Kentucky Geological Survey
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UNIVERSITY OF KENTUCKY, LEXINGTON

MAP AND CHART 118
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Generalized Geologic Map for Land-Use Planning: Garrard County, Kentucky

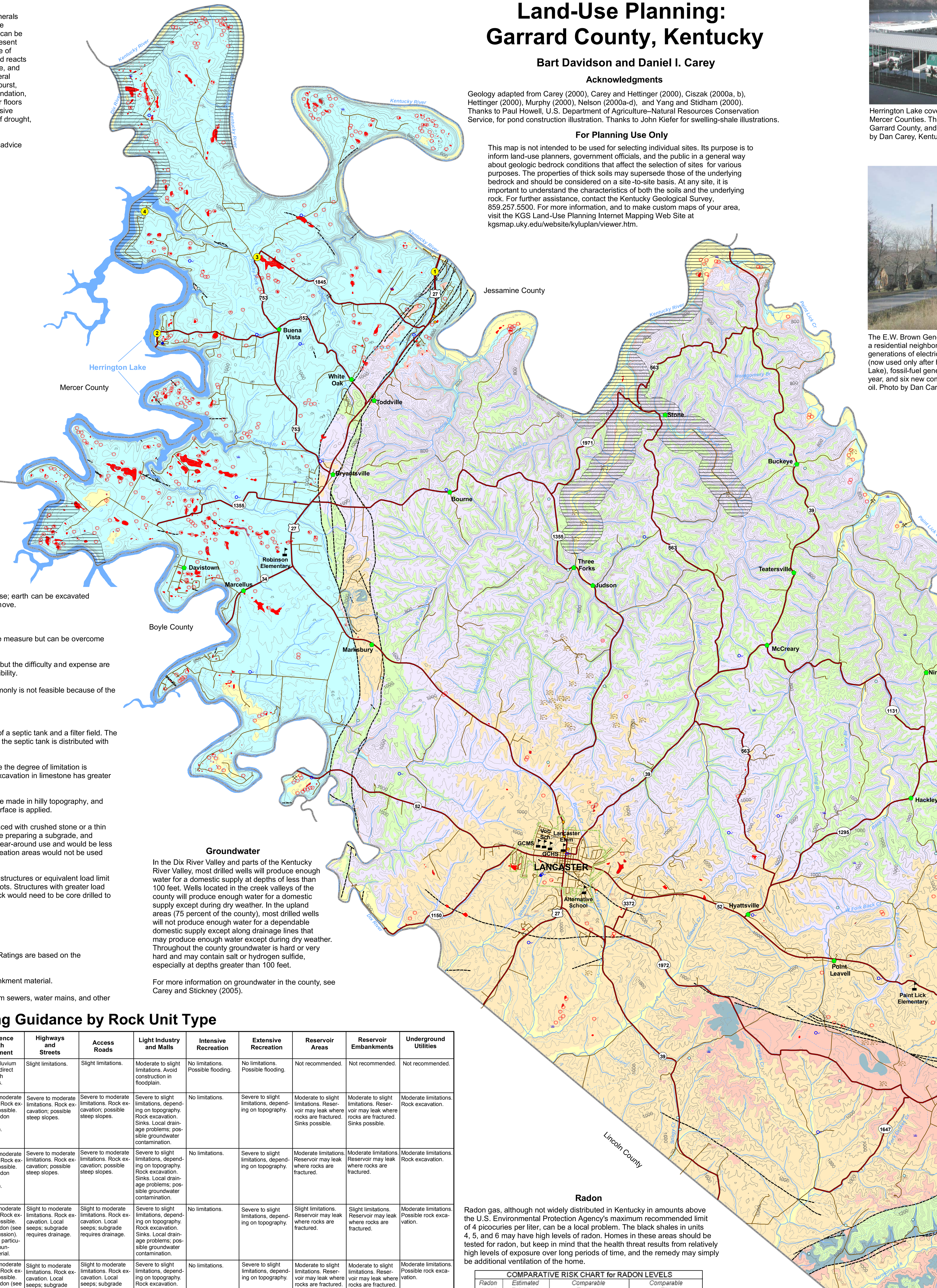
Bart Davidson and Daniel I. Carey

Acknowledgments

Geology adapted from Carey (2000), Carey and Hettinger (2000), Ciszak (2000a, b), Hettinger (2000), Murphy (2000), Nelson (2000a-d), and Yang and Stidham (2000). Thanks to Paul Howell, U.S. Department of Agriculture–Natural Resources Conservation Service, for pond construction illustration. Thanks to John Kiefer for swelling-shale illustrations.

