Kentucky Geological Survey
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MAP AND CHART 94
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Generalized Geologic Map for Land-Use Planning: Russell County, Kentucky

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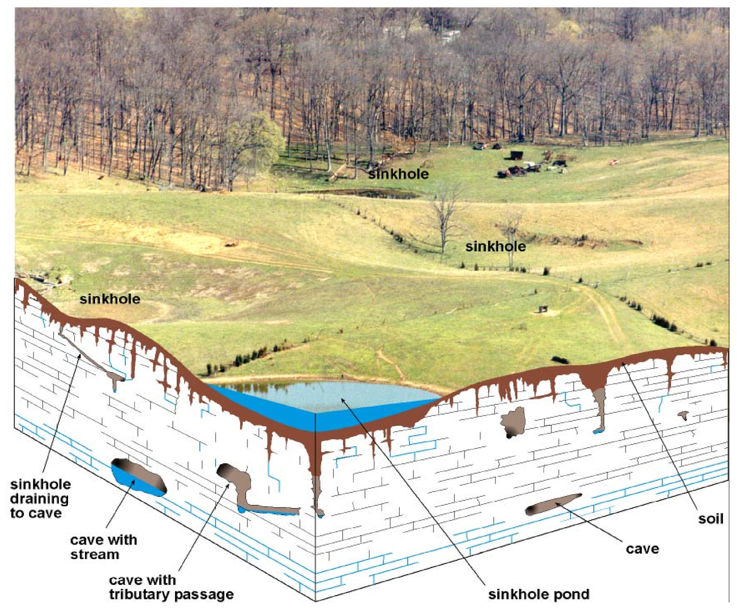
Acknowledgments

Geology adapted from Ciszak (2004), Conley (2004), Johnson (2004a, b), Lambert (2004a, b), Murphy (2004a, b), Mullins and Thompson (2004), Petersen (2004), Zhang (2004a, b), and Zhang and Melton (2004). Sinkhole data from Paylor and others (2004). Thanks to Jim Currens, Kentucky Geological Survey, for karst illustrations.

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.

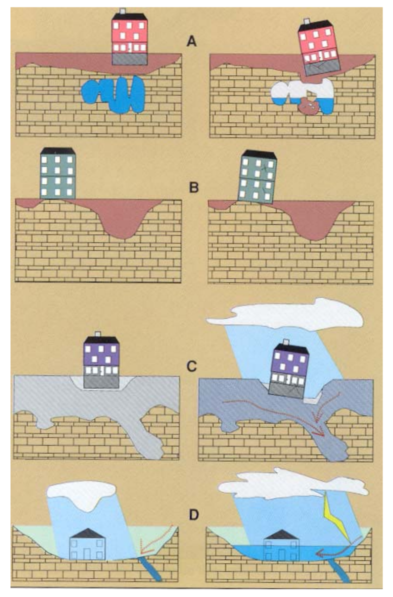
See to it that sinkholes near or in crop fields are bordered with trees, shrubs, or grass buffer strips. This will filter runoff flowing into sinkholes and also keep tilled areas away from sinkholes.

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)

Residential Construction



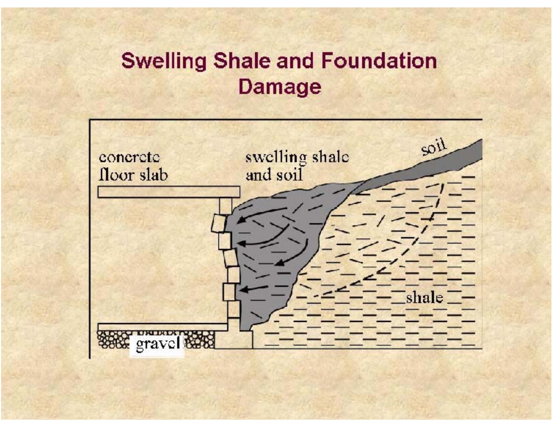
Limestone terrain can be subject to subsidence hazards, which usually can be overcome by prior planning and site evaluation. "A" shows construction above an open cavern, which later collapses. This is one of the most difficult situations to detect, and the possibility of this situation beneath a structure 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).

