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

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

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Acknowledgments

Geology adapted from Harper (2002), Harper and Sparks (2002), Nelson (2002), Sparks (2002a,b), Tyra (2002), and Zhang (2002a,b). Thanks to Paul Howell, U.S. Department of Agriculture–Natural Resources Conservation Service.

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 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.

Flood Protection

The levee in Newport, looking north toward the Newport Aquarium (center). Newport has an excellent system of levees to protect the city from flooding by the Ohio River. Photo by Richard Smath, Kentucky Geological Survey.

Slope Failure

Mass movements or landslides of surficial materials are by far the most frequent and most costly geologic hazards in the northern Kentucky area. Northern Kentucky has the greatest monetary loss per capita caused by landslides in the country. The failure of the slope may be rapid, but more commonly is a slow almost imperceptible movement, called creep, of a few inches per year. Whether rapid or slow, the end results and damage are similar and costly: broken plumbing, cracked walls and foundations, cracked streets and sidewalks, and commonly total loss of the structures.

Virtually all of the mass movements in northern Kentucky occur in colluvium—the weathered soil and rock materials that crumble from the bedrock as it weathers. The lower slopes of unit 2 are commonly thickly mantled with colluvium.

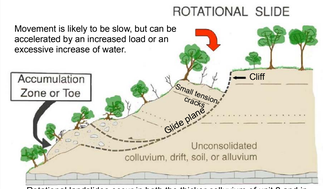
Shales of unit 2 and adjacent unit 3 will break down and weather rapidly when exposed to air and water. These shaly units tend to swell considerably when exposed to water. For this reason, plumbing trenches under walls and foundations should be prevented from accumulating water. Units 2 and 3 may share a translational landslide.

Gravity is the main driving force, but water nearly always plays a critical role by adding weight and lubricating the particles in the colluvium. Cutting into or overloading a slope with structures and fill can also be major contributing factors.

Precautions include taking care of all surface-water runoff by making certain that all runoff from roofs, gutters, patios, sidewalks, and driveways is carried well away from and not toward the house; diverting drainage from areas sloping toward the house; cutting into natural slopes as little as possible and avoiding the use of fill; and trying to place the foundation of the structure on undisturbed bedrock.

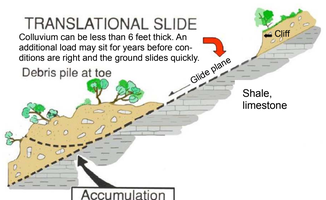
When in doubt, consult an engineering geologist or a geotechnical engineer. Relict landslides can also be easily reactivated. Look for unusual bulges or cracks in the slope, tilted or curved trees, springs coming out onto the hillside, and tilted and cracked sidewalks, streets, and retaining walls.

For more information, see Potter (1996).



Movement is likely to be slow, but can be accelerated by an increased load or an excessive increase of water.

Rotational landslides occur in both the thicker colluvium of unit 2 and in glacial deposits. The head or top area has tension cracks or small cliffs; the toe or bottom has transverse ridges or bulges; and a principal glide plane connects the top to bottom. Small tension cracks in the top become large scarps or cliffs as material moves downslope and small bulges in the bottom become larger ones. After Potter (1996).



A transitional landslide is a relatively thin sheet of colluvium that separates from the underlying bedrock and slides catastrophically downslope more or less as a coherent sheet until it abruptly stops and becomes a crumbled, disorganized pile of debris. Such failures are common on steeper slopes of shale-dominated units (units 2, 3) when both colluvium and the weathered, more permeable bedrock below become fully saturated with water. After Potter (1996).

Groundwater

The Ohio River alluvium is the best source of groundwater. Alluvium will produce several hundred gallons per minute, and most wells are able to produce enough for a domestic supply at depths of less than 100 feet. Water is hard or very hard, but otherwise of good quality. In the Licking River Valley and the lower sections of the larger creek valleys in Campbell County, most drilled wells will produce enough water for a domestic supply at depths of less than 100 feet. Some wells located in the smaller creek valleys will produce enough water for a domestic supply except during dry weather. In upland areas (about 60 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. Groundwater in these areas 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 (2005).

Newport Courthouse

Campbell County is unique in that it has two county seats: Newport and Alexandria. Newport was established as the county seat in 1794, and in 1840, a second county courthouse was built in Alexandria because it was more centrally located. Kenton County is the only other Kentucky county with two county seats: Covington and Independence. Photo by Richard Smath, Kentucky Geological Survey.

Alexandria Courthouse

The courthouse in Alexandria was remodeled in 1928, and houses the circuit clerk and county clerk, with historical society offices on the second floor. Photo by Richard Smath, Kentucky Geological Survey.

Campbell County, an area of 152 square miles in the Outer Bluegrass Region, was established in 1795. Elevation ranges from 920 feet in the uplands to 455 at the Ohio River. The population in 2004 was 87,256, a 1.5 percent decrease from 2000.