For Planning Use Only

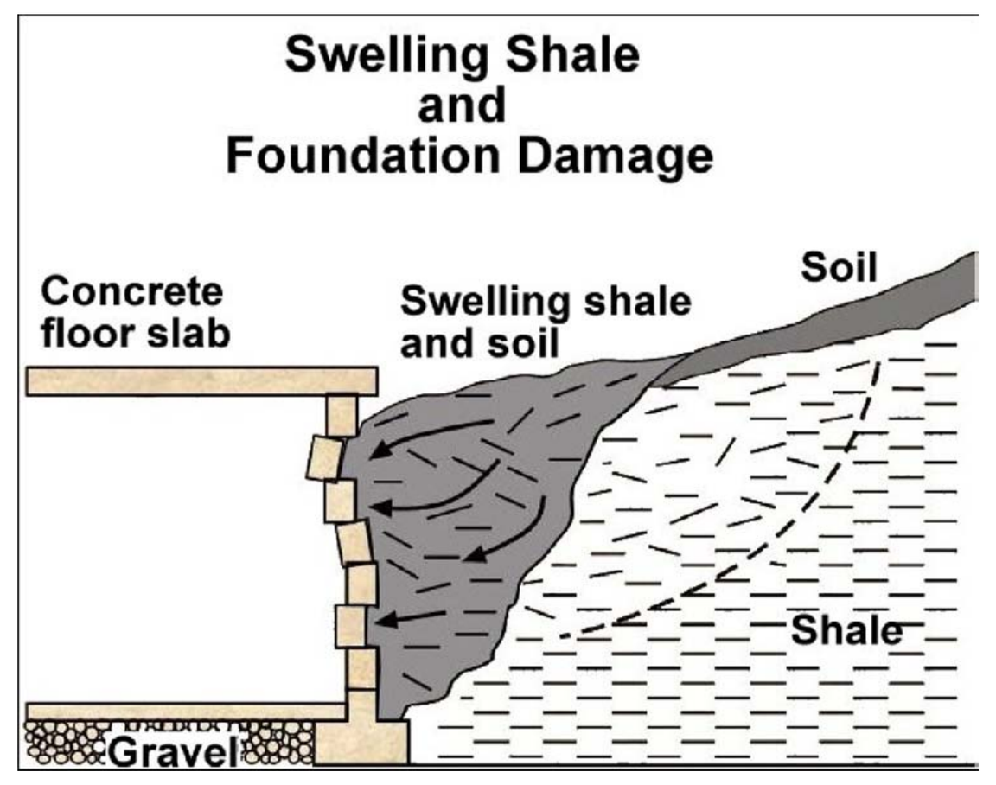
This map is not intended to be used for selecting individual sites. Its purpose is to inform land-use planners, government officials, and the public in a general way about geologic bedrock conditions that affect the selection of sites for various purposes. The properties of thick soils may supersede 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.



Swelling Shales and Soils

A potential concern in Garrard County is swelling of some of the clay minerals in shales in units 4, 5, and 6. This 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 can even 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 will 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). Photograph by John Kiefer, Kentucky Geological Survey.

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.

Groundwater

In the Dix River Valley and parts of the Kentucky River Valley, most drilled wells will produce enough water for a domestic supply at depths of less than 100 feet. Wells located in the creek valleys of the county will produce enough water for a domestic supply except during dry weather. In the upland areas (75 percent of the county), most drilled wells will not produce enough water for a dependable domestic supply except along drainage lines that 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 (2005).

