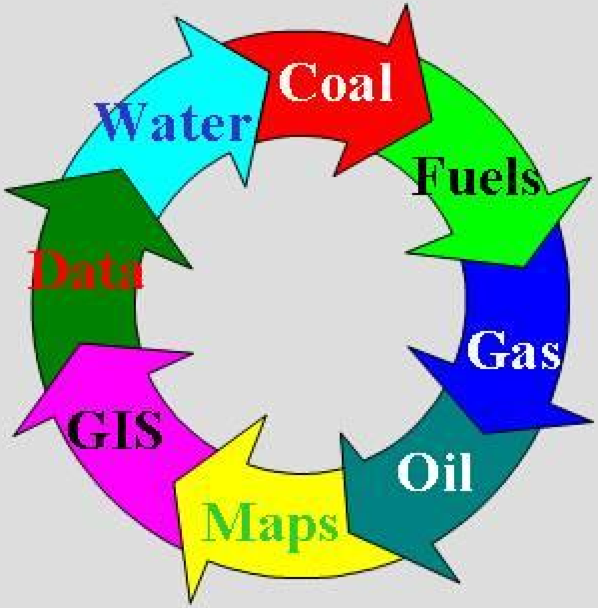
Generalized Geologic Maps for Land-Use Planning

Daniel I. Carey
Kentucky Geological Survey
carey@uky.edu



Kentucky Geological Survey

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Kentucky Geological Survey
James C. Cobb, State Geologist and Director
UNIVERSITY OF KENTUCKY, LEXINGTON

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

Gerald A. Weisenfluh and Daniel I. Carey

MAP AND CHART 132
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Carter County Courthouse at Olive Hill

Carter County, with an area of 411 square miles, was established in the Eastern Kentucky Coal Field in 1838. Steep slopes are common in the county, and the elevation ranges from 542 feet, where the Little Sandy River leaves the county, to 1,300 feet on a ridge about 0.6 mile north of Interstate 64 on the Rowan County line.

The population in 2004, 27,459, was 2.1 percent more than in 2000. The cities of Olive Hill and Grayson, and the Rattlesnake Ridge Water District, provide public water to over 85 percent of county households. The majority of those not on public water rely on private water wells. The cities of Grayson and Olive Hill also provide wastewater treatment services for 20 percent of county residents. The 1,500-acre Grayson Lake provides for recreation and water supply.

Groundwater

In the eastern half of the county, most wells in valley bottoms produce enough water for domestic use. In the rest of the county groundwater becomes more scarce, with less than half of the wells drilled in valley bottoms able to produce enough water for a domestic supply. Throughout the county, wells on hillsides and ridges become progressively less productive away from valley bottoms. Most of the water from drilled wells is very to extremely hard and contains noticeable amounts of iron. Salty water is commonly found in wells drilled less than 100 feet below the level of the principal valley bottoms. A few springs supply enough water for domestic use. Almost all springs yield less than 5 gallons per minute. For more information on groundwater in the county, see Carey and Stickney (2005).

Siltstone

Siltstone of unit 3 forms steep slopes in northwestern Carter County. Photo by Jerry Weisenfluh, Kentucky Geological Survey.

Limestone and Shale

Limestone (unit 4) lies above red and green shales (unit 8) at this roadcut off Ky. 2 just north of Interstate 64. The shales quickly slake away when exposed, allowing massive limestone blocks to collapse. Photo by Dan Carey, Kentucky Geological Survey.

Acknowledgments

Geology adapted from Lambert and Sparks (2005), Murphy (2005a, b), Murphy and Petersen (2005), Nelson and Curl (2002a, b), Nelson and Petersen (2005a, b), Palmgreen (2005), Petersen (2002), Plauché (2002a, b; 2005), Plauché and Petersen (2006), and Smith (2002). Mapped sinkhole data from Paylor and others (2004). Thanks to Paul Howell, U.S. Department of Agriculture, Natural Resources Conservation Service, for landslide illustrations.

EXPLANATION

- Oil well
- Gas well
- Enhanced recovery well

Water wells

- ● Domestic
- ● Monitoring
- ● Public
- ● Industrial

- Spring
- ● Sinkhole
- Wet area
- Rock outcrop
- Mine or quarry
- ― County line
- Watershed boundary
- ― Geologic fault
- ― Outcrop clay bed**
- 🟥 Mapped sinkhole
- ▥ Mined area
- ▨ Wildlife management area
- ▨ State park
- ▤ Source-water protection area zone 1
- ▨ Wetlands > 1 acre (U.S. Fish and Wildlife Service, 2003)
- ☐ Incorporated city boundaries
- ▩ Quarry
- ▨ Designated flood zone* (FEMA, 2005)
- ▥ Public lands
- 100-foot contour interval
- ● Photo location

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

**The outcrop line of the Olive Hill clay bed is an indicator not only of the clay, but the possible presence of old underground or surface mines.

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.

Stone Blast Furnace

Five iron furnaces were active in the 19th century. The Mount Savage furnace, the last to close, ceased operation in 1882. Stone chimneys like this are all that remain. Photo by Jerry Weisenfluh, Kentucky Geological Survey.

Karst Geology

Some areas of the county are underlain by karst limestone. 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 where water emerges from underground to become surface water. Caves are solution-enlarged fractures or conduits large enough for a person to enter.

Siltstone, Sandstone, Shale, Coal

Siltstone, shale, sandstone, and coal layers in this roadcut on Ky. 7 are typical of rock units 5 and 6. Photo by Jerry Weisenfluh, 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. Seasonal high water table. Subject to flooding. Refer to soil report (Kelley and Newton, 1983).	Severe limitations. Seasonal high water table. Subject to flooding. Refer to soil report (Kelley and Newton, 1983).	Severe limitations. Seasonal high water table. Subject to flooding. Refer to soil report (Kelley and Newton, 1983).	Severe limitations. Seasonal high water table. Subject to flooding. Refer to soil report (Kelley and Newton, 1983).	Severe limitations. Seasonal high water table. Subject to flooding. Refer to soil report (Kelley and Newton, 1983).	Severe limitations. Seasonal high water table. Subject to flooding. Refer to soil report (Kelley and Newton, 1983).	Slight to severe limitations, depending on type of activity and topography. Subject to flooding. Refer to soil report (Kelley and Newton, 1983).	Slight to severe limitations, depending on type of activity and topography. Subject to flooding. Refer to soil report (Kelley and Newton, 1983).	Pervious material. Seasonal high water table. Subject to flooding. Refer to soil report (Kelley and Newton, 1983).	Fair stability. Fair compaction characteristics. Piping hazard. Refer to soil report (Kelley and Newton, 1983).	Slight limitations, in general, except for seasonal high water table. Subject to flooding. Refer to soil report (Kelley and Newton, 1983).
2. Clay, silt, sand, and gravel (terrace deposits) 🟧	Fair foundation material; easy to excavate.	Severe to slight limitations, depending on amount of soil cover.	Moderate to slight limitations, depending on slope.	Slight limitations.	Slight limitations, depending on slope.	Slight limitations, depending on slope.	Moderate to slight limitations, depending on activity and slope.	Slight limitations, depending on slope.	Pervious material. Not recommended.	Severe to slight limitations. Unstable steep slopes.	Slight limitations.
3. Siltstone, shale* 🟨	Excellent foundation material; difficult to excavate.	Severe limitations. Thin soils and impermeable rock associated with shales.	Moderate to severe limitations. Rock excavation. Very steep slopes.	Moderate to severe limitations. Rock excavation. Very steep slopes.	Moderate to severe limitations. Rock excavation may be required. Very steep slopes.	Moderate to severe limitations. Rock excavation may be required. Very steep slopes.	Moderate to severe limitations. Rock excavation may be required. Very steep slopes.	Slight to severe limitations, depending on activity and topography. Possible steep wooded slopes. Slight limitations for forest or nature preserve.	Slight to moderate limitations. Reservoir may leak where rocks are fractured.	Slight to moderate limitations. Reservoir may leak where rocks are fractured.	Severe limitations. Thin soils. Rock excavation.
4. Limestone (limited to valley bottoms and sides) 🟦	Excellent foundation material; difficult to excavate.	Severe limitations. Locally bad 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. Drainage required.	Slight limitations. Local drainage problems from seeps or springs. Sinks possible.	Slight to moderate limitations, depending on topography. Rock excavation, locally upper few feet may be rippable. Sinks possible. Local drainage problems.	Slight to severe limitations. Rock excavation may be required.	Slight to moderate limitations, depending on activity and topography. Slight limitations for forest or nature preserve.	Severe limitations. Likely reservoir rock leaks. Locally, conditions may be favorable. Sinks possible.	Severe limitations. Leaky rock.	Severe limitations. Rock excavation.
5. Siltstone, sandstone, shale (sparse coal)* 🟩	Fair to good foundation material; difficult to excavate. Possible low strength associated with shales, sparse coals, and underclays.	Severe limitations. Thin soils and impermeable rock associated with shales.	Severe to moderate limitations. Rock excavation may be required.	Moderate to severe limitations. Rock excavation may be required. Possible steep slopes.	Moderate to severe limitations. Rock excavation may be required. Possible steep slopes.	Moderate to severe limitations. Rock excavation may be required. Possible steep slopes.	Moderate to severe limitations. Rock excavation may be required.	Slight to severe limitations, depending on activity and topography. Possible steep wooded slopes. Slight limitations for forest or nature preserve.	Slight limitations. Reservoir may leak where rocks, including coal, are jointed or fractured.	Severe limitations. Reservoir may leak where rocks are fractured.	Severe to moderate limitations. Thin soils. Possible rock excavation.
6. Sandstone, siltstone, shale, coal* ⬛	Fair to good foundation material; difficult to excavate. Possible low strength associated with shales, coals, and underclays. Possibility of underground coal mine voids.	Severe limitations. Thin soils and impermeable rock associated with shales.	Severe to moderate limitations. Rock excavation may be required. Possible steep slopes.	Moderate to severe limitations. Rock excavation may be required. Possible steep slopes.	Moderate to severe limitations. Rock excavation may be required. Possible steep slopes.	Moderate to severe limitations. Rock excavation may be required. Possible steep slopes.	Moderate to severe limitations. Rock excavation may be required.	Slight to severe limitations, depending on activity and topography. Possible steep wooded slopes. Slight limitations for forest or nature preserve.	Slight limitations. Reservoir may leak where rocks, including coal, are jointed or fractured.	Severe limitations. Reservoir may leak where rocks are fractured.	Severe to moderate limitations. Thin soils. Possible rock excavation.
7. Sandstone (limited to valley bottoms and sides) 🟩	Excellent foundation material; difficult to excavate.	Severe limitations. Thin soils.	Severe to moderate limitations. Rock excavation may be required. Possible steep slopes.	Severe to moderate limitations. Rock excavation may be required. Possible steep slopes.	Moderate to severe limitations. Rock excavation may be required. Possible steep slopes.	Moderate to severe limitations. Rock excavation may be required. Possible steep slopes.	Slight to severe limitations, depending on activity and topography. Possible steep wooded slopes.	Slight to severe limitations, depending on activity and topography. Possible steep wooded slopes. Slight limitations for forest or nature preserve.	Slight to moderate limitations. Reservoir may leak where rocks are fractured.	Slight to moderate limitations. Reservoir may leak where rocks are fractured.	Severe limitations. Rock excavation. Thin soils.
8. Units containing red and green shales* 🟪	Poor foundation material; easy to moderately difficult to excavate. Low strength and stability. May contain plastic clays.	Severe limitations. Thin soils and low permeability.	Severe limitations. Low strength, slumping, and seepage problems.	Severe limitations on slopes. Strength, slumping, and seepage problems.	Severe limitations on slopes. Strength, slumping, and seepage problems.	Severe limitations on slopes. Strength, slumping, and seepage problems.	Moderate to severe limitations, depending on activity.	Slight to severe limitations, depending on activity. Slight limitations for forest or nature preserve.	Slight limitations. Reservoir may leak where rocks are fractured. Mud seals on shale are successful.	Severe limitations. Poor strength and stability.	Moderate limitations. Poor strength. Wetness.