Constructed between 1941 and 1950, Wolf Creek Dam is a comprehensive flood-control system for the Cumberland River. It impounds Lake Cumberland, one of the largest lakes in Kentucky and a vital source of tourism for Kentucky. Photo by Bart Davidson, Kentucky Geological Survey.

The Chattanooga Shale (unit 8), shown at left, is the equivalent of the New Albany Shale in Estill County, which is well known for exhibiting pyrite expansion. The telltale yellow weathering usually denotes the presence of pyrite. Care must be taken to check for swelling shales when building on this material.

Photo by Bart Davidson, Kentucky Geological Survey.

Swelling Shales and Soils



A problem of considerable concern in this area is the swelling of some of the clay minerals in shales such as units 2, 3, 5, and 8. This process is exacerbated when the shale contains the mineral pyrite (fool's gold), such as is the case in the Chattanooga Shale (unit 8). 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 can even damage upper floors and interior partitions. This phenomenon has been responsible for extensive damage to schools, homes, and businesses in Kentucky.

We strongly suggest that anyone planning construction on these shales seek professional advice from a geologist or engineer familiar with the problem.

These cattle are resting near a pond that is probably a sinkhole pond, meaning that it is connected to the limestone aquifer by fractures in the bedrock, but is plugged with soil. Cattle feedlots or pastures such as this can cause increased nitrates in groundwater if the ponds or feedlots drain into the aquifer. Photo by Bart Davidson, Kentucky Geological Survey.

Sinkholes such as this one (right center) may appear overnight when the soil plug at their base collapses into a fracture or cave in the underlying limestone. Photo by Bart Davidson, Kentucky Geological Survey.

Karst Geology

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.

Mapped Surface Faults

Faults are common geologic structures across Kentucky, and have been mapped in many of the Commonwealth's counties. The faults shown on this map represent seismic activity that occurred several million years ago at the latest. There has been no activity along these faults in recorded history. Seismic risk associated with these faults is very low. Faults may be associated with increased fracturing of bedrock in the immediately adjacent area. This fracturing may influence slope stability and groundwater flow in these limited areas.

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 supercede those of the underlying bedrock and should be considered on a site-to-site basis. At any site, it is important to understand both the soils and the underlying rock. For further assistance, contact Bart Davidson, Kentucky Geological Survey, 859-257-5500 x162. For more information, and to make custom maps of your local area, visit our Land-Use Planning Internet Mapping Web Site at kgsmap.uky.edu/website/kyluplan/viewer.htm.