Planning Guidance by Rock Unit Type

Rock Unit	Karst Potential Rating	Foundation and Excavation	Septic System	Residence with Basement	Highways and Streets	Access Roads	Light Industry and Malls	Intensive Recreation	Extensive Recreation	Reservoir Areas	Reservoir Embankments	Underground Utilities
1. Silt, sand, and gravel	None, but investigation recommended where less than 25 feet to soluble rock.	Fair foundation material; easy to excavate.	Severe limitations. Failed septic systems can contaminate groundwater.	Water in alluvium may be in direct contact with basements.	Slight limitations.	Slight limitations.	Moderate to slight limitations. Avoid construction in floodplain.	No limitations. Possible flooding.	No limitations. Possible flooding.	Not recommended.	Not recommended.	Not recommended.
2. Dolomite and limestone	Medium.	Excellent foundation material; difficult to excavate.	Severe to moderate limitations. Locally, fast drainage through fractures and sinks to water table. Possible groundwater contamination.	Severe to moderate limitations. Rock excavation possible. Possible radon (see radon discussion).	Severe to moderate limitations. Rock excavation; possible steep slopes.	Severe to moderate limitations. Rock excavation; possible steep slopes.	Severe to slight limitations, depending on topography. Rock excavation. Sinks. Local drainage problems; possible groundwater contamination.	No limitations.	Severe to slight limitations, depending on topography.	Moderate to slight limitations. Reservoir may leak where rocks are fractured. Sinks possible.	Moderate to slight limitations. Reservoir may leak where rocks are fractured. Sinks possible.	Moderate limitations. Rock excavation.
3. Limestone	High.	Excellent foundation material; difficult to excavate.	Severe to moderate limitations. Locally, fast drainage through fractures and sinks to water table. Possible groundwater contamination.	Severe to moderate limitations. Rock excavation possible. Possible radon (see radon discussion).	Severe to moderate limitations. Rock excavation; possible steep slopes.	Severe to moderate limitations. Rock excavation; possible steep slopes.	Severe to slight limitations, depending on topography. Rock excavation. Sinks. Local drainage problems; possible groundwater contamination.	No limitations.	Severe to slight limitations, depending on topography.	Moderate limitations. Reservoir may leak where rocks are fractured.	Moderate limitations. Reservoir may leak where rocks are fractured.	Moderate limitations. Rock excavation.
4. Limestone, dolomite, and shale	High to medium.	Excellent foundation material; difficult to excavate.	Severe to moderate limitations. Locally, fast drainage through fractures and sinks to water table. Possible groundwater contamination.	Severe to moderate limitations. Rock excavation possible. Possible radon (see radon discussion). Plastic clay particularly poor foundation material.	Slight to moderate limitations. Rock excavation. Local seeps; subgrade requires drainage.	Slight to moderate limitations. Rock excavation. Local seeps; subgrade requires drainage.	Severe to slight limitations, depending on topography. Rock excavation. Sinks. Local drainage problems; possible groundwater contamination.	No limitations.	Severe to slight limitations, depending on topography.	Slight limitations. Reservoir may leak where rocks are fractured.	Slight limitations. Reservoir may leak where rocks are fractured.	Moderate limitations. Possible rock excavation.
5. Limestone, shale, and siltstone	Medium.	Excellent to fair foundation material; moderately difficult to excavate.	Severe to moderate limitations. Locally, fast drainage through fractures and sinks to water table. Possible groundwater contamination.	Severe to moderate limitations. Rock excavation possible. Possible radon (see radon discussion). Plastic clay particularly poor foundation material.	Slight to moderate limitations. Rock excavation. Local seeps; subgrade requires drainage.	Slight to moderate limitations. Rock excavation. Local seeps; subgrade requires drainage.	Severe to slight limitations, depending on topography. Rock excavation. Sinks. Local drainage problems; possible groundwater contamination.	No limitations.	Severe to slight limitations, depending on topography.	Moderate to slight limitations. Reservoir may leak where rocks are fractured.	Moderate to slight limitations. Reservoir may leak where rocks are fractured.	Moderate limitations. Possible rock excavation.
6. Shale	Low.	Fair to poor foundation material; easy to moderately difficult to excavate. Possible pyrite expansion in shales. Plastic clay presents particularly poor foundation conditions.	Severe to moderate limitations. Impermeable rock. Locally, fast drainage through fractures and sinks to water table. Possible groundwater contamination.	Severe to moderate limitations. Rock excavation possible. Possible radon (see radon discussion). Plastic clay particularly poor foundation material.	Moderate limitations. Rock excavation. Local drainage problems. Plastic clay particularly poor foundation material and will not hold up to high-angle roadcuts.	Moderate limitations. Rock excavation. Local drainage problems. Plastic clay particularly poor foundation material and will not hold up to high-angle roadcuts.	Severe to slight limitations, depending on topography. Rock excavation. Sinks. Local drainage problems; possible pyrite expansion in shales.	No limitations.	Severe to slight limitations, depending on topography.	Slight limitations. Most favorable sites on this unit. Locally, impermeable rock thin and underlain by fissured limestone.	Slight limitations. Most favorable sites on this unit. Locally, impermeable rock thin and underlain by fissured limestone.	Moderate limitations. Possible rock excavation.
7. Shale and limestone or dolomite	Medium to low.	Excellent to fair foundation material; moderately difficult to excavate.	Severe to moderate limitations. Locally, fast drainage through fractures and sinks to water table. Possible groundwater contamination.	Severe to moderate limitations. Rock excavation possible. Possible radon (see radon discussion). Plastic clay particularly poor foundation material.	Slight to moderate limitations. Rock excavation. Local seeps; subgrade requires drainage.	Slight to moderate limitations. Rock excavation. Local seeps; subgrade requires drainage.	Severe to slight limitations, depending on topography. Rock excavation. Sinks. Local drainage problems; possible groundwater contamination.	No limitations.	Severe to slight limitations, depending on topography.	Moderate to slight limitations. Reservoir may leak where rocks are fractured.	Moderate to slight limitations. Reservoir may leak where rocks are fractured.	Moderate limitations. Possible rock excavation.
8. Siltstone, shale, and limestone	Medium to low.	Excellent to fair foundation material; moderately difficult to excavate.	Severe to moderate limitations. Locally, fast drainage through fractures and sinks to water table. Possible groundwater contamination.	Severe to moderate limitations. Rock excavation possible. Possible radon (see radon discussion). Plastic clay particularly poor foundation material.	Slight to moderate limitations. Rock excavation. Local seeps; subgrade requires drainage.	Slight to moderate limitations. Rock excavation. Local seeps; subgrade requires drainage.	Severe to slight limitations, depending on topography. Rock excavation. Sinks. Local drainage problems; possible groundwater contamination.	No limitations.	Severe to slight limitations, depending on topography.	Moderate to slight limitations. Reservoir may leak where rocks are fractured.	Moderate to slight limitations. Reservoir may leak where rocks are fractured.	Moderate limitations. Possible rock excavation.

