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

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

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Acknowledgments

Geology adapted from Crawford (2004a-c), Johnson (2004), Murphy (2004a, b), Nelson (2004a-e), and Petersen (2004a, b). Mapped sinkholes from Paylor and others (2004). Thanks to Paul Howell, U.S. Department of Agriculture, Natural Resources Conservation Service, for pond construction illustration. Thanks to Mike Carey, St. Augustine School, for photo assistance. Thanks to Kim and Kent Anness, Kentucky Division of Geographic Information, for base map data.

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.

Water Resources

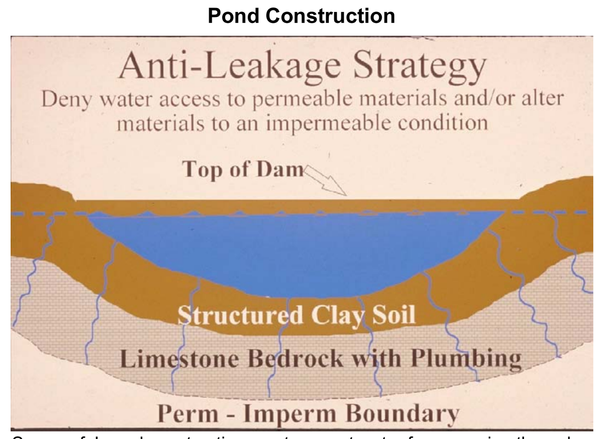
Sportsmans Lake, near the Lebanon city limits, is a public recreational area owned by the Commonwealth of Kentucky and operated by Marion County. The lake and surrounding area offer a clubhouse, a playground, and facilities for fishing, picnicking, and archery. Drinking water for Lebanon and Marion County is provided by the Rolling Fork River and the Fagan Branch Reservoir; 95 percent of the residents are on public water. Photo by Dan Carey, Kentucky Geological Survey.

Groundwater

Groundwater resources in Marion County are limited. Wells located in the larger valley bottoms throughout the county will produce enough water for a domestic supply, except during dry weather. In upland areas (80 percent of the county), most drilled wells will not produce enough water for a dependable domestic supply, unless they are drilled along drainage lines, in which case they may produce enough water except during dry weather. Throughout the county, groundwater is hard or very hard, and may contain salt or hydrogen sulfide, especially at depths greater than 100 feet.

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

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 3 units horizontal to 1 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.

Marion County Courthouse

Marion County, an area of 346 square miles, was established in 1834. The 2005 population was 18,754 (54 people per square mile), 10.4 percent larger than in 1990. The county includes parts of the Outer Bluegrass, Knobs, and Mississippian Plateau Regions. The southern boundary of the county approximates the position of Muldraugh Hill, a regional escarpment. The highest point in the county is Putnam Knob, 1,260 feet, about 6 miles east of Lebanon. The lowest elevation, 475 feet, is where Hardin Creek leaves the northern tip of the county. The geographic center of Kentucky is in Marion County, just northwest of Lebanon. Photo by Dan Carey, Kentucky Geological Survey.

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.

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 3 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.

