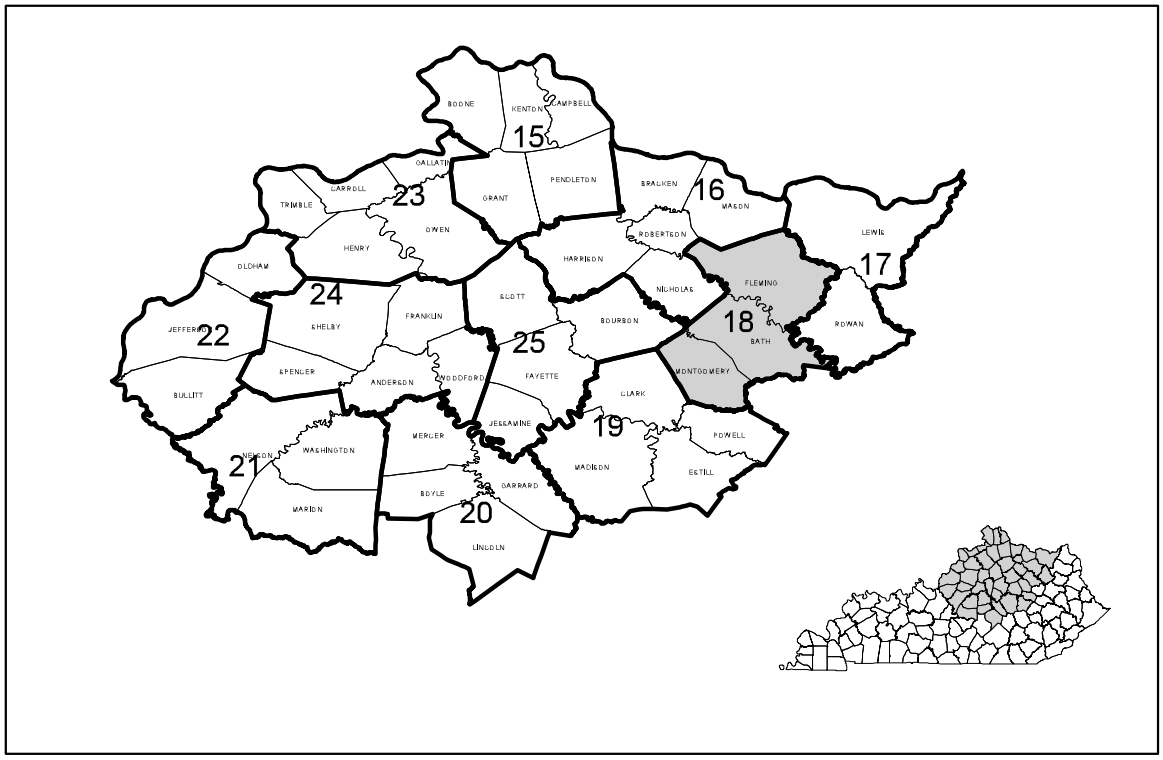
DEPARTMENT OF THE INTERIOR
UNITED STATES GEOLOGICAL SURVEY

PREPARED IN COOPERATION WITH
THE COMMONWEALTH OF KENTUCKY
AND THE KENTUCKY GEOLOGICAL SURVEY
UNIVERSITY OF KENTUCKY

AVAILABILITY OF GROUND WATER IN BATH, FLEMING, AND MONTGOMERY COUNTIES, KENTUCKY

By
F.R. Hall and W.N. Palmquist, Jr.

HYDROLOGIC INVESTIGATIONS
ATLAS HA-18



INDEX MAP OF THE BLUE GRASS REGION, KENTUCKY, SHOWING COUNTY GROUPS AND AREA OF THIS ATLAS

This is 1 of 11 atlases (HA-15 to HA-25) showing geology and availability of ground water in the Blue Grass region, Kentucky U.S. Geological Survey Water-Supply Paper 1533 contains a text description and illustrations providing further information on the occurrence and quality of ground water in the Blue Grass region.