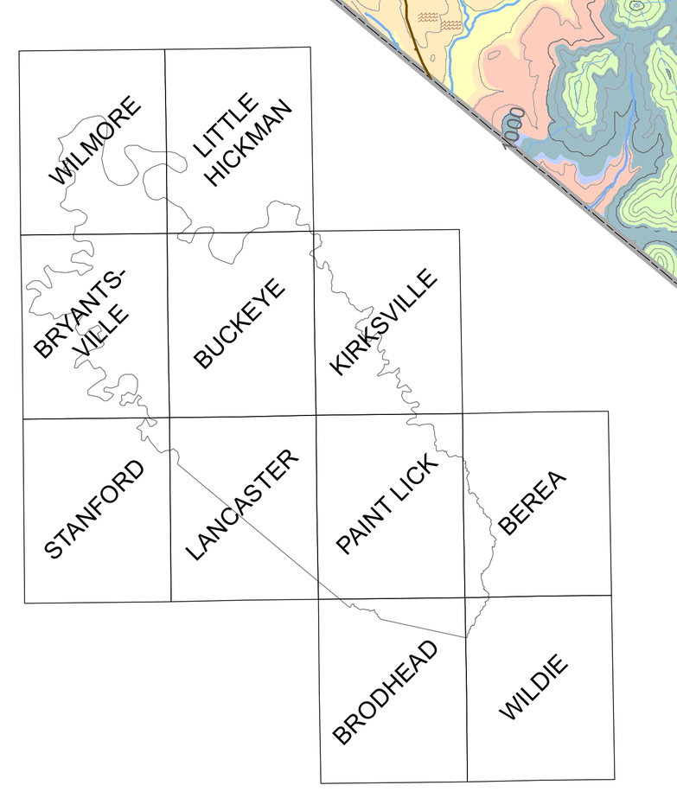
Radon

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 in units 4, 5, and 6 may have high levels of radon. Homes in these areas should be tested for radon, but 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 Levels*	*Comparable Risk Estimate*
200	440 - 770	1,000 times average outdoor level	More than 60 times non-smoker risk
100	270 - 630	100 times average outdoor level	Four pack/day smoker or 20,000 chest X-rays/yr
40	120 - 380	100 times average outdoor level	Two-pack/day smoker
20	60 - 210		
10	30 - 120	10 times average indoor level	One pack/day smoker
4	13 - 50	10 times average outdoor level	Five times non-smoker risk
2	7 - 30		
1	3 - 13	Average indoor level	Non-smoker risk of fatal lung cancer
0.2	1 - 3	Average outdoor level	20 chest X-rays/yr