Radon Ventilation

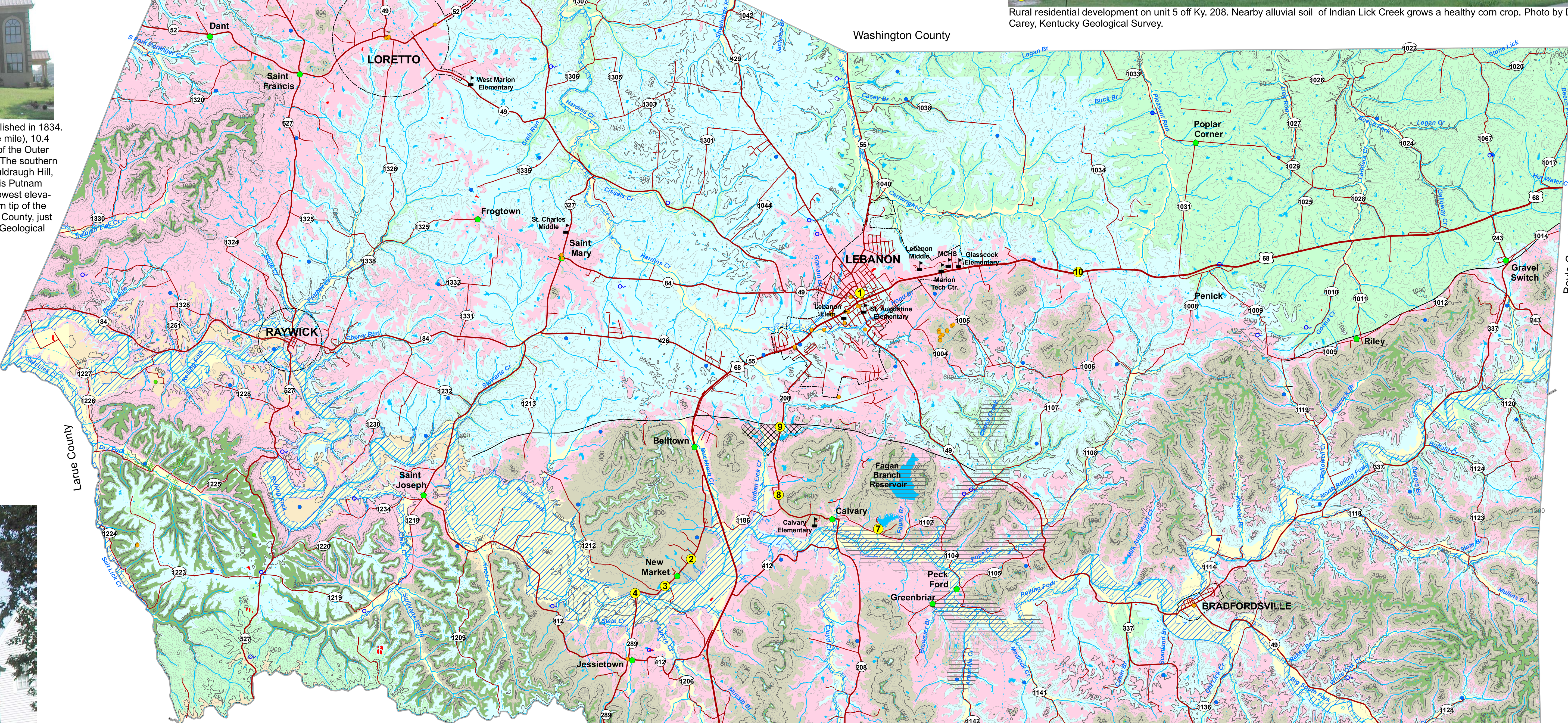
Ventilation system removes radon from the basement area of this home on unit 5. Photo by Dan Carey, Kentucky Geological Survey.

Alluvium

Alluvium deposited by the Rolling Fork provides fertile soils for row crops. Photo by Dan Carey, Kentucky Geological Survey.

Limestone and Dolomite—Unit 3

Limestone and dolomite of unit 3 in northern Marion County provide soils for a strong agricultural economy. Photo by Dan Carey, Kentucky Geological Survey.



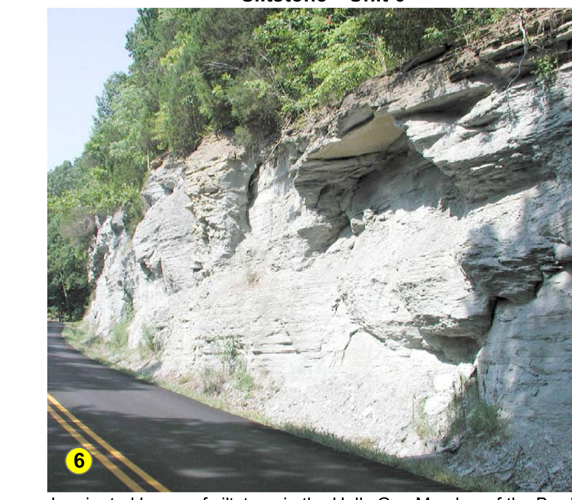
Site Drainage

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).

Limestone, Siltstone, Shale—Units 5, 6, and 7

Limestone and siltstone layers (units 6 and 7) overlying the shale layer (unit 5) at this roadcut on U.S. 68/Ky. 55 near the Taylor County line provide a good illustration of these Mississippian (350 million years old) rocks. Photo by Dan Carey, Kentucky Geological Survey.