U.S. 27 Expansion

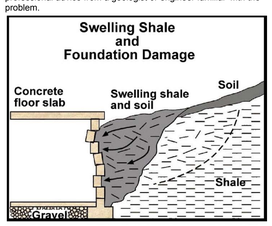
U.S. 27 south of Alexandria is being expanded to four lanes. It is still the major north-south thoroughfare in the region. Photo by Richard Smath, Kentucky Geological Survey.

Landslides

Shales in unit 2 can fail, resulting in landslides like this one on Ky. 8 east of Dayton. Many areas along this highway have trees that are severely slanted toward the road in the direction of ground movement, and the road surface itself is often undulating because of the unstable base. A 1-mile portion of Ky. 8 is being reconstructed using "geofoam" as a roadbed to remedy this problem. Rocks of unit 2 must be carefully managed when used as the foundation for buildings and roadways. Photo by Richard Smath, Kentucky Geological Survey.

Swelling and Shrinking Shales

A problem of considerable concern in this area is the swelling of some of the clay minerals in shale units 2 and 3. Expanding shale can cause backfill to swell, and concrete to crack and crumble. It can heave the foundation, the slab, and interior partitions resting on it, and damage upper floors and interior partitions. This phenomenon has been responsible for extensive damage to schools, homes, and businesses in Kentucky. During times of drought, these same shales may shrink, causing foundations to drop. Anyone planning construction on these shales should seek professional advice from a geologist or engineer familiar with the problem.



Some shales and the soils derived from them swell when exposed to water or rain. 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.

Limestone Bluffs

View from the top of O'Fallon Street in Bellevue looking north toward the Ohio River. This residential area consists mainly of older homes, but some new construction is under way. Limestones (units 3 and 4) cap the bluffs on which the homes are situated. This geologic setting not only provides for a good foundation, but also is well above the floodplain. Photo by Richard Smath, Kentucky Geological Survey.

EXPLANATION

- School

Water wells
- Domestic
- Monitoring
- Public
- Industrial
- Spring
- Watershed boundary
- Railroad
- Designated flood zone* (FEMA, 2005)
- Wetlands > 1 acre (U.S. Fish and Wildlife Service, 2003)
- Incorporated city boundaries
- Source-water protection area, zone 1
- Artificial fill

40-foot contour interval

4 Photo location

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

Source-Water Protection Areas

Source-water protection areas are those in which activities are likely to affect the quality of the drinking-water source. For more information, see kgsweb.uky.edu/download/water/swapp/swapp.htm.

7.5-Minute Topographic Map Index

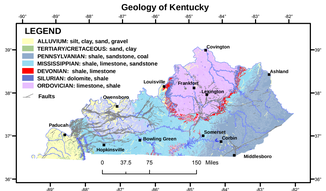
Industry

The LaFarge Gypsum Company is the largest manufacturer of drywall in the United States, and operates this facility in Silver Grove. Gypsum, a byproduct of electricity production, is brought to the plant from Cinergy's Walter C. Beckjord Power Plant in New Richmond, Ohio, a few miles up the river. Photo by Richard Smath, Kentucky Geological Survey.

Scale 1:48,000 1 inch equals 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/