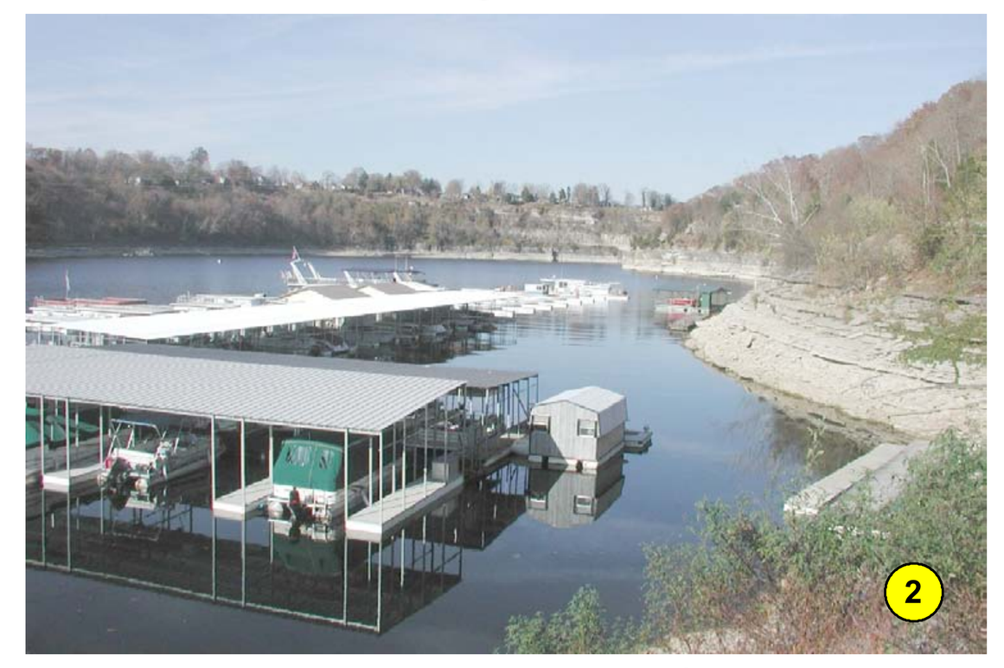
EPA recommends action be taken if indoor levels exceed 4 picocuries per liter, which is 10 times the average outdoor level. Some EPA representatives believe the action level should be lowered to 2 picocuries per liter; other scientists dissent and claim the risks estimated in this chart are already much 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)



7.5-Minute Topographic Map Index

Scale 1:48,000
1 inch = 3/4 mile
2 1 0 2 Miles

Herrington Lake

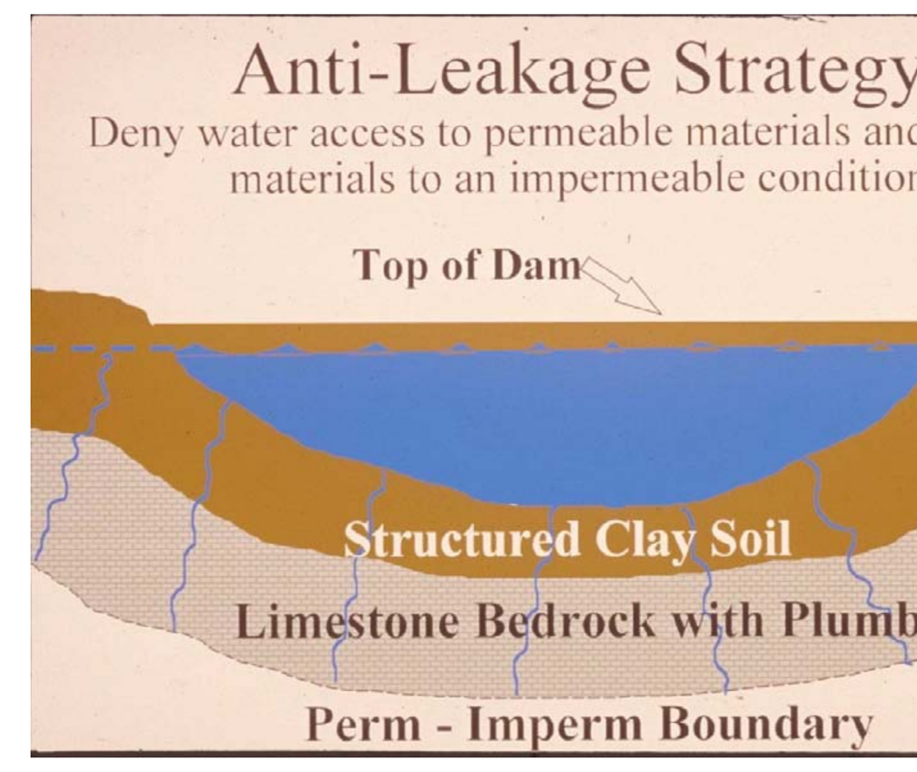


Herrington Lake covers nearly 3,500 acres in Garrard, Boyle, and Mercer Counties. The lake is a major recreational resource in Garrard County, and is surrounded by residential housing. Photo by Dan Carey, Kentucky Geological Survey.