Siltstone—Unit 6



Laminated layers of siltstone in the Halls Gap Member of the Borden Formation (unit 6) are exposed at this roadcut on Ky. 208 south of Phillipsburg. Photo by Dan Carey, Kentucky Geological Survey.

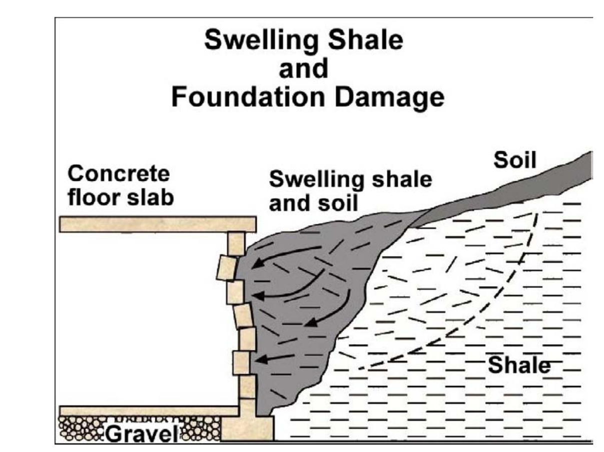
Rural Residential Development

Rural residential development on unit 5 off Ky. 208. Nearby alluvial soil of Indian Lick Creek grows a healthy corn crop. Photo by Dan Carey, Kentucky Geological Survey.

Swelling and Shrinking Shales

A problem of some concern in Marion County is the swelling of some of the clay minerals in shale units 5 and 6. 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 laterally 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.



Some shales, and the soils derived from them, swell when exposed to water or air. These swelling shales and soils can have severe impacts on building foundations and other structures (e.g., bridges, dams, roads). Photo by John Kiefer, Kentucky Geological Survey.

EXPLANATION

- School
- Water wells
  - Domestic
  - Agricultural
  - Monitoring
- Springs
- Gas well
- Oil well
- Incorporated city boundary
- Wildlife management area
- Source-water protection area, zone 1
- Designated flood zone (FEMA, 2004)
- Wetlands > 1 acre (U.S. Fish and Wildlife Service, 2003)
- Watershed boundaries
- Quarry
- Mapped sinkhole
- Artificial fill
- Concealed fault
- Fault

40-foot contour interval

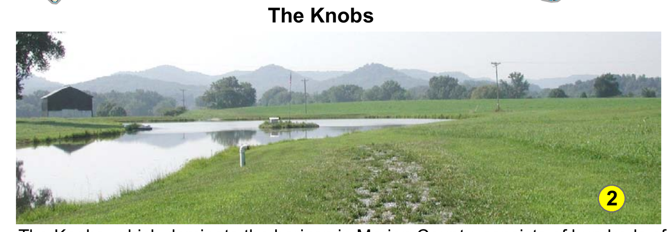
- Photo location

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

Source-Water Protection Areas

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.

The Knobs



The Knobs, which dominate the horizon in Marion County, consists of hundreds of isolated, steep-sloping, often cone-shaped hills. They were originally continuous with the Mississippian Plateau, but were separated from the plateau by stream erosion. Many of the knobs are still capped by erosionally resistant limestones or sandstones. The sharp slopes of the Knobs are mostly composed of shales of the 350-million-year-old Mississippian Borden Formation, which are more easily eroded than the overlying limestones and sandstones. The base of the Knobs commonly contains Devonian black shales. Photo by Dan Carey, Kentucky Geological Survey.