Groundwater Availability

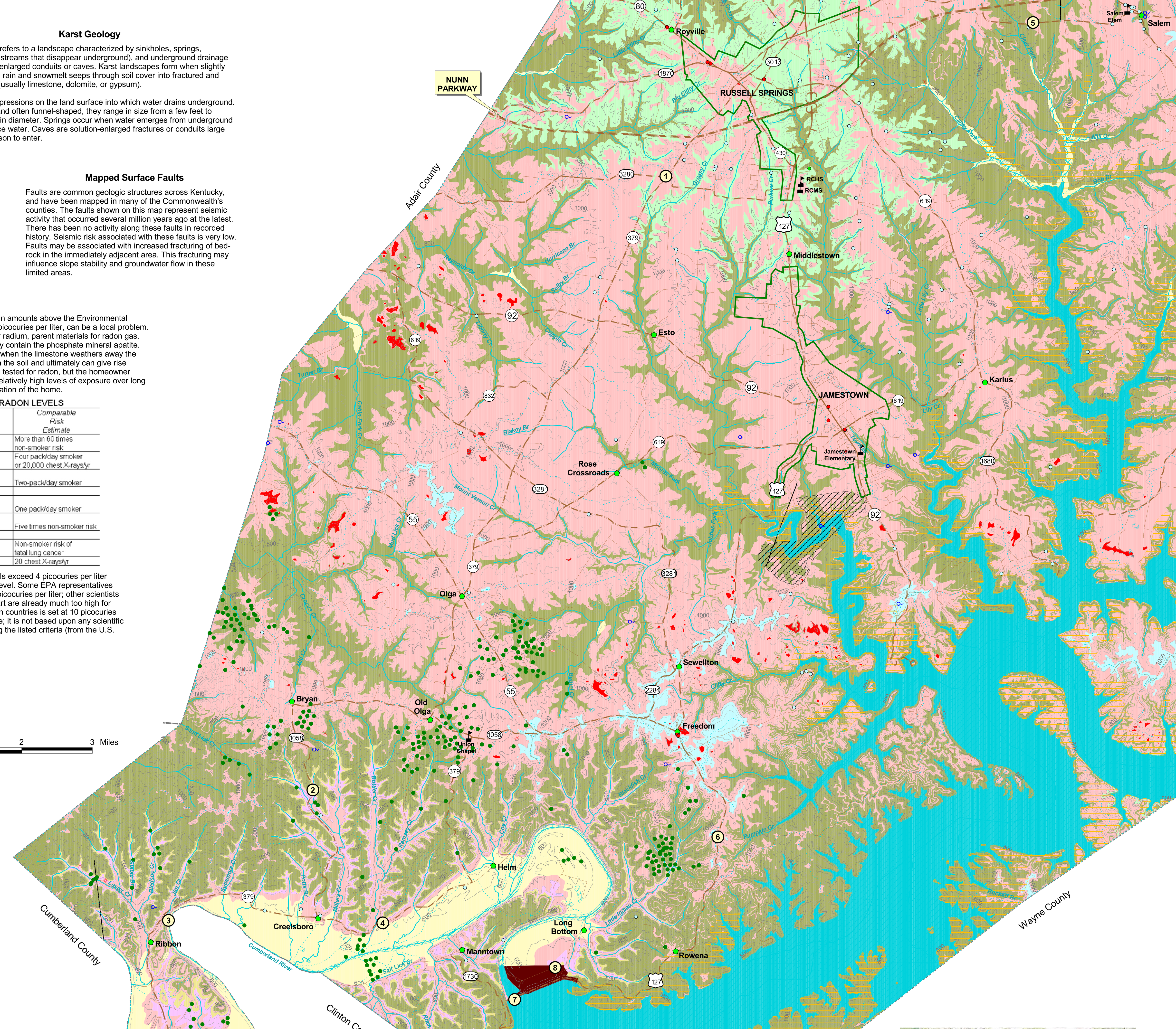
In the northwestern third of Russell County about three-quarters of the drilled wells yield enough water for domestic use. Throughout the rest of the county, only a few wells yield enough water for a domestic supply, except in areas close to the Cumberland River in the southern end of the county. In the southern end of the county most wells are adequate for a domestic supply, especially wells that penetrate small solution openings within the limestone bedrock.

For more information on the groundwater resources of the county, see Carey and Stickney (2004).

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.

A cattle watering trough, probably fed from the nearby water well. Such wells are often the most economical source of water for rural communities. Photo by Bart Davidson, Kentucky Geological Survey.



EXPLANATION

- School
- Oil and Gas Wells
  - Gas well
  - Oil well
- Spring
- Water Wells
  - Domestic
  - Industrial
  - Monitoring
  - Public
- Incorporated city
- Wetlands > 1 acre (U.S. Fish & Wildlife Service, 2003)
- Wildlife management area
- Source-water protection area, zone 1
- Sinkholes
- Artificial fill
- Watershed divide
- Faults
  - Concealed fault
  - Fault
- County line
- Photo location

50-foot contour interval

N

Scale 1:48,000

1 inch equals 3/4 mile

1 0 1 2 3 Miles

For information on obtaining copies of this map and other Kentucky Geological Survey maps and publications call:

Public Information Center
859.257.3896
877.778.7827 (toll free)

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

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 and without 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.

Radon

Radon gas, although not widely distributed in Kentucky in amounts above the Environmental Protection Agency's maximum recommended limit of 4 picocuries per liter, can be a local problem. Unit 6 on the map may contain high levels of uranium or radium, parent materials for radon gas. This unit and several other limestones in the state locally contain the phosphate mineral apatite. Uranium is sometimes part of the apatite structure, and when the limestone weathers away the phosphates containing uranium become concentrated in the soil and ultimately can give rise to high levels of radon. Homes in these areas should be tested for radon, but the homeowner should keep in mind that the health threat results from relatively high levels of exposure over long periods, and the remedy may simply be additional ventilation of the home.