*Shales and clays in these units can 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.

Red and Green Shales

Red and green shales (unit 8) are low strength, sensitive to moisture, and prone to slumping and landslides. Hillslopes with little stabilizing vegetation show extensive downslope movement of soil material that can damage structures built too close to the hill. Cattle can exacerbate the soil movement. Photos by Jerry Weisenfluh, Kentucky Geological Survey.

Swelling and Shrinking Shales

A problem of some concern in this area is the swelling of some of the clays and shales. 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.

Road Slump

Poorly drained substrates under roads built on unit 8 can result in costly failures. Photo by Jerry Weisenfluh, Kentucky Geological Survey.

Landslides

Hillside construction can cause earth movements if not properly planned. Photos by Paul Howell, U.S. Department of Agriculture, Natural Resources Conservation Service.

What Are the Factors That Cause Landslides?

Many factors contribute to landslides. The most common in eastern Kentucky are listed below.

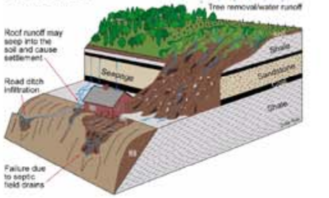
1. Steep slopes. Avoid when choosing a building site.
2. Water. Slope stability decreases as water moves into the soil. Springs, seeps, roof runoff, gutter downspouts, septic systems, and site grading that cause ponding or runoff are sources of water that often contribute to landslides.
3. Changing the natural slope by creating a level area where none previously existed.
4. Poor site selection for roads and driveways.
5. Improper placement of fill material.
6. Removal of trees and other vegetation. Site construction often results in the elimination of trees and other vegetation. Plants, especially trees, help remove water and stabilize the soil with their extensive root systems.

What Are Some Ways to Prevent Landslides?

1. Seek professional assistance prior to construction.
2. Proper site selection. Some sloping areas are naturally prone to landslides. Inspect the site for springs, seeps, and other wet areas that might indicate water problems. Take note of unusual cracks or bulges at the soil surface. These are typical signs of soil movement that may lead to slope failure. Also be aware of geologically sensitive areas where landslides are more likely to occur.
3. Alter the natural slope of the building site as little as possible during construction. Never remove soil from the toe or bottom of the slope or add soil to the top of the slope. Landslides are less likely to occur on sites where disturbance has been minimized. Seek professional assistance before earth moving begins.
4. Remove as few trees and other vegetation as possible. Trees develop extensive root systems that are very useful in slope stabilization. Trees also remove large amounts of groundwater. Trees and other permanent vegetative covers should be established as rapidly as possible and maintained to reduce soil erosion and landslide potential.
5. Household water disposal system. Seek professional assistance in selecting the appropriate type and location of your septic system. Septic systems located in fill material can saturate soil and contribute to landslides.
6. Proper water disposal. Allowing surface waters to saturate the sloping soil is the most common cause of landslides in eastern Kentucky. Properly located diversion channels are helpful in redirecting runoff away from areas disturbed during construction. Runoff should be channeled and water from roofs and downspouts piped to stable areas at the bottom of the slope.

(From U.S. Department of Agriculture, Natural Resources Conservation Service, no date)

Water Can Cause Landslides



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.

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.

Mineral Resources

Fire clay, coal, and limestone are the principal mineral resources of Carter County. High-quality silica sand is a potential resource. Mining of the Olive Hill Clay occurred around the turn of the last century, primarily from small underground mines and to a lesser extent from strip mines. Coal has been surface and underground mined on a small scale in many places. Significant mining ended in 1965. Limestone mines and quarries are still active.

Limestone

Limestone bluff (unit 4) overlying steep slopes formed by unit 3. Photo by Dan Carey, Kentucky Geological Survey.

Active limestone quarries in unit 4 near Boone Furnace supply the region with construction aggregate and other lime products. Photo (2004) from the U.S. Department of Agriculture, Farm Services Administration.

Carter Caves

Carter Caves State Resort Park is a popular attraction for tourism, golfing, and business meetings. Beautiful hiking trails and caves can be found in the steep-sided tributary valleys of Tygarts Creek, formed in units 4 and 7. Photo by Dan Carey, Kentucky Geological Survey.

Alluvium

Alluvium in the meandering floodplain valleys of the Little Sandy River, Tygarts, and other large creeks provides soils for agriculture, and level land for development above flood levels. Photo by Dan Carey, Kentucky Geological Survey.

Geology of Kentucky

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

7.5-Minute Quadrangle Index

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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 Carter County.

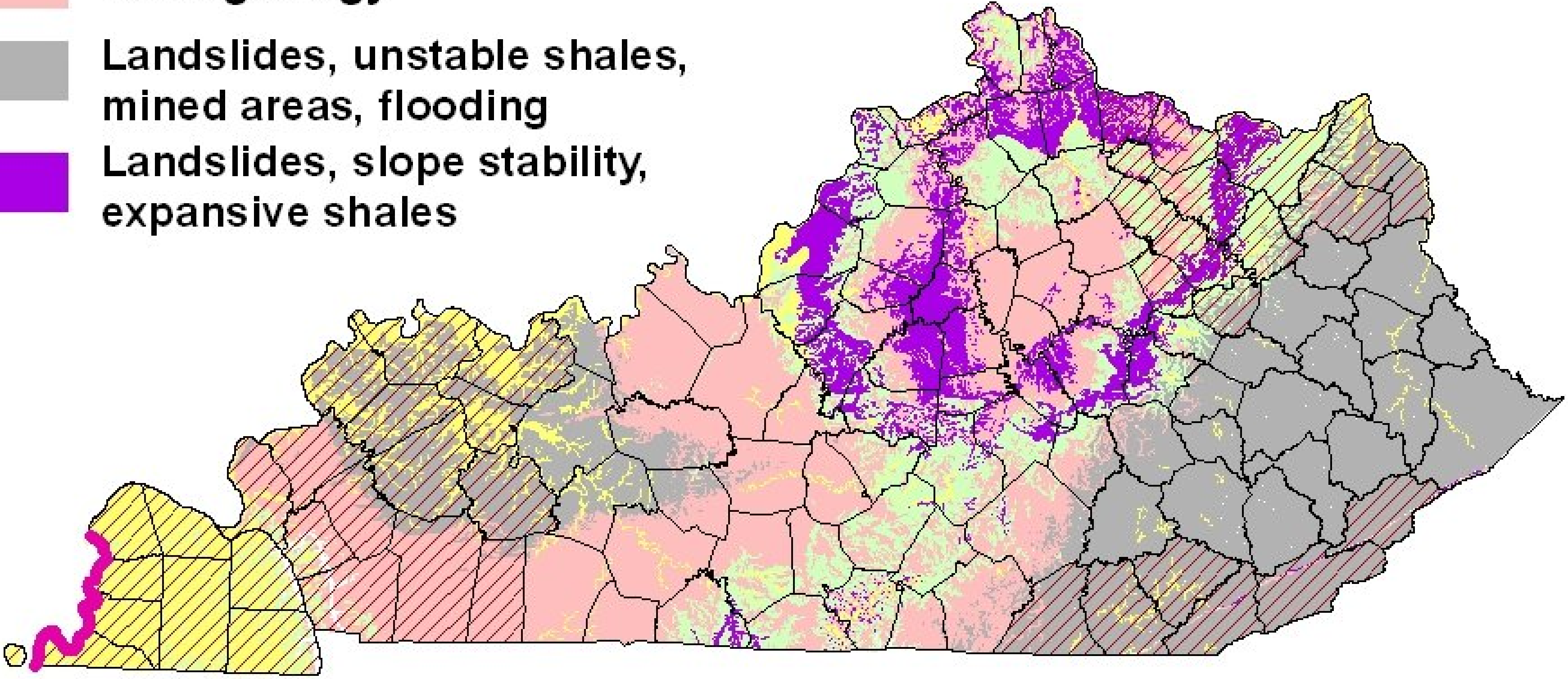
ces.ca.uky.edu/carter/ University of Kentucky Cooperative Extension Service
www.fivco.org/ Fivco Area Development District
www.thinkkentucky.com/edis/cmnty/cw035/ Kentucky Economic Development Information System
www.uky.edu/KentuckyAtlas/21043.html Kentucky Atlas and Gazetteer, Carter County
quickfacts.census.gov/qfd/states/21/21043.html U.S. census data
kgsweb.uky.edu/download/kgsplanning.htm Planning information from the Kentucky Geological Survey

For information on obtaining copies of this map and other Kentucky Geological Survey maps and publications call our Public Information Center at 859.257.3896 or 877.778.7827 (toll free).

