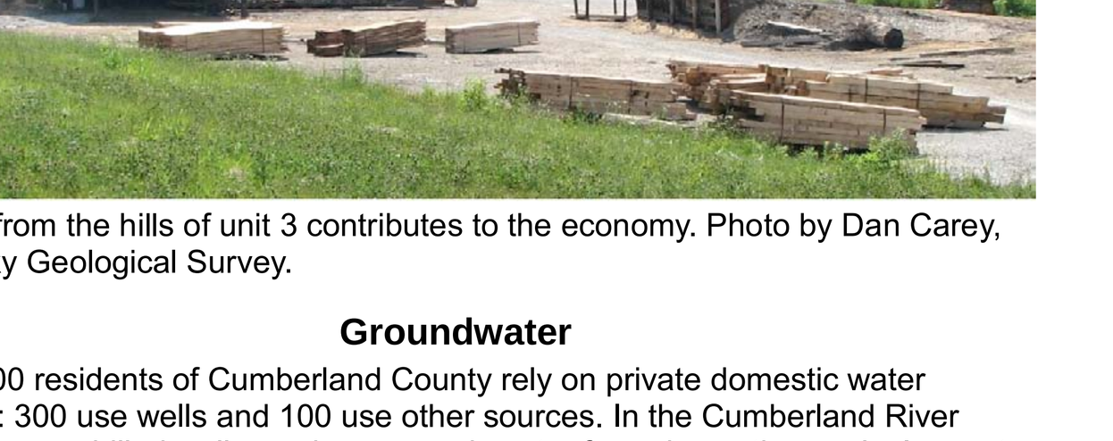
Oil and gas contribute to the Cumberland County economy. Photo by Dan Carey, Kentucky Geologica Survey.

Radon Ventilation



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

Timber Resources



Timber from the hills of unit 3 contributes to the economy. Photo by Dan Carey, Kentucky Geological Survey.

Groundwater

About 400 residents of Cumberland County rely on private domestic water supplies: 300 use wells and 100 use other sources. In the Cumberland River bottom, many drilled wells produce enough water for a domestic supply. In most of Cumberland County, wells will not produce enough water for a domestic supply, except for a few in lowland areas bordering streams. Small springs and wet-weather seeps occur in many areas throughout the county. Spring flows generally do not exceed several gallons a minute, and most springs stop flowing during extended dry periods in late summer and fall. For more information on groundwater in the county, see Carey and Stickney (2005).

Radon

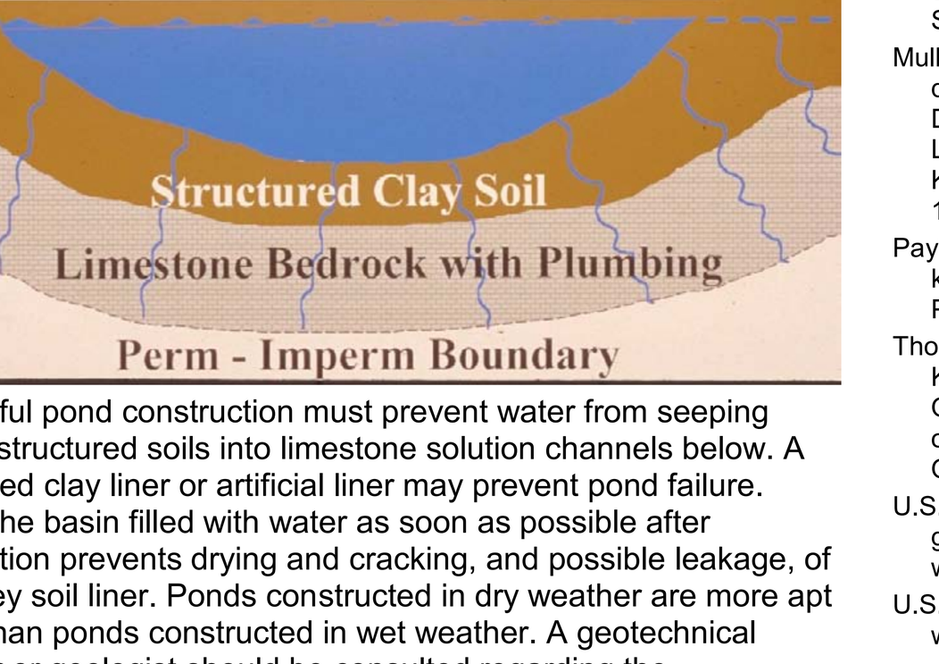
Radon gas can be a local problem, in some areas exceeding the U.S. Environmental Protection Agency's maximum recommended limit of 4 picocuries per liter. The shales of unit 5 and limestones of unit 2, in particular, may contain high levels of uranium or radium, parent materials for radon gas. Homes in 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.

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.

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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 Cumberland County:
www.cumberlandcounty.com/—Cumberland County
www.burkesville.com/ccn/—Cumberland County News
www.burkesville.com/—Burkesville
ces.ca.uky.edu/cumberland/—UK Cooperative Extension Service
www.lcadd.org/—Lake Cumberland Area Development District
www.thinkkentucky.com/edis/—Kentucky Economic Development Information System
www.uky.edu/KentuckyAtlas/21057.html—Kentucky Atlas and Gazetteer
quickfacts.census.gov/qfd/states/21/21057.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