Planning Guidance by Rock Unit Type

Rock Unit	Foundation and Excavation	Septic System	Residence with Basement	Highways and Streets	Access Roads	Light Industry and Malls	Intensive Recreation	Extensive Recreation	Reservoir Areas	Reservoir Embankments	Underground Utilities
1. Clay, silt, sand, and gravel (alluvium)	Fair foundation material; easy to excavate.	Severe limitations. Failed septic systems can contaminate groundwater. Refer to soil report (Kelley and Craddock, 1991).	Severe limitations. Water in alluvium may be in direct contact with basements. Refer to soil report (Kelley and Craddock, 1991).	Moderate to severe limitations. Seasonal high water table. Subject to flooding. Refer to soil report (Kelley and Craddock, 1991).	Severe limitations. Seasonal high water table. Subject to flooding. Refer to soil report (Kelley and Craddock, 1991).	Severe limitations. Seasonal high water table. Subject to flooding. Refer to soil report (Kelley and Craddock, 1991).	Subject to flooding. Poor drainage. Refer to soil report (Kelley and Craddock, 1991).	Subject to flooding. Refer to soil report (Kelley and Craddock, 1991).	Pervious material. Seasonal high water table. Subject to flooding. Refer to soil report (Kelley and Craddock, 1991).	Fair stability. Fair compaction characteristics. Piping hazard. Refer to soil report (Kelley and Craddock, 1991).	Moderate to severe limitations. Wetness, flooding. Refer to soil report (Kelley and Craddock, 1991).
2. Silt, clay, sand, and gravel (terrace deposits)	Fair to good foundation material; easy to excavate.	Moderate to severe limitations, depending on amount of soil cover.	Slight to moderate limitations.	Slight limitations.	Slight limitations.	Slight limitations.	Moderate to slight limitations, depending on activity and slope.	Slight limitations.	Not recommended. Pervious material.	Not recommended. Pervious material.	Moderate limitations. Possible rock excavation.
3. Limestone, dolomite	Excellent foundation material; difficult to excavate.	Moderate to severe limitations. Impermeable rock. Locally fast drainage through fractures and sinks to water table, with possible contamination.	Severe limitations. Rock excavation.	Severe limitations. Rock excavation.	Severe to moderate limitations. Rock excavation.	Slight to moderate limitations, depending on topography. Rock excavation. Sinks possible. Local drainage problems.	Slight to moderate limitations, depending on activity and topography.	Slight to moderate limitations, depending on activity and topography.	Moderate limitations. Reservoir may leak where rocks are fractured. Sinks possible.	Moderate limitations. Reservoir may leak where rocks are fractured. Sinks possible.	Severe limitations. Rock excavation.
4. Limestone and shale	Fair to good foundation material; moderately difficult to difficult to excavate.	Severe limitations. Impermeable rock. Locally fast drainage through fractures to water table, with possible contamination.	Severe limitations. Rock excavation.	Moderate to severe limitations. Rock excavation; locally, upper few feet may be rippable.	Slight 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.	Slight to moderate limitations. Rock excavation may be required.	Slight to moderate limitations, depending on activity and topography.	Slight to moderate limitations. Reservoir may leak where rocks are fractured.	Severe limitations. Reservoir may leak where rocks are fractured.	Moderate to severe limitations. Possible 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. Siltstone and shale*	Siltstone, fair to good foundation material; difficult to excavate. See unit 5 for shale.	Severe limitations. Thin soils and low permeability.	Severe limitations. Rock excavation. Steep slopes. See unit 5 for shale.	Severe limitations. Rock excavation. Steep slopes. See unit 5 for shale.	Severe limitations. Rock excavation. Steep slopes. See unit 5 for shale.	Severe limitations. Rock excavation. Steep slopes. See unit 5 for shale.	Severe to moderate limitations, depending on activity and topography.	Severe to slight limitations, depending on activity and topography. Slight limitations for forest preserve.	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. See unit 5 for shale.
7. Siltstone, dolomite, and limestone	Excellent foundation material; difficult to excavate.	Severe limitations. Thin soils and impermeable rock.	Moderate to severe limitations. Rock excavation may be required.	Severe limitations. Rock excavation. Possible steep slopes.	Severe to moderate limitations. Rock excavation may be required. Possible steep slopes.	Severe limitations. Rock excavation. Possible steep slopes.	Severe to moderate limitations. Rock excavation may be required.	Severe to slight limitations, depending on activity and topography.	Slight to moderate limitations. Reservoir may leak where rocks are fractured.	Severe limitations. Reservoir may leak where rocks are fractured.	Severe limitations. Rock excavation.

* See discussions of swelling shales and soils

N

Scale = 1:63,360

1 inch equals 1 mile

0 0.5 1 2 3 4 5 6 Miles

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.