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

Geologic Hazards in Kentucky

- ▨ Earthquake
- 🟨 Flooding
- 🟪 Landslides
- 🟥 Karst geology
- ⬜ Landslides, unstable shales, mined areas, flooding
- 🟪 Landslides, slope stability, expansive shales



Sinkhole collapse, Bowling Green

If we don’t understand the rocks beneath us, we will end up paying the reality tax.

Photo by Richard McGehee, Kentucky Department of Transportation.

Pavement failure on shale is common.

Photo by Paul Howell, U.S.D.A.-NRCS

Remedial roadbed support and drainage on shales.

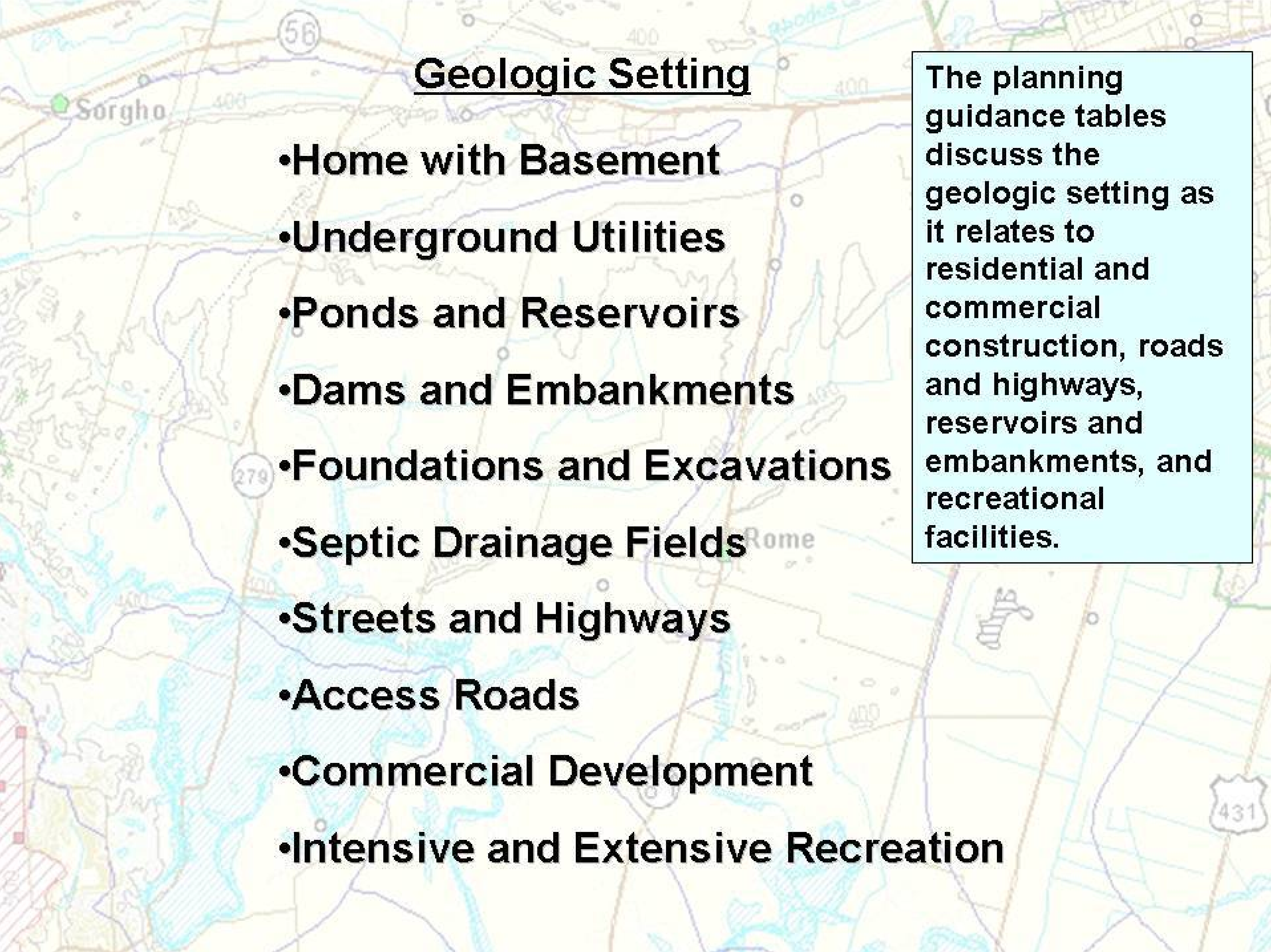
Hillside construction can cause earth movements if not properly planned

Photo by Paul Howell, U.S.D.A.-NRCS

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 floodplain. 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*, limestone 🟥	Fair to good foundation material; difficult excavation. Slumps when wet. Avoid steep slopes.	Slight to severe limitations, depending on amount of soil cover and depth to impermeable rock.	Severe to moderate limitations. Rock excavation may be required. Slumps when wet. Avoid steep slopes.	Moderate to severe limitations. Rock excavation may be required. Possible steep slopes.	Moderate limitations. Rock excavation likely. Local drainage problems, especially on shale. Sinks common.	Slight to severe limitations, depending on topography. Rock excavation. Sinks common. Local drainage problems. Groundwater contamination possible.	Slight to moderate limitations, depending on activity and topography. Possible steep wooded slopes.	Slight limitations, depending on activity and topography. 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 limitations, depending on amount of soil cover and depth to impermeable 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 limitations, depending on topography. Rock excavation. Sinks common. Local drainage problems. Groundwater contamination possible.	Slight to moderate limitations. Rock excavation may be required.	Slight limitations, depending 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 foundation material; difficult to excavate.	Severe limitations. Impermeable rock. Locally fast drainage through fractures and sinks. Danger of groundwater contamination.	Severe to moderate limitations. Rock excavation may be required.	Severe limitations. Rock excavation. Possible steep slopes.	Severe to moderate limitations. Possible rock excavation. 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 topography. Possible wooded slopes.	Severe to slight limitations, depending on activity and topography. 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 limitations, depending on amount of soil cover.	Moderate to slight limitations, depending 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 topography. Possible wooded slopes.	Slight limitations, depending on activity and topography. Possible wooded slopes. Slight limitations for nature preserve.	Pervious material. Not recommended.	Severe to slight limitations. Unstable 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.

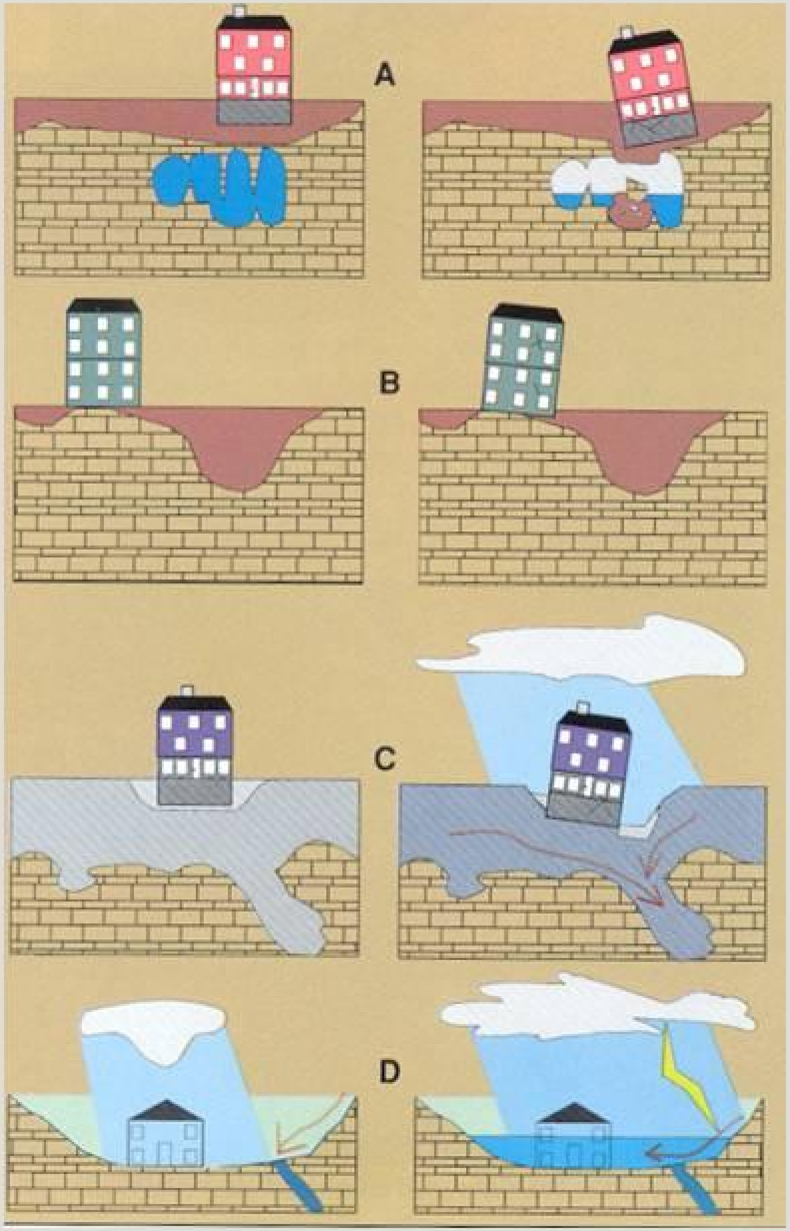


Geologic Setting

- Home with Basement
- Underground Utilities
- Ponds and Reservoirs
- Dams and Embankments
- Foundations and Excavations
- Septic Drainage Fields
- Streets and Highways
- Access Roads
- Commercial Development
- Intensive and Extensive Recreation