Power Generation

The E.W. Brown Generating Station in Mercer County as seen from a residential neighborhood in Garrard County. The station has three generations of electricity-producing processes: a hydroelectric plant (now used only after heavy rainfall raises water levels at Herrington Lake), fossil-fuel generating units burning 1.5 million tons of coal per year, and six new combustion turbines, fueled by natural gas or fuel oil. Photo by Dan Carey, Kentucky Geological Survey.

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. Photo (below) by Stephen Greb, Kentucky Geological Survey.

Kentucky River Fault Zone

The Kentucky River Fault at Camp Nelson is situated in the Ordovician High Bridge Group on Highway 27 just south of the Kentucky River. This structural feature includes kink folds (shown here), breccias, slickensides and mineralized fractures. Downdropped to the southeast, the fault exhibits as much as 700 feet of structural relief. Photo by Bart Davidson, 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.

EXPLANATION

- School
- Geologic fault
- County line
- Mapped sinkholes
- Artificial fill
- Watershed boundary
- Wetlands > 1 acre (U.S. Fish and Wildlife Service, 2003)
- Source-water protection area, zone 1
- Incorporated city boundary

Water wells
- Domestic
- Monitoring
- Public
- Severely eroded area
- Gravelly area
- Rock outcrop
- Sinkhole
- Wet area
- Mine or quarry
- Spring
- Gas well
- Oil well