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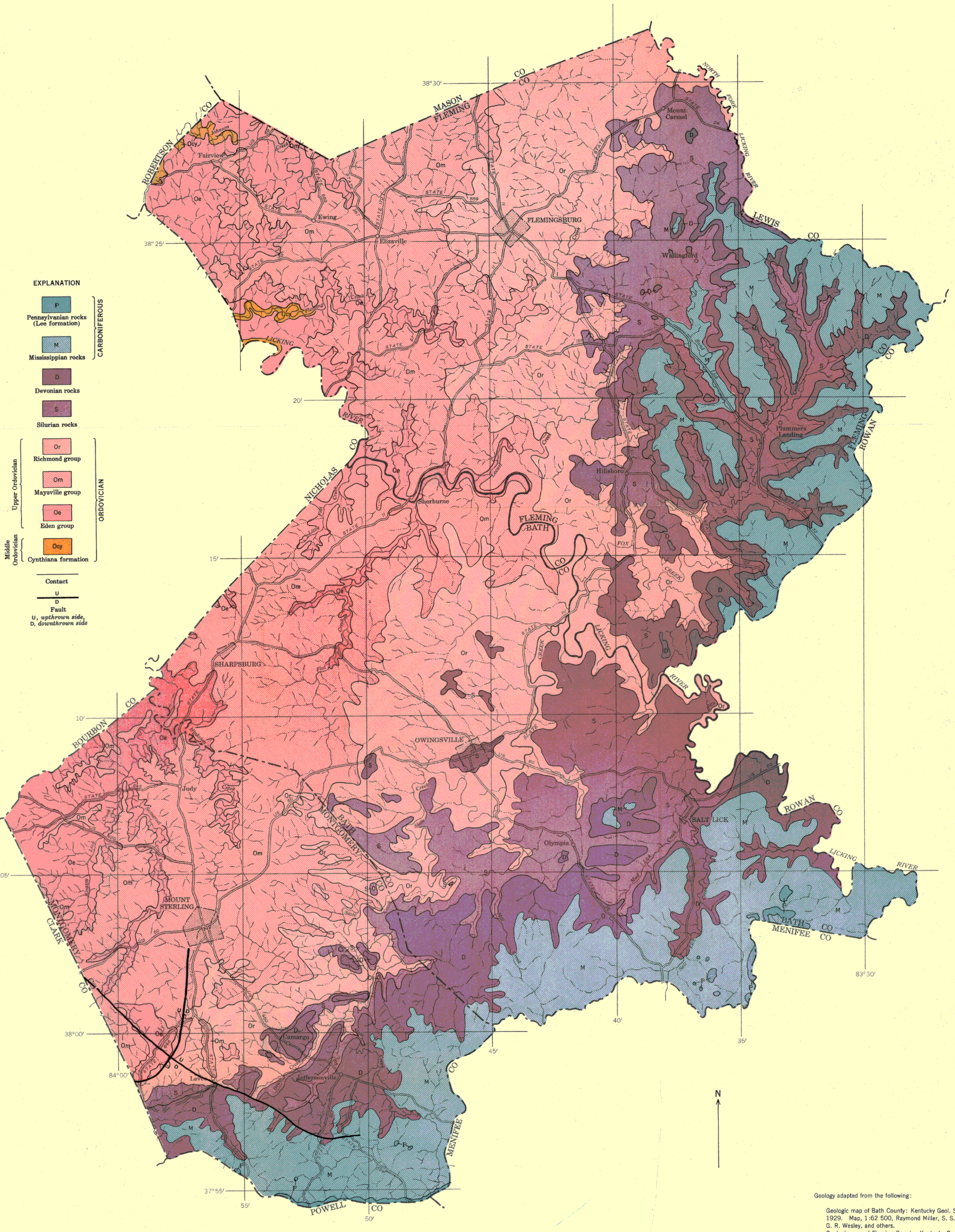

Base from general county highway maps of Kentucky, 1950, Kentucky State Highway Department, State-wide Planning Survey

Geology adapted from the following:

Geologic map of Bath County: Kentucky Geol. Survey, ser. 6, 1929. Map, 1:62 500, Raymond Miller, S. S. Goodwin, G. R. Wesley, and others.
Geologic map of Fleming County: Kentucky Geol. Survey, ser. 6, 1929. Map, 1:62 500, Raymond Miller, S. S. Goodwin, G. R. Wesley, and G. H. Briggs.
Map of areal and structural geology at Montgomery County: Kentucky Geol. Survey, ser. 6, 1929. Map, 1:62 500, A. C. McFarlan and S. S. Goodwin

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GEOLOGIC MAP OF BATH, FLEMING, AND MONTGOMERY COUNTIES, KENTUCKY (COUNTY GROUP 18)

Scale 1:125 000

1 0 1 2 3 4 5 6 7 8 9 10 Miles

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HYDROLOGIC INVESTIGATIONS
ATLAS HA-18 (SHEET 1 OF 3)

EXPLANATION

Well

Spring

No objectionable quantities of salt or hydrogen sulfide in water

Sulfurous water[1]
Contains hydrogen sulfide in noticeable amounts

Salty water
Contains sodium chloride in amounts readily detected by tasting

Salty and sulfurous[1] water
Contains both sodium chloride and hydrogen sulfide in readily detectable amounts

Om-N / 33 Well — S-2 Spring

Aquifer

- Qal Alluvium (Quaternary)
- M Mississippian rocks
- D Devonian rocks
- S Silurian rocks
- Or Richmond group (Ordovician)
- Om Maysville group (Ordovician)
- Oe Eden group (Ordovician)
- Ocy Cynthiana formation (Ordovician)