COMPARATIVE RISK CHART for RADON LEVELS

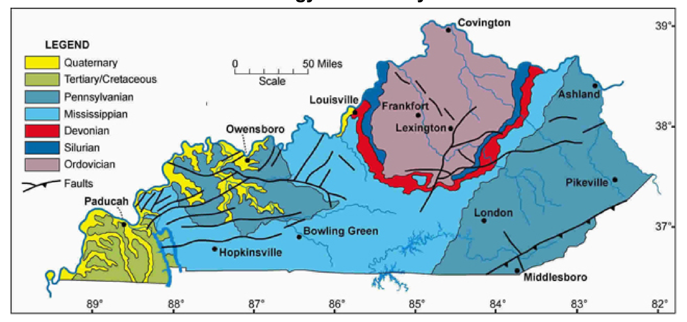
Radon Level pCi/L	*Estimated Fatal Lung Cancers/1000*	*Comparable Exposure Levels*	*Comparable Risk Estimate*
200	440 - 770	1,000 times average outdoor level	More than 60 times non-smoker risk
100	270 - 630	100 times average outdoor level	Four pack/day smoker or 20,000 chest X-rays/yr
40	120 - 380	100 times average outdoor level	Two-pack/day smoker
20	60 - 210		
10	30 - 120	10 times average indoor level	One pack/day smoker
4	13 - 50	10 times average outdoor level	Five times non-smoker risk
2	7 - 30		
1	3 - 13	Average indoor level	Non-smoker risk of fatal lung cancer
0.2	1 - 3	Average outdoor level	20 chest X-rays/yr

EPA recommends action be taken if indoor levels exceed 4 picocuries per liter (pCi/L), which is 10 times the average outdoor level. Some EPA representatives believe the action level should be lowered to 2 picocuries per liter; other scientists dissent and claim the risks estimated in this chart are already much too high for low levels of radon. The action level in European countries is set at 10 picocuries per liter. Note that this chart is only one estimate; it is not based upon any scientific result from a study of a large population meeting the listed criteria (from the U.S. Environmental Protection Agency, 1986).