40-foot contour interval

4 Photo location

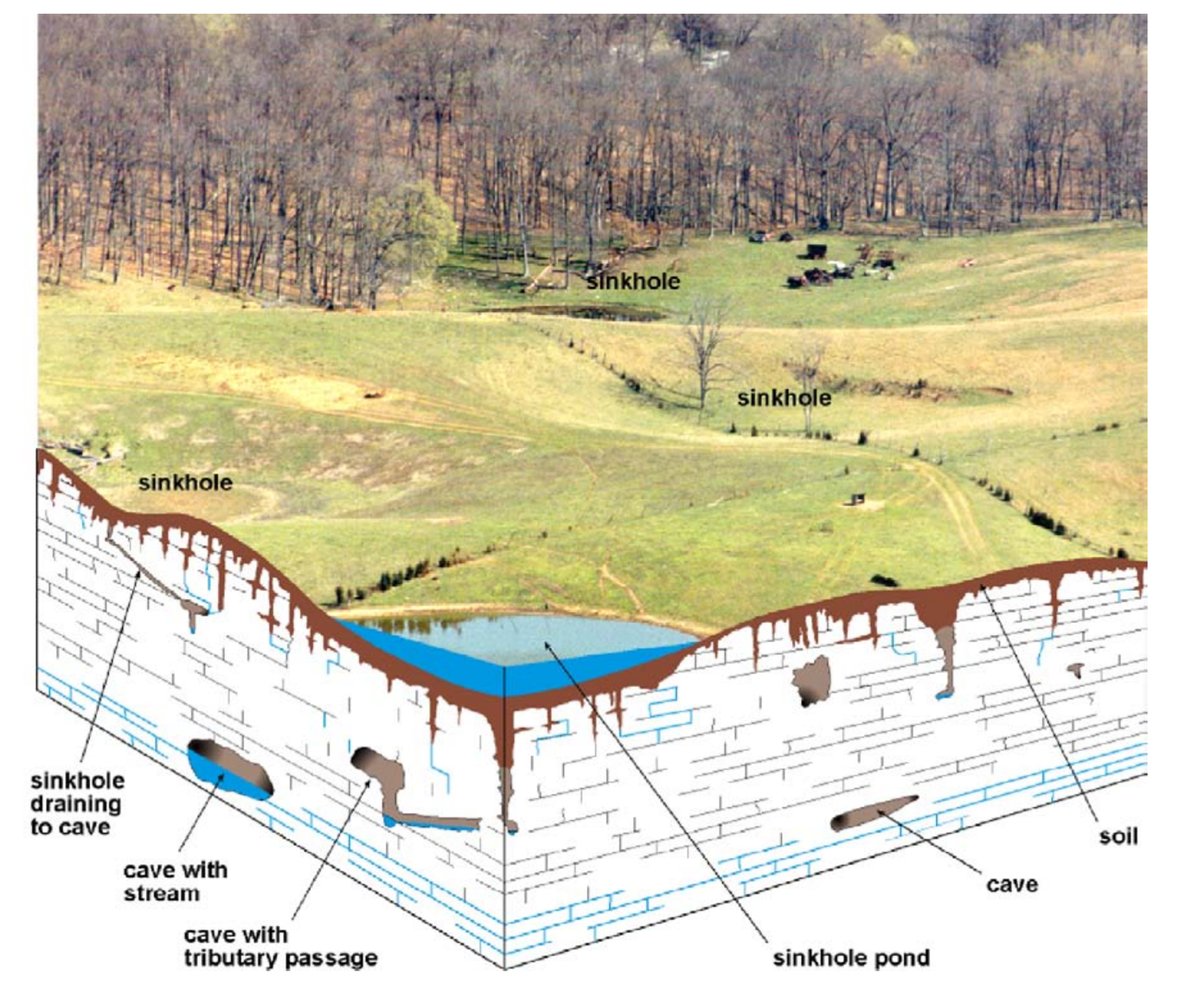
Source-Water Protection Areas

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

Karst Geology

The term "karst" refers to a landscape characterized by sinkholes, springs, sinking streams (streams that disappear underground), and underground drainage through solution-enlarged conduits or caves. Karst landscapes form when slightly acidic water from rain and snowmelt seeps through soil cover into fractured and soluble bedrock (usually limestone, dolomite, or gypsum). Sinkholes are depressions on the land surface into which water drains underground. Usually circular and often funnel-shaped, they range in size from a few feet to hundreds of feet in diameter. Springs occur when water emerges from underground to become surface water. Caves are solution-enlarged fractures or conduits large enough for a person to enter.

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)

This sinkhole, located along Ky. 753 in northern Garrard County, is typical of the karst topography of the area. Groundwater flow occurs in fractures in the limestone bedrock. Sinkholes should be carefully considered prior to any development in karst areas, which include sinking streams, caves, and springs. Photo by Dan Carey, Kentucky Geological Survey.