The planning guidance tables discuss the geologic setting as it relates to residential and commercial construction, roads and highways, reservoirs and embankments, and recreational facilities.

Illustrations of Local Issues



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 support
subside
the struc
site eval
geophys
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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 an infrequent heavy storm cannot be carried away quickly enough to prevent flooding of low-lying areas. Adapted from AIPG (1993).

Illustrations on the maps show how geology affects construction and the environment.

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.

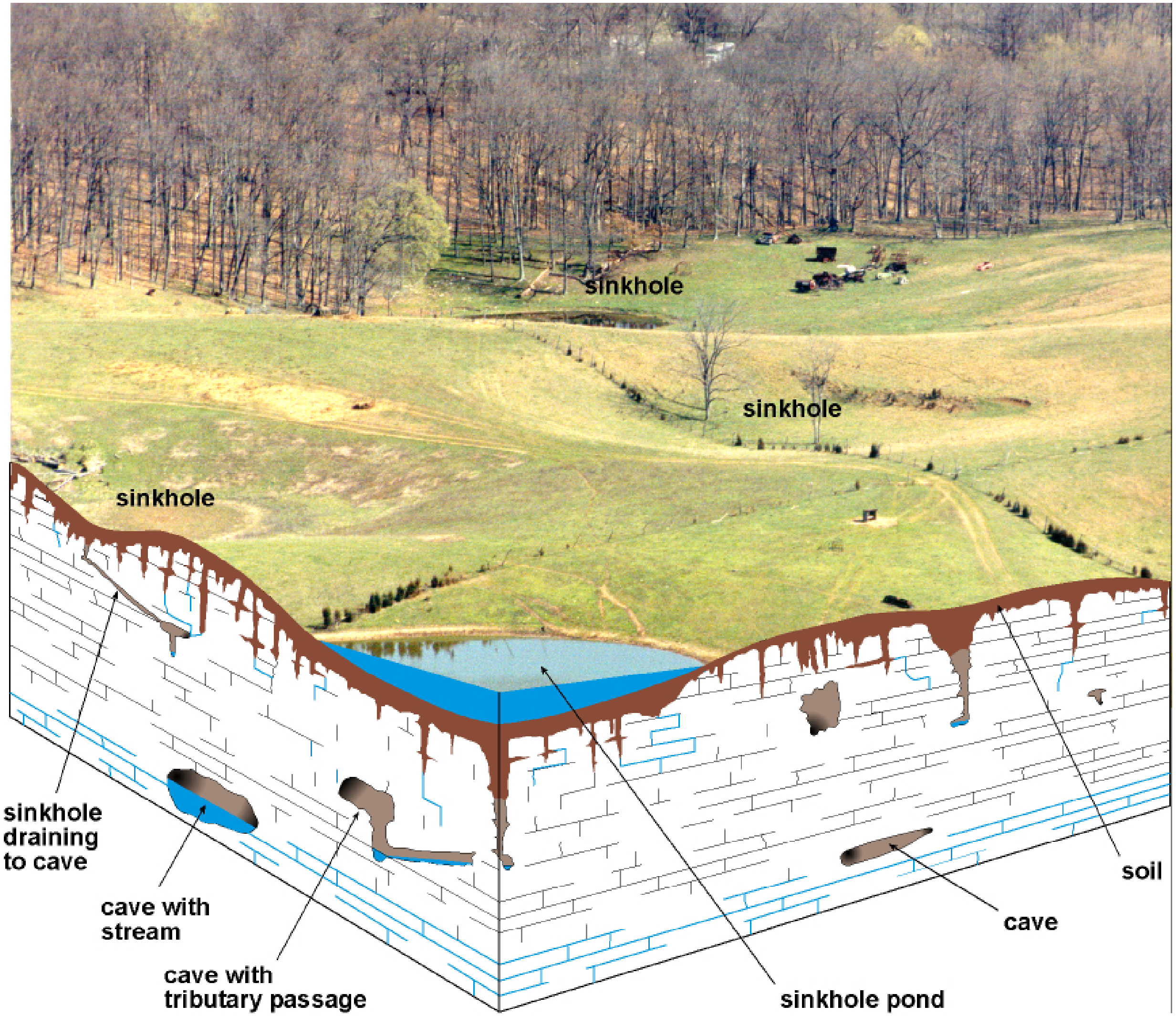
- Keep cattle and other livestock out of sinkholes and sinking streams. There are other methods of providing water to livestock.

- 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.

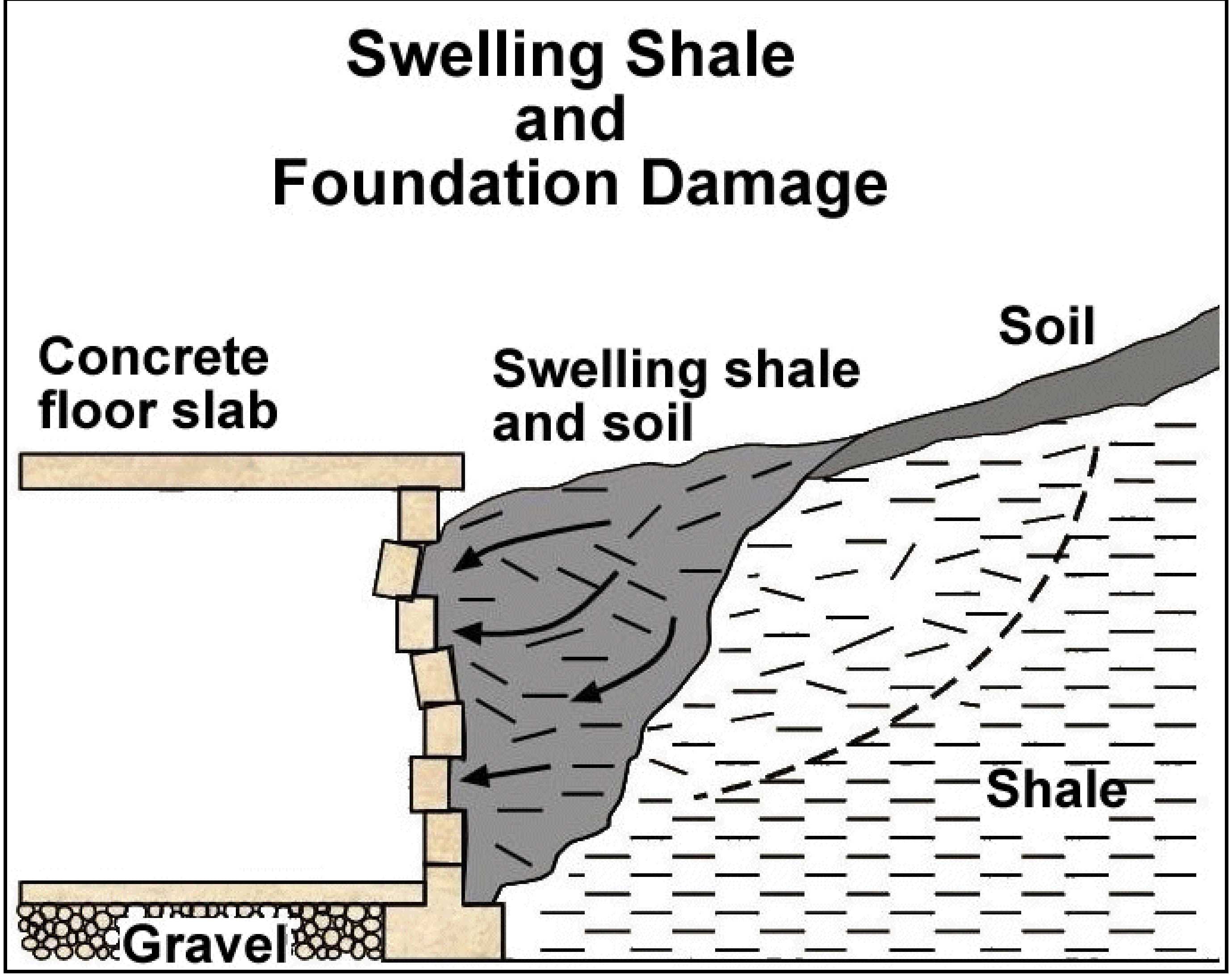
- Construct waste-holding lagoons in karst areas carefully, to prevent the bottom of the lagoon from collapsing, which would result in a catastrophic emptying of waste into the groundwater.