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. Alluvium, landslide, and terrace deposits	Fair to good foundation material; easily excavated. Refer to soil report (Fehr, 1982).	Slight limitations. Easy to excavate. Refer to soil report (Fehr, 1982).	Moderate to severe limitations. Check area to determine if flood prone. Basements can be wet. Refer to soil report (Fehr, 1982).	Slight to moderate limitations. Refer to soil report (Fehr, 1982).	Slight to moderate limitations. Refer to soil report (Fehr, 1982).	Slight limitations. Refer to soil report (Fehr, 1982).	Check to see if area is flood prone. If not, slight limitations based on type of structures. Refer to soil report (Fehr, 1982).	Check to see if area is flood prone. If not, slight limitations based on type of structures. Refer to soil report (Fehr, 1982).	Severe limitations. Leaky reservoir material. Refer to soil report (Fehr, 1982).	Severe limitations. Leaky reservoir material. Refer to soil report (Fehr, 1982).	High groundwater table possible. Moderate to severe limitations. Refer to soil report (Fehr, 1982).
2. Shale, siltstone, sandstone, and coal	Fair to good foundation material. Difficult to excavate. Possible expansive shales.	Severe limitations. Impermeable rock. Thin soils.	Severe to moderate limitations. Rock excavation; locally, upper few feet may be rippable. Steep slopes. 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.	Slight limitations. Reservoir may leak where rocks are fractured.	Severe limitations. Steep slopes.	Moderate limitations. Highly variable amount of rock and earth excavation.
3. Shale, sandstone, limestone, and siltstone	Fair to good foundation material. Difficult to excavate. Possible expansive shales.	Severe limitations. Impermeable rock. Thin soils.	Severe to moderate limitations. Rock excavation; locally, upper few feet may be rippable. Steep slopes. 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.	Slight limitations. Reservoir may leak where rocks are fractured.	Severe limitations. Steep slopes.	Moderate limitations. Highly variable amount of rock and earth excavation.
4. Sandstone, conglomerate, and minor shale	Fair to good foundation material. Difficult to excavate.	Severe limitations. Impermeable rock. Thin soils.	Severe to moderate limitations. Rock excavation; locally, upper few feet may be rippable. Steep slopes.	Severe limitations. Rock excavation; locally, upper few feet may be rippable. Steep slopes.	Moderate limitations. Rock excavation. Steep slopes.	Severe limitations. Rock excavation; locally, upper few feet may be rippable. Steep slopes.	Severe limitations. Steep slopes.	Slight to moderate limitations.	Slight limitations. Reservoir may leak where rocks are fractured.	Severe limitations. Steep slopes.	Moderate limitations. Highly variable amount of rock and earth excavation.
5. Limestone, shale, and siltstone	Fair to good foundation material. Difficult to excavate. Possible expansive shales.	Severe limitations. Thin soils and impermeable rock. Fast drainage through fractures to water table; possible groundwater contamination.	Moderate limitations. Rock excavation; locally, upper few feet may be rippable. Steep slopes along major drainages. Possible expansion of shales.	Moderate limitations. Rock excavation; locally, upper few feet may be rippable. Steep slopes along major drainages. Possible expansion of shales.	Slight limitations. Rock excavation. Steep slopes along major drainages.	Slight limitations. Rock excavation; locally, upper few feet may be rippable. Steep slopes along major drainages. Possible expansion of shales.	Moderate limitations. Steep to moderate slopes.	Slight limitations.	Slight to moderate limitations. Reservoir may leak where rocks are fractured. Sinks possible.	Slight limitations. Reservoir may leak where rocks are fractured.	Moderate limitations. Possibility of thin soils and rock excavation.
6. Limestone, dolomite, and shale	Fair to very good foundation material. Difficult to excavate.	Severe limitations. Impermeable rock. Locally fast drainage through fractures and sinks to water table; possible groundwater contamination.	Severe limitations. Rock excavation may be required. Steep slopes along major drainages.	Moderate limitations. Rock excavation. Local drainage problems. Sinks common.	Moderate limitations. Rock excavation. Local drainage problems. Sinks common.	Severe to slight limitations, depending on topography. Rock excavation. Local drainage problems. Sinks common. Groundwater contamination possible.	Severe to slight limitations, depending on activity and topography. Possible steep wooded slopes.	Severe to slight limitations, depending on activity and topography. Possible steep wooded slopes.	Moderate to severe limitations. Reservoir may leak where rocks are fractured. Sinks possible.	Moderate to severe limitations. Reservoir may leak where rocks are fractured. Sinks possible.	Severe limitations. Possible rock excavation.
7. Dolomite and limestone/siltstone	Very good foundation material. Difficult to excavate.	Severe limitations. Impermeable rock. Locally fast drainage through fractures and sinks to water table; possible groundwater contamination.	Severe limitations. Rock excavation may be required. Steep slopes along major drainages.	Severe limitations. Rock excavation. Possible steep slopes.	Severe to moderate limitations. Rock excavation. Possible steep slopes and narrow ravines.	Moderate to slight limitations, depending on topography. Rock excavation. Local drainage problems. Sinks common.	Severe to slight limitations, depending on activity and topography. Possible steep wooded slopes.	Severe to slight limitations, depending on activity and topography. Possible steep wooded slopes.	Slight to moderate limitations. Reservoir may leak where rocks are fractured. Sinks possible.	Slight to moderate limitations. Reservoir may leak where rocks are fractured. Sinks possible.	Severe limitations. Possible rock excavation.
8. Shale and dolomite	Fair to good foundation material. Difficult excavation. Possible expansion of shales.	Severe limitations. Impermeable rock. Locally fast drainage through fractures and sinks to water table; possible groundwater contamination.	Severe to moderate limitations. Rock excavation; locally, upper few feet may be rippable. Steep slopes. 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 to slight limitations, depending on activity and topography. Possible steep wooded slopes.	Severe to slight limitations, depending on activity and topography. Possible steep wooded slopes.	Slight to moderate limitations. Reservoir may leak where rocks are fractured.	Slight to moderate limitations. Reservoir may leak where rocks are fractured.	Severe to moderate limitations. Possible rock excavation.
9. Siltstone, dolomite and chert	Fair to good foundation material. Difficult to excavate.	Severe limitations. Thin soils and impermeable rock. Fast drainage through fractures to water table; possible groundwater contamination.	Severe to moderate limitations. Rock excavation may be required. Possible steep slopes.	Severe to moderate limitations. Rock excavation may be required. Possible steep slopes.	Severe to moderate limitations. Rock excavation may be required. Possible steep slopes.	Severe to moderate limitations. Rock excavation may be required. Possible steep slopes.	Severe to moderate limitations. Rock excavation may be required.	Severe to slight limitations, depending on activity and topography. Possible steep wooded slopes.	Slight limitations. Reservoir may leak where rocks are fractured.	Severe limitations. Reservoir may leak where rocks are fractured. Sinks possible.	Severe to moderate limitations. Possible rock excavation.