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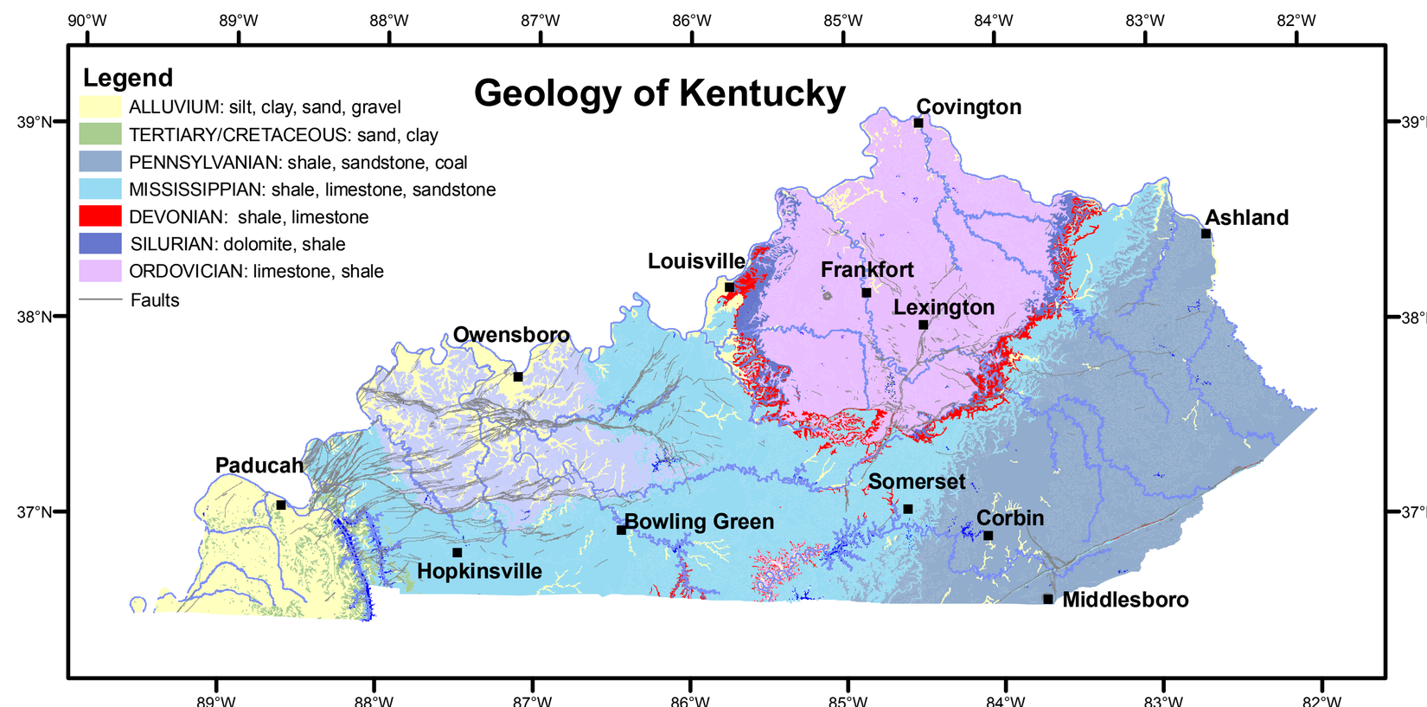
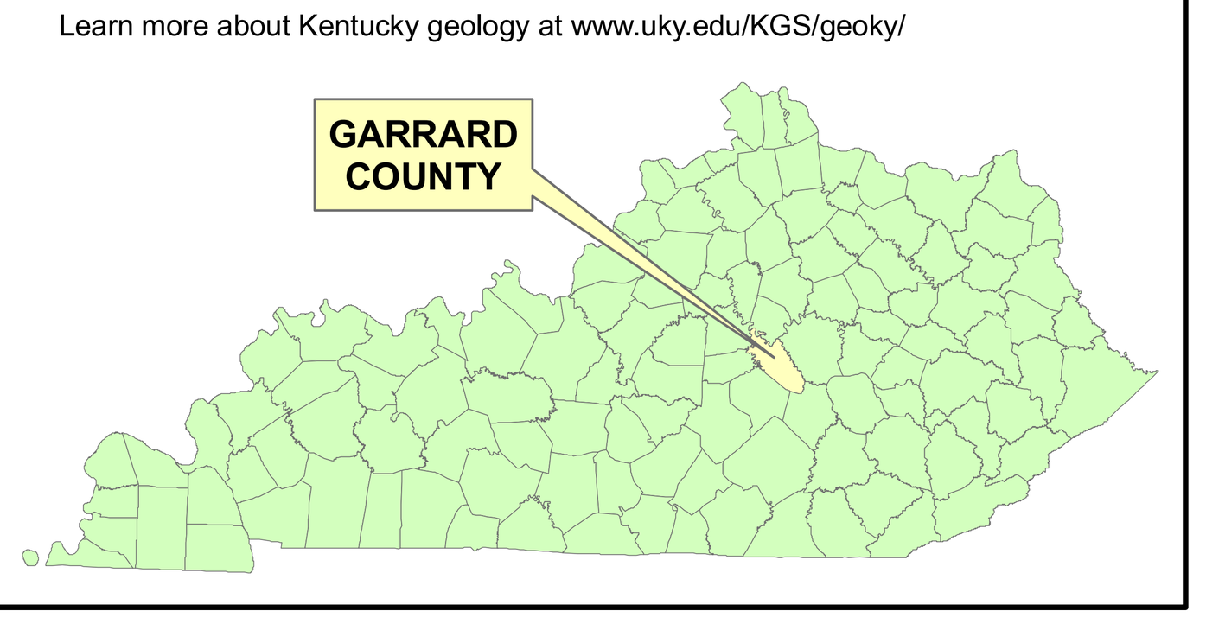
Additional Resources

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

ces.ca.uky.edu/garrard/ University of Kentucky Cooperative Extension Service
www.kineticnet.net/kyrcd/kh.html Kentucky Heritage Resource Conservation and Development Council Inc.
www.bgadd.org/ Bluegrass Area Development District
www.thinkkentucky.com/edis/cmnty/cw094/ Detailed county statistics
www.uky.edu/KentuckyAtlas/21079.html Kentucky Atlas and Gazetteer, Garrard County
quickfacts.census.gov/qfd/states/21/21079.html U.S. Census data



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



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

Public Information Center
859.257.3896 or
877.778.7827 (toll free)

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