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, loess, and gravel	Fair foundation material; easy to excavate.	Severe limitations. Failed septic systems can contaminate groundwater. Refer to soil report (Weisenberger and others, 1989).	Water in alluvium may be in direct contact with basements. Refer to soil report (Weisenberger and others, 1989).	Slight limitations. Refer to soil report (Weisenberger and others, 1989).	Slight to moderate limitations. Refer to soil report (Weisenberger and others, 1989).	Slight to moderate limitations. Avoid construction in flood-plain. Refer to soil report (Weisenberger and others, 1989).	Refer to soil report (Weisenberger and others, 1989).	Refer to soil report (Weisenberger and others, 1989).	Refer to soil report (Weisenberger and others, 1989).	Not recommended. Refer to soil report (Weisenberger and others, 1989).	Not recommended. Refer to soil report (Weisenberger and others, 1989).
2. Shale*, lime-stone	Fair to good foun-dation material; difficult excavation. Slumps when wet. Avoid steep slopes.	Slight to severe limita-tions, depending on amount of soil cover and depth to impeme-able rock.	Severe to moderate limitations. Rock excavation may be required. Slumps when wet. Avoid steep slopes.	Moderate to severe limitations. Rock ex-cavation may be required. Possible steep slopes.	Moderate limitations. Rock excavation likely. Local drainage problems, especially on shale. Sinks common.	Slight to severe lim-itations, depending on topography. Rock excavation. Sinks common. Local drainage problems. Groundwater contam-ination possible.	Slight to moderate limitations, depending on activity and topog-raphy. Possible steep wooded slopes.	Slight limitations, depending on activity and topog-raphy. Possible steep wooded slopes. Slight limitations for forest or nature preserve.	Moderate to slight limitations. Reservoir may leak where rocks are fractured. Sinks possible.	Moderate to severe limitations. Reservoir may leak where rocks are fractured. Sinks possible.	Moderate to severe limitations. Possible rock excavation. Susceptible to landslides.
3. Limestone, shale*	Good to excellent foundation material; difficult to excavate.	Slight to severe limita-tions, depending on amount of soil cover and depth to impeme-able rock.	Severe to moderate limitations. Rock excavation may be required.	Moderate limitations. Rock excavation possible. Local drainage problems, especially on shale. Sinks common and caves possible.	Moderate limitations. Rock excavation possible. Possible steep slopes. Slight limitations with suitable topography.	Slight to severe lim-itations, depending on topography. Rock excavation. Sinks common. Local drainage problems. Groundwater contam-ination possible.	Slight to moderate limitations. Rock excavation may be required.	Slight limitations, de-pending on activity and topography. Possible steep wooded slopes. No limitations for nature or forest preserve.	Moderate to slight limitations. Reservoir may leak where rocks are fractured. Sinks possible.	Moderate to severe limitations. Reservoir may leak where rocks are fractured. Sinks possible.	Severe to moderate limitations. Possible rock excavation.
4. Limestone	Excellent founda-tion material; easy to excavate.	Severe limitations. Impermeable rock. Locally fast drainage through fractures and sinks. Danger of groundwater con-tamination.	Severe to moderate limitations. Rock excavation may be required.	Severe limitations. Rock excavation. Possible steep slopes.	Severe to moderate limitations. Possible steep slopes and narrow ravines.	Slight to moderate limitations, depending on topography. Rock excavation possible. Sinks common. Local drainage problems.	Moderate to slight limitations, depending on activity and topog-raphy. Possible wooded slopes.	Severe to slight limitations, depending on activity and topog-raphy. Possible wooded slopes. Slight limitations for nature preserve.	Slight to severe limitations. Reservoir may leak where rocks are fractured. Sinks possible.	Slight to severe limitations. Reservoir may leak where rocks are fractured. Sinks possible.	Severe to moderate limitations. Possible rock excavation.
5. Clay, silt, sand, and gravel (high-level terrace deposits)	Fair foundation material; easy to excavate.	Severe to slight limita-tions, depending on amount of soil cover.	Moderate to slight limitations, depend-ing on slope.	Slight limitations.	Slight limitations, depending on degree of slope.	Slight limitations, depending on degree of slope.	Moderate to slight limitations, depending on activity and topog-raphy. Possible wooded slopes.	Slight limitations, depending on activity and topog-raphy. Possible wooded slopes. Slight limitations for nature preserve.	Pervious material. Not recommended.	Severe to slight limitations. Un-stable steep slopes.	Slight limitations.

*Some of these shales can shrink during dry periods and swell during wet periods and cause cracking of foundations. On hillsides, especially where springs are present, they can also be susceptible to landslides.

Floodplain Land Uses

The Edward S. Pendrey Sports Park near Silver Grove is a large recreational complex on the floodplain of the Ohio River. It is bounded by the river, industry, and the CSX Transportation railroad. It is a good example of the use of a floodprone area for intensive recreation purposes. Photo by Richard Smath, Kentucky Geological Survey.

Power Generation

Walter C. Beckjord Power Plant, owned by Cinergy Inc., in New Richmond, Ohio, across the river from Silver Grove. The coal-fired plant serves southern Ohio and northern Kentucky. Photo by Richard Smath, Kentucky Geological Survey.

Shaly Limestone Terrain

Steep, rolling hills characterize areas underlain by shaly limestone (unit 2). Photo by Richard Smath, Kentucky Geological Survey.

World Peace Bell at Newport

The World Peace Bell in Newport was cast in 1998 in Annecy, France, and at 33 tons is the largest swinging bell in the world. It was cast to honor the onset of the new millennium, and is rung on important occasions. It is 12 feet in diameter, made of 80 percent copper and 20 percent tin, and is in the key of A. It is a major tourist attraction in northern Kentucky. Photo by Richard Smath, Kentucky Geological Survey.

A. J. Jolly Park

The county-owned 900-acre A. J. Jolly Park includes an 18-hole golf course, a 200-acre fishing lake, nine ball fields and four soccer fields, play equipment, campgrounds, a bird sanctuary, a handicapped accessible boat and fishing pier, and public and private picnic areas. Aerial photo (2004) by the U.S. Agriculture Department, Farm Services Administration, National Agricultural Imagery Program.

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

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.

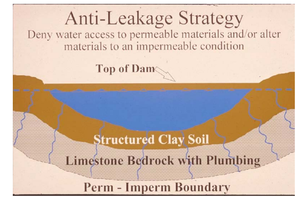
Extensive recreation—Camp sites, picnic areas, parks, etc.

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.

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.

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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 Campbell County:

ces.ca.uky.edu/campbell/ University of Kentucky Co operative Extension Service
www.nkadd.org/ Northern Kentucky Area Development District
www.thinkkentucky.com/edis/cmnty/cw049/ Kentucky Economic Development Informatio n System
kgsweb.uky.edu/download/kgsplanning.htm County planning data from the Kentucky Geological Survey
www.uky.edu/KentuckyAtlas/21037.html Kentucky Atlas and Gazetteer
quickfacts.census.gov/qfd/states/21/21037.html U.S. Census data
www.campbellcounty.ky.gov/ Local government site