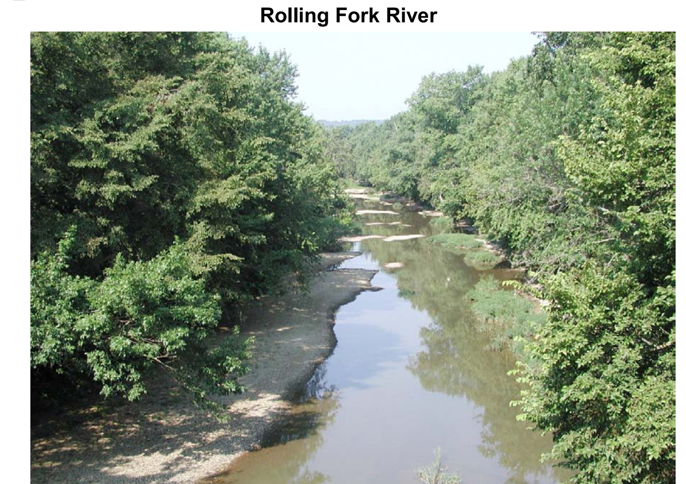
Extensive recreation—Camp sites, picnic areas, parks, etc.

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.

Rolling Fork River



Gravel bars in the Rolling Fork River west of New Market. The Rolling Fork provides water for agriculture and communities. Photo by Dan Carey, 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 Marion County:

www.lebanonky.org—Lebanon/Marion County
www.lebanon-ky.com—Lebanon-Marion County Chamber of Commerce
ces.ca.uky.edu/marion/—UK Cooperative Extension Service
www.ltadd.org/—Lincoln Trail Area Development District
www.thinkkentucky.com/edis/cmnty/cw042/—Kentucky Economic Development Information System
www.uky.edu/KentuckyAtlas/21155.html—Kentucky Atlas and Gazetteer
quickfacts.census.gov/qfd/states/21/21155.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

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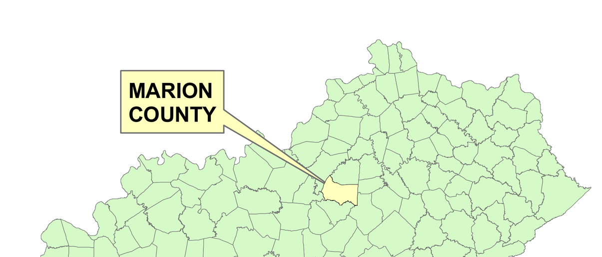
View the KGS World Wide Web site at: www.uky.edu/kgs

Mineral Resources

Nally & Hayden LLC extract over 500,000 tons of limestone per year from unit 3 in this quarry and provide crushed stone and agricultural limestone to the county. Photo by Dan Carey, Kentucky Geological Survey.



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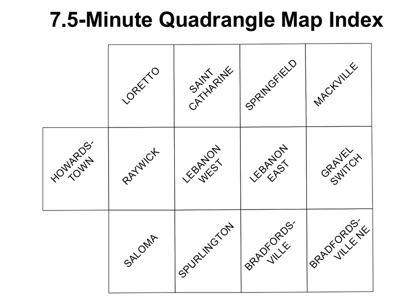
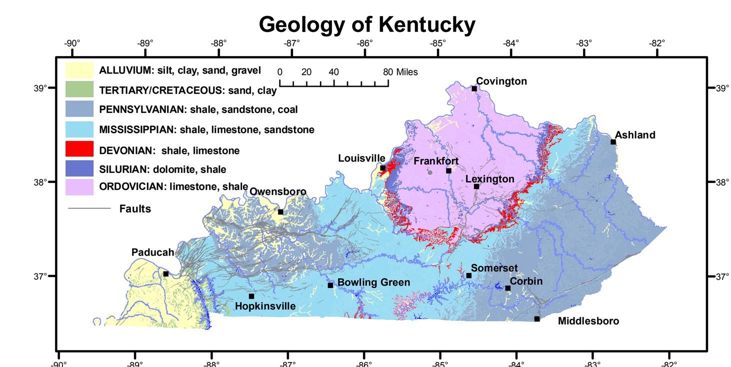
7.5-Minute Quadrangle Map Index



Geology of Kentucky



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