- If required, develop a groundwater protection plan (410KAR5:037) or an agricultural water-quality plan (KRS224.71) for your land use.

(From Currens, 2001)



Karst areas require special care.

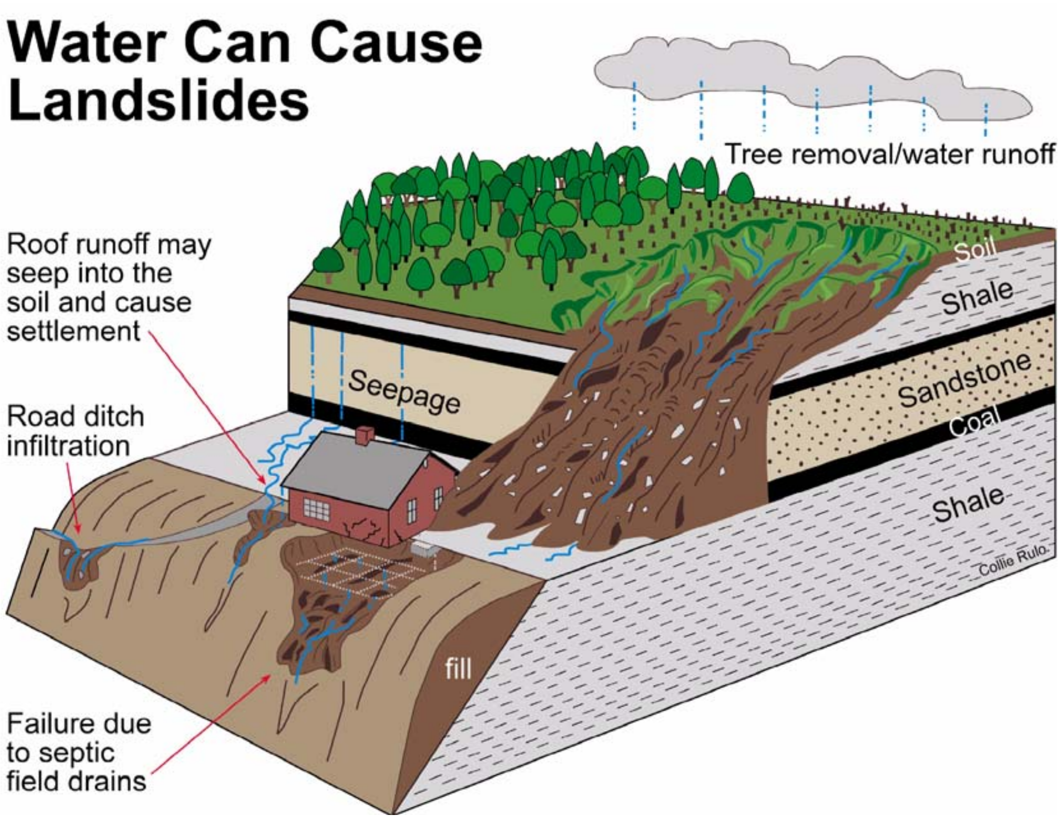


Swelling Shale and Foundation Damage

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 can even damage upper floors and interior partitions. This phenomenon has been responsible for extensive damage to schools, homes, and businesses in Kentucky.

What Are the Factors That Cause Landslides?

- Many factors contribute to landslides. The most common in eastern Kentucky are listed below:
- Steep slopes: Avoid when choosing a building site.
- Water: Slope stability decreases as water moves into the soil. Springs, seeps, roof runoff, gutter downspouts, septic systems, and site grading that cause ponding or runoff are sources of water that often contribute to landslides.
- Changing the natural slope by creating a level area where none previously existed.
- Poor site selection for roads and driveways.
- Improper placement of fill material.
- Removal of trees and other vegetation: Site construction often results in the elimination of trees and other vegetation. Plants, especially trees, help remove water and stabilize the soil with their extensive root systems.



What Are Some Ways to Prevent Landslides?

●Seek professional assistance prior to construction.

●Proper site selection: Some sloping areas are naturally prone to landslides. Inspect the site for springs, seeps, and other wet areas that might indicate water problems. Take note of unusual cracks or bulges at the soil surface. These are typical signs of soil movement that may lead to slope failure. Also be aware of geologically sensitive areas where landslides are more likely to occur.

●Alter the natural slope of the building site as little as possible during construction. Never remove soil from the toe or bottom of the slope or add soil to the top of the slope. Landslides are less likely to occur on sites where disturbance has been minimized. Seek professional assistance before earth moving begins.

●Remove as few trees and other vegetation as possible. Trees develop extensive root systems that are very useful in slope stabilization. Trees also remove large amounts of groundwater. Trees and other permanent vegetative covers should be established as rapidly as possible and maintained to reduce soil erosion and landslide potential.

●Household water disposal system: Seek professional assistance in selecting the appropriate type and location of your septic system. Septic systems located in fill material can saturate soil and contribute to landslides.

●Proper water disposal: Allowing surface waters to saturate the sloping soil is the most common cause of landslides in eastern Kentucky. Properly located diversion channels are helpful in redirecting runoff away from areas disturbed during construction. Runoff should be channeled and water from roofs and downspouts piped to stable areas at the bottom of the slope.

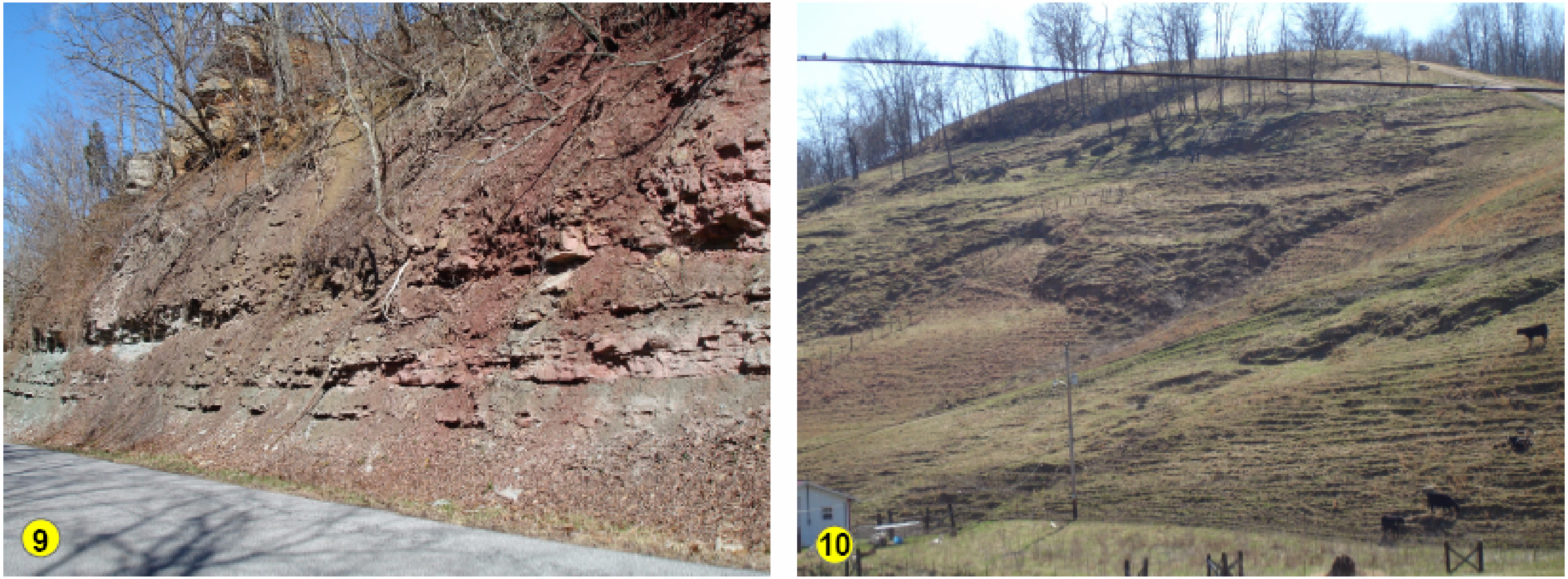
(From U.S. Department of Agriculture, Natural Resources Conservation Service, no date)

Photographing Local Issues

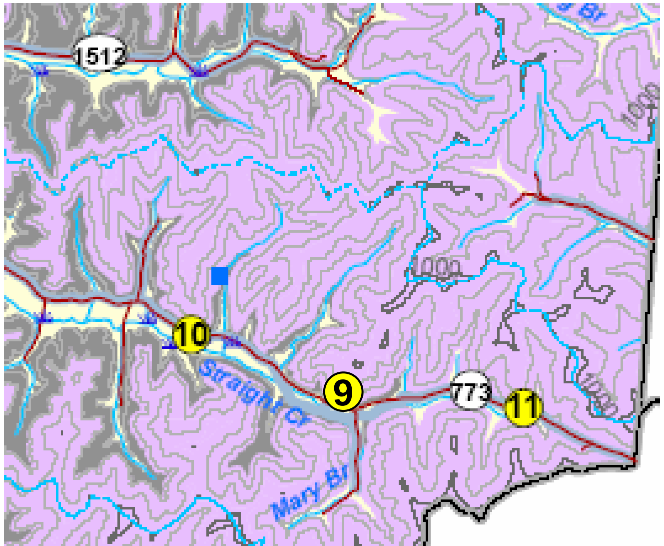
Photos taken in each county illustrate local geologic conditions.

Steep slopes in the Knobs region and in the eastern part of the county are susceptible to sliding and slumping because they are composed of thick shales (units 5 and 6). Photo by John Kiefer, Kentucky Geological Survey.