Geology of Kentucky



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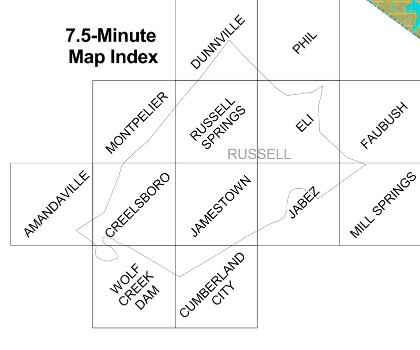
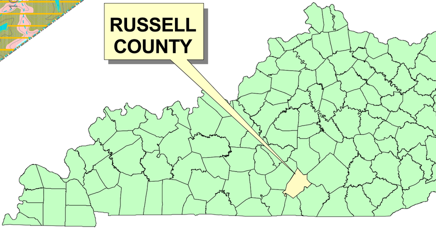
7.5-Minute Map Index





A power transmission line from nearby Wolf Creek Dam crosses southern Russell County near Creelsboro. Power line right-of-ways must be taken into account for land-use planning purposes. Photo by Bart Davidson, Kentucky Geological Survey.

The Creelsboro Arch, locally known as the Rockbridge, in southwestern Russell County, is formed from limestone in the Mississippian Fort Payne formation. While not officially a state park, it is protected by the landowner and is a common destination for tourists and artists. Photo by Bart Davidson, Kentucky Geological Survey.

Wolf Creek National Fish Hatchery, located next to Wolf Creek Dam, produces over a million pounds of trout annually. Water feeding the hatchery comes from Lake Cumberland at a rate of 10,000 gallons per minute, and is between 40 and 65 degrees Fahrenheit. Photo by Bart Davidson, Kentucky Geological Survey.

Additional Planning Resources

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

www.russellcountyky.com/—Russell County C hamber of Commerce
ces.ca.uky.edu/russell/—University of Kentucky Cooperative Extension Service
www.lcadd.org/—Lake Cumberland Area Development District
www.thinkkentucky.com/edis/cmnty/cw077/—Kentucky Economic Development Information System
www.uky.edu/KentuckyAtlas/21207.html—Kentucky Atlas and Gazetteer, Russell County
quickfacts.census.gov/qfd/states/21/21207.html—U.S. Census data
kgsweb.uky.edu/download/kgsplanning.htm—Planning information from the Kentucky Geological Survey

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Johnson, T.L., 2004b, Spatial database of the Jamestown quadrangle, Kentucky: Kentucky Geological Survey, ser. 12, Digitally Vectorized Geologic Quadrangle Data DVGQ-182. Adapted from Thaden, R.E., and Lewis, R.Q., Sr., 1962, Geology of the Jamestown quadrangle, Kentucky: U.S. Geological Survey Geologic Quadrangle Map GQ-182, scale 1:24,000.
Lambert, J.R., 2004a, Spatial database of the Amandaville quadrangle, Kentucky: Kentucky Geological Survey, ser. 12, Digitally Vectorized Geologic Quadrangle Data DVGQ-186. Adapted from Taylor, A.R., 1962, Geology of the Amandaville quadrangle, Kentucky: U.S. Geological Survey Geologic Quadrangle Map GQ-186, scale 1:24,000.
Lambert, J.R., 2004b, Spatial database of the Wolf Creek Dam quadrangle, Kentucky: Kentucky Geological Survey, ser. 12, Digitally Vectorized Geologic Quadrangle Data DVGQ-177. Adapted from Lewis, R.Q., Sr., and Thaden, R.E., 1962, Geology of the Wolf Creek Dam quadrangle, Kentucky: U.S. Geological Survey Geologic Quadrangle Map GQ-177, scale 1:24,000.
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