Red and Green Shales



Red and green shales (unit 8) are low strength, sensitive to moisture, and prone to slumping and landslides. Hillslopes with little stabilizing vegetation show extensive downslope movement of soil material that can damage structures built too close to the hill. Cattle can exacerbate the soil movement. Photos by Jerry Weisenfluh, Kentucky Geological Survey.

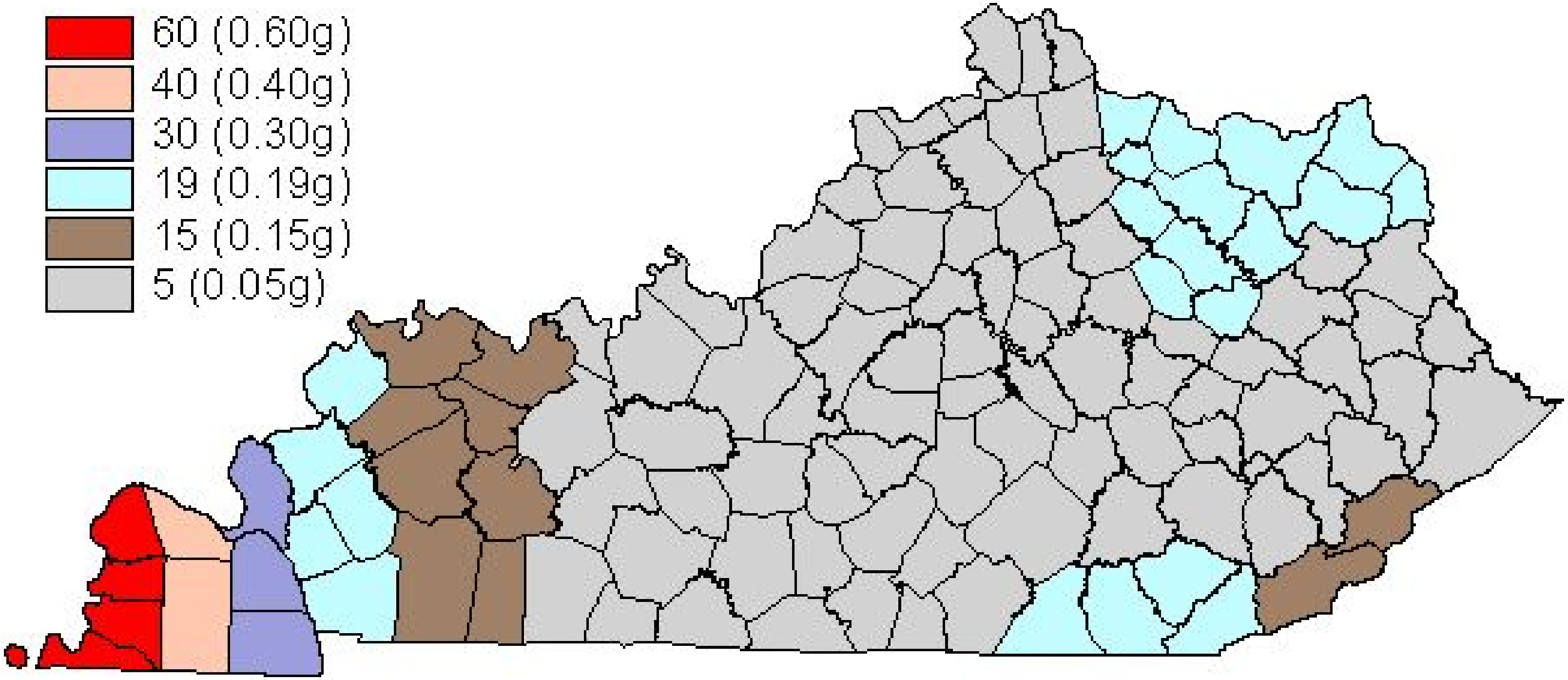


Road Slump

Poorly drained substrates under roads build on unit 8 can result in costly failures. Photo by Jerry Weisenfluh, Kentucky Geological Survey.

Earthquake Hazard Information

Peak ground acceleration at the top of rock that will probably occur in the next 500 years in Kentucky



Although we do not know when and where the next major earthquake will occur, we do know that an earthquake will cause damage. Damage severity depends on many factors, such as earthquake magnitude, the distance from the epicenter, and local geology. Information on earthquake effects is obtained by monitoring earthquakes and performing research. Such information is vital for earthquake hazard mitigation and risk reduction.

The most important information for seismic-hazard mitigation and risk reduction is ground-motion hazard. One way of predicting ground-motion hazard is by determining the peak ground acceleration (PGA) that may occur in a particular timeframe. The map above shows the PGA at the top of bedrock that will likely occur within the next 500 years in Kentucky (Street and others, 1996). It shows, as expected, that PGA would be greatest in far western Kentucky near the New Madrid Seismic Zone. Ground-motion hazard maps for the central United States and other areas are available from the U.S. Geological Survey. These maps are used to set general policies on mitigating damage. For example, maps produced by the USGS in 1996 were used to determine seismic design in building codes. For additional information pertaining to earthquake hazards visit the Kentucky Geological Survey website at www.uky.edu/KGS/geologichazards/geologichazards.html

Radon

Radon gas, although not widely distributed in Kentucky in amounts above the U.S. Environmental Protection Agency's maximum recommended limit of 4 picocuries per liter, can be a local problem. The black shales may have 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 of time, 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 Level	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 X-rays /yr
40	120-380	100 times average outdoor level	Two-pack/day smoker
20	60-210		
10	30-120	10 times average outdoor 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 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)

Pond Construction

The maps provide guidance to homeowners who want to build a pond on their property.

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 exceed-ing 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 Resource Conservation Service.

Photographing Local Issues

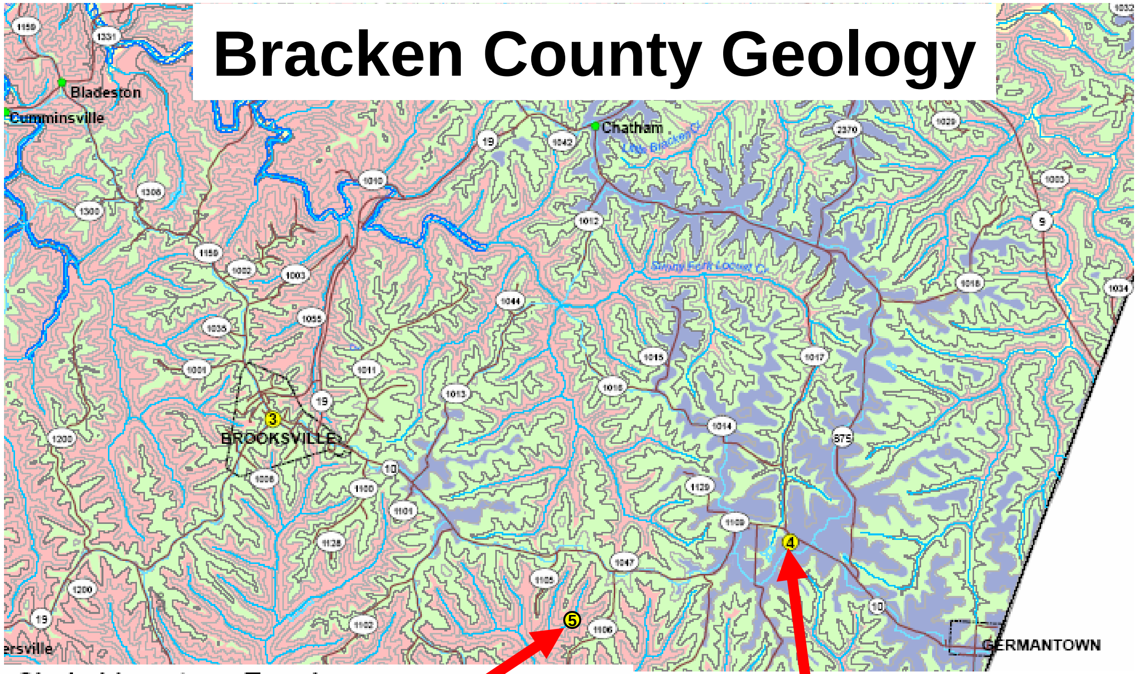
Seepage at the interface of units 9 and 10, permeable rock overlying relatively impermeable rock. Successful ponds are often located below this seepage zone. Ponds should be constructed so that the springs or seeps will always be above the level of the pond surface. (photo by Paul Howell)

Shaly Limestone – Unit 2

Steep, rolling, mammillary topography is characteristic of areas underlain by shaly limestone (unit 2). Photo by Dan Carey, Kentucky Geological Survey.

Bracken County Geology

GPS is used in the field to determine photo location



Shaly Limestone Terrain

Steep, rolling, knobby hills characterize the underlying shaly limestones of unit 2. Photo by Dan Carey, Kentucky Geological Survey.

Limestone Terrain

The presence of underlying limestone (unit 4) is revealed by gently rolling terrain and soils that provide for rich agriculture. Photo by Dan Carey, Kentucky Geological Survey.

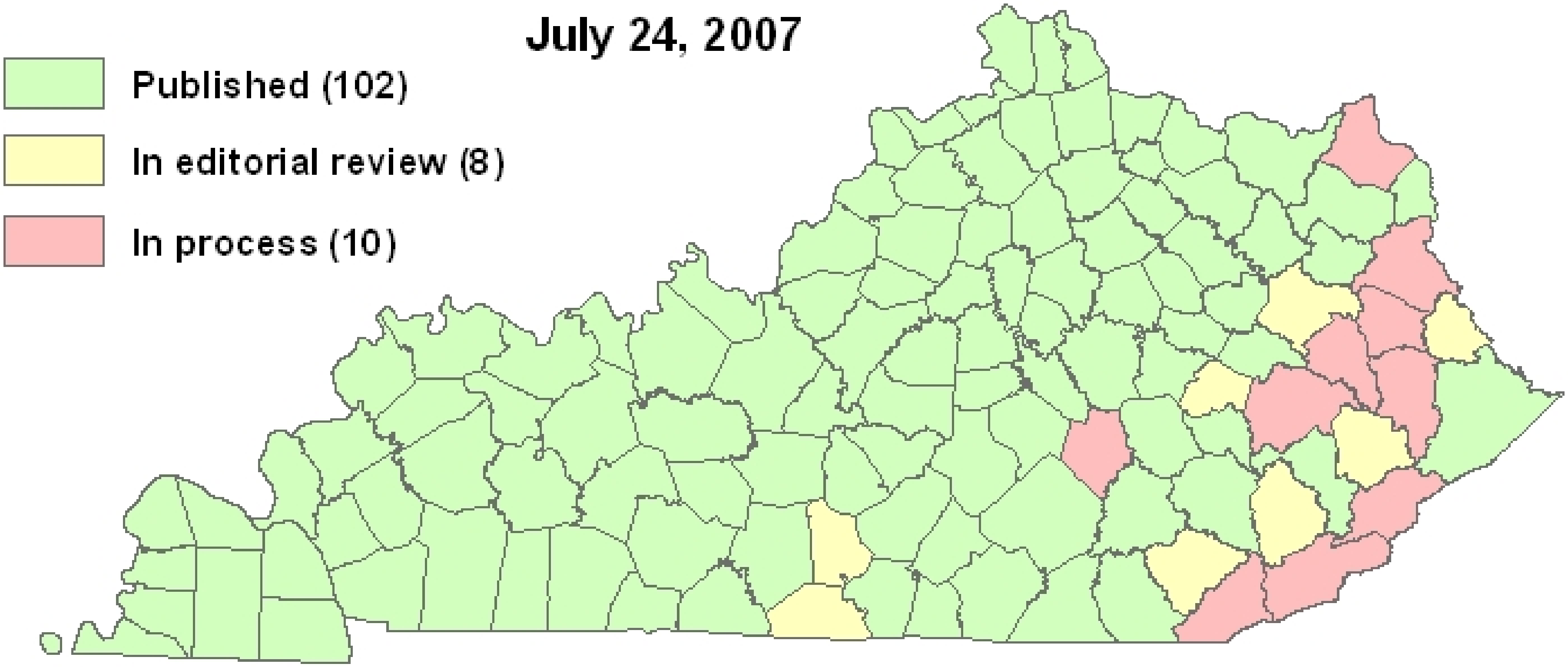
Generalized Geologic Maps for Land-Use Planning in Kentucky Counties

July 24, 2007

🟩 Published (102)

🟨 In editorial review (8)

🟥 In process (10)



Land-Use Planning Maps
Kentucky Geological Survey

www.uky.edu/kgs

Land-Use Map Authors

T. Jeffrey Adams, E. Glynn Beck, Daniel I. Carey, Matthew M. Crawford, Bart Davidson, Garland R. Dever, Jr., Stephen F. Greb, Edward C. Hodges, Paul Howell, Martin C. Noger, Brandon Nuttall, Bethany Overfield, Randy Paylor, Richard A. Smath, John F. Stickney, Steven Webb, Gerald A. Weisenfluh, David A. Williams

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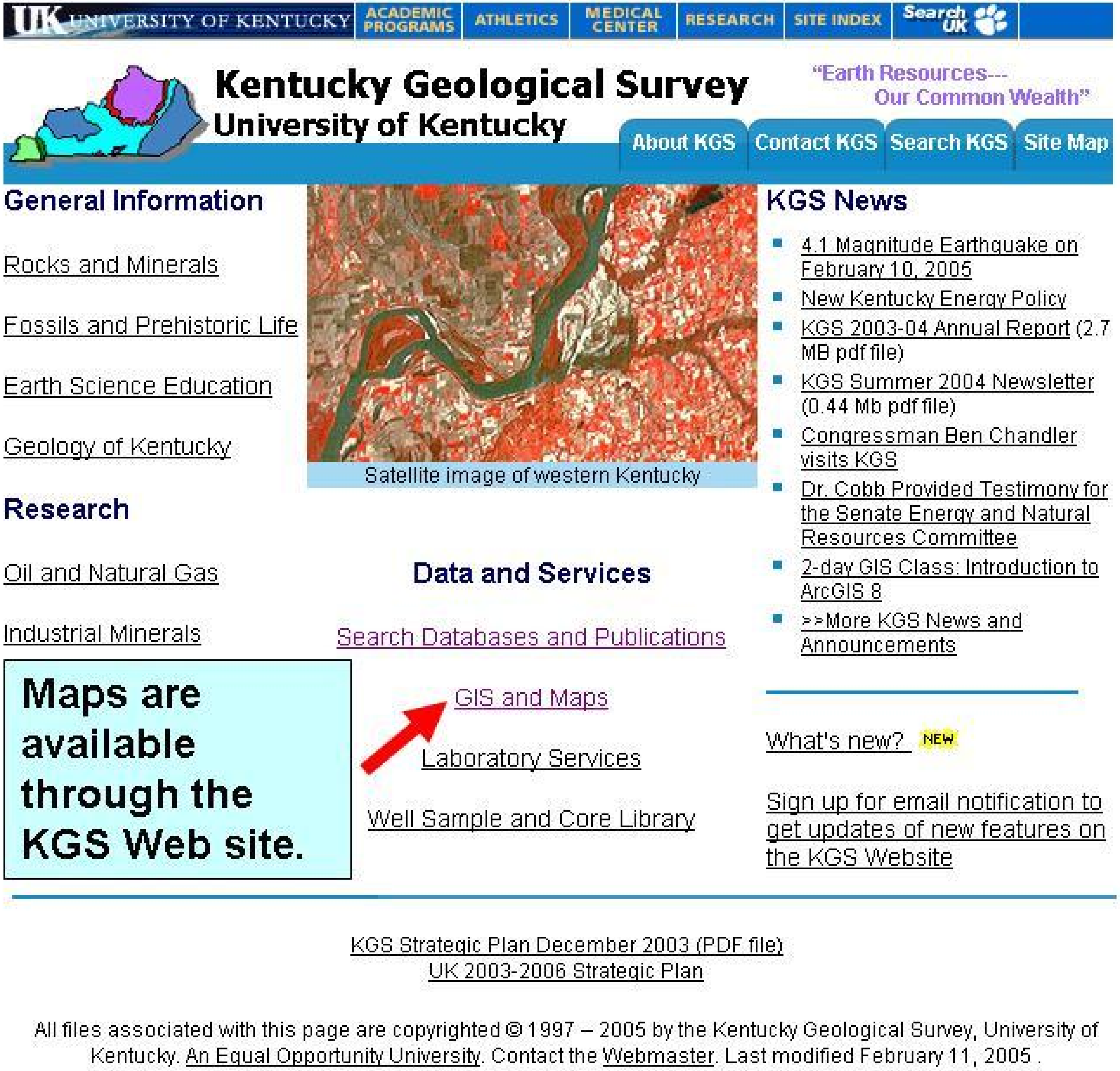

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Rocks and Minerals

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Earth Science Education

Geology of Kentucky

Satellite image of western Kentucky

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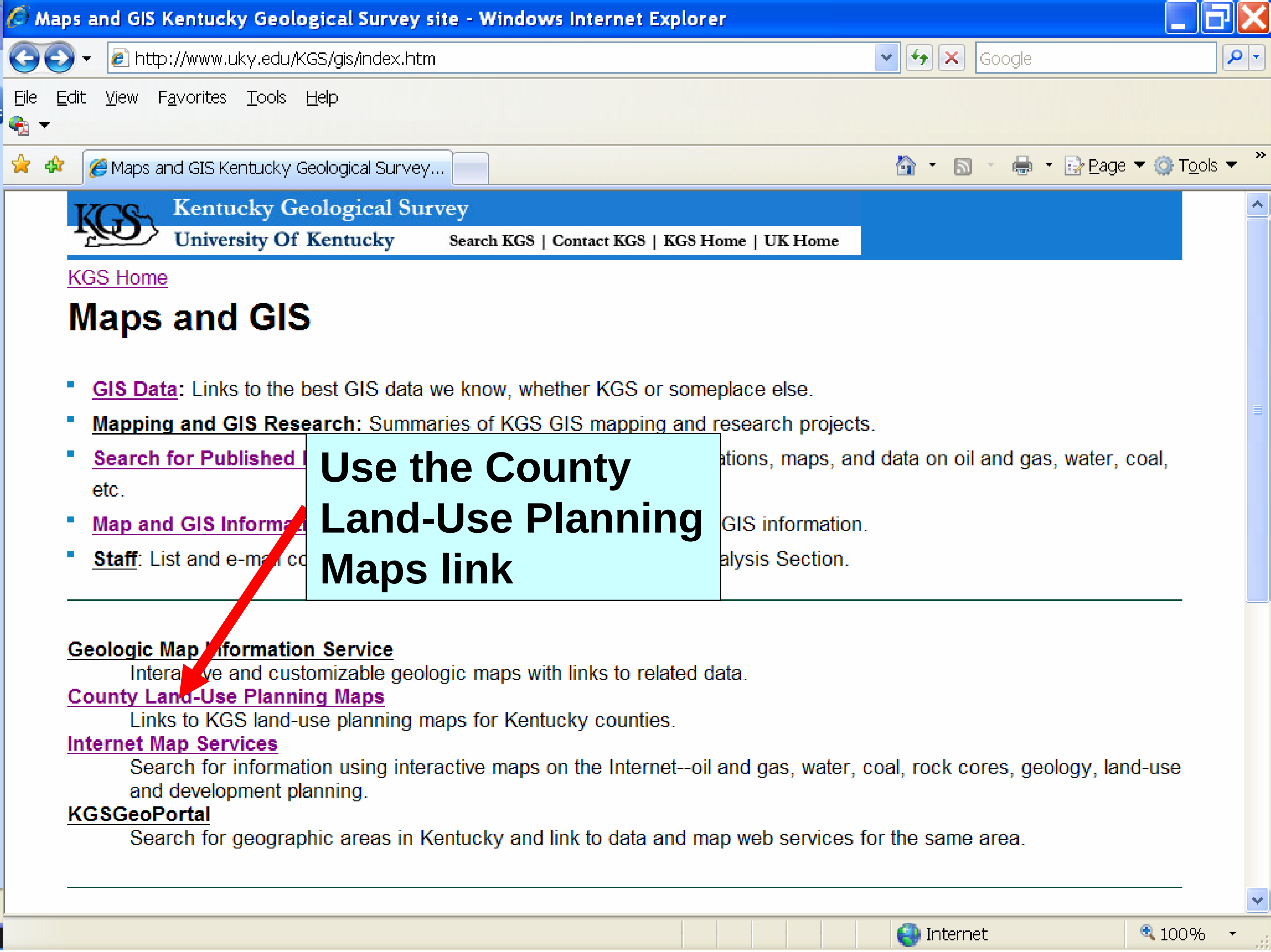

Use the County Land-Use Planning Maps link

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You may click directly on the map or use the dropdown county list to look at a map.
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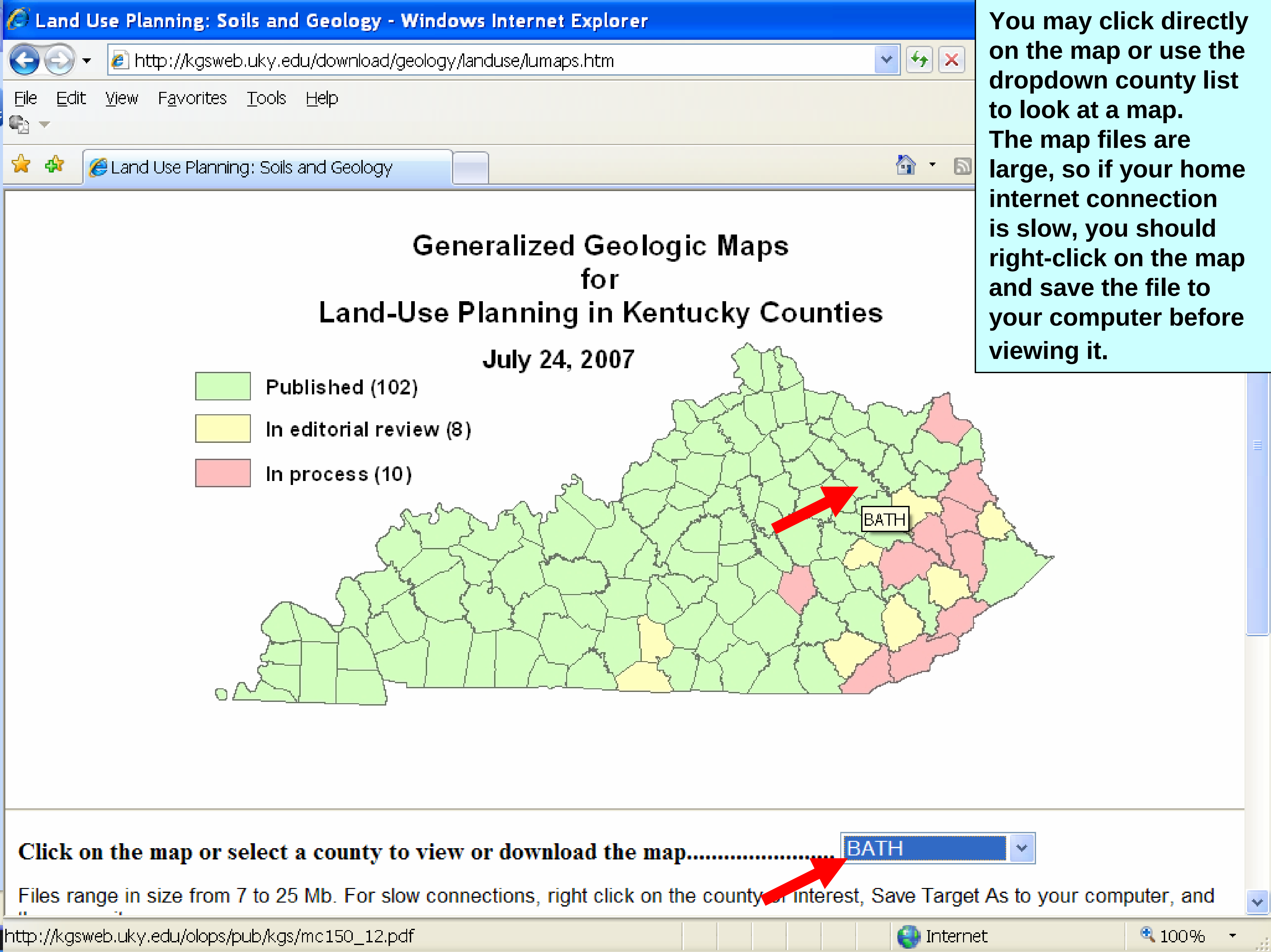

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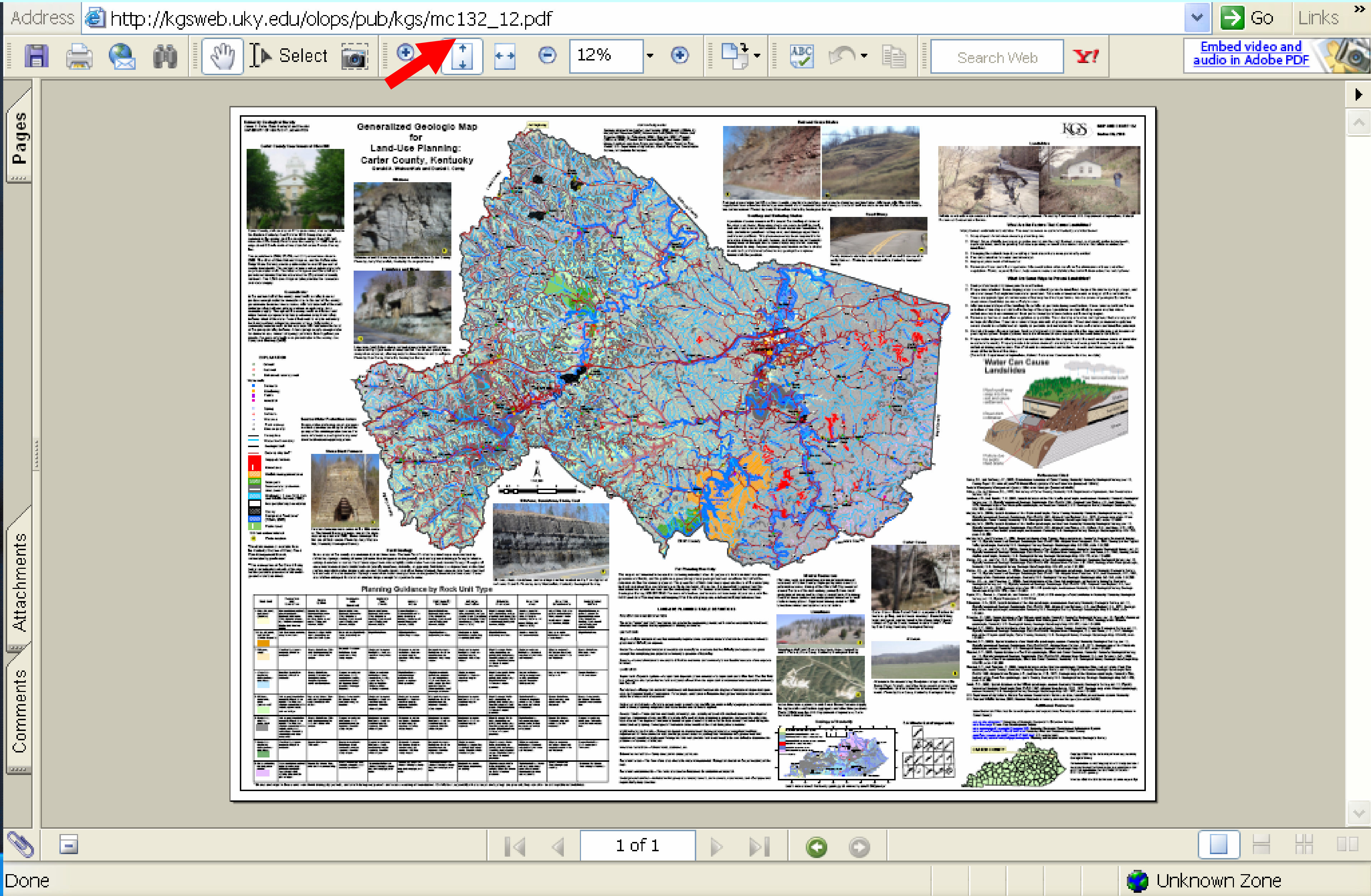
Maps may be viewed with the free Adobe Reader or downloaded to your machine as pdf files. Maps are at least 36”x36”. You may order a printed/laminated map from KGS toll-free at phone 877.778.7827 or e-mail KGS-PUB@lsv.uky.edu.



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Zoom: 12%

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

Page: 1 of 1