Yield

- 2 Figure above line indicates yield, in gallons per minute, where known
- P Reported adequate for power-pump installation
- H Reported adequate for hand-pump installation
- N No pump, or reported inadequate supply

Depth

33 Figure below line indicates depth of well, in feet

[1] Much of the sulfurous (hydrogen sulfide-bearing) water is satisfactory for domestic use, as the hydrogen sulfide escapes as a gas upon exposure of the water to the air

EXPLANATION

Area 2
Most drilled wells in this area will produce enough water for a domestic supply with a power pump and and pressure system (more than 500 gallons a day) at depths of less than 100 feet. Water is hard or very hard and may contain salt or hydrogen sulfide, especially at depths greater than 100 feet

Area 3
Most drilled wells in this area will produce enough water for a domestic supply with a hand pump (100 to 500 gallons a day) at depths of less than 100 feet. Some wells will produce more than 500 gallons a day except during dry weather. Water is hard or very hard and may contain salt or hydrogen sulfide, especially at depths greater than 100 feet

Area 4
Most drilled wells in this area will not produce enough water for a dependable domestic supply (100 gallons a day). Wells along drainage lines may produce enough water for a domestic supply except during dry weather. Water is hard and may contain salt or hydrogen sulfide at depths greater than 100 feet

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AVAILABILITY OF GROUND WATER IN BATH, FLEMING, AND MONTGOMERY COUNTIES, KENTUCKY (COUNTY GROUP 18)

Scale 1:125 000

1 0 1 2 3 4 5 6 7 8 9 10 Miles

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DEPARTMENT OF ECONOMIC DEVELOPMENT

HYDROLOGIC INVESTIGATIONS
ATLAS HA-18 (SHEET 3 OF 3)

SYSTEM	SERIES	GROUP	FORMATION	THICKNESS, IN FEET	SECTION	LITHOLOGY	TOPOGRAPHY	HYDROLOGY
QUATERNARY	PLEISTOCENE AND RECENT		ALLUVIUM	20±		Thin, discontinuous deposits of fine-grained sand, silt, and clay in the Licking River Valley and major tributary streams. Not shown on map.	Terraces and flood plains of Licking River and tributaries.	Yields almost no water to drilled wells; yields small quantities to dug wells.
PENNSYLVANIAN	PLEISTOCENE AND RECENT		LEE FORMATION	100±		Massive crossbedded pebbly sandstone with a few thin coal seams and shale partings, and beds and lenses of conglomerate which become thicker toward the base. In places these rocks fill erosion channels cut into the underlying limestone of Mississippian age.	Tops and steep upper slopes of ridges and knobs.	Yields almost no water to drilled wells on hilltops and narrow ridgetops, but yields 100 to 500 gpd (gallons per day) to wells on broad ridges; yields water to small springs, some of which are perennial. Water is soft and has a low dissolved-solids content.
CARBONIFEROUS SYSTEMS — MISSISSIPPIAN	UPPER MISSISSIPPIAN		UNDIFFERENTIATED LIMESTONE	125±		From top to bottom: Thick-bedded to moderately thick-bedded bluish-gray coarse-grained limestone with some thin shale partings, massive layers of yellow oolitic limestone, argillaceous shelly limestone, shaly limestone and shale, and oolitic limestone. Entire section is present in only a few places because of local erosion.	Tops and steep upper slopes of ridges and knobs.	Yields almost no water to wells; yields water to springs high on ridges at heads of streams. Springs have large winter and small summer flow. Water is moderately hard to hard but otherwise of good quality.
	LOWER MISSISSIPPIAN	BORDEN[1]	MULDRAUGH FORMATION[2]	50±		Argillaceous limestone with shaly partings in upper part and clayey shale in lower part.	Dissected upper slopes of Mississippian escarpment and some knobs. Limestone beds project as ledges or small cliffs in ravines and hillsides.	Yields 100 to 500 gpd to wells in valley bottoms, more than 500 gpd to some wells near streams, and almost no water to drilled wells in shale; yields little water to wells on hills; yields water to small springs and seeps. Water from wells drilled below stream level may contain objectionable amounts of salt or sulfate. Water from dug wells and springs is soft and has a low dissolved-solids content. The rocks are well suited for dug wells because they are soft and silty. Most dug wells yield less than 500 gpd. In valley bottoms the water table is at a shallow depth and most drilled wells are less than 50 feet deep. Water of poor quality is found at shallow depths. Many wells that penetrate the underlying Ohio shale yield water of poor quality.
			FLOYDS KNOB FORMATION[1]	1±		Glauconitic silt or siltstone with glauconitic streaks or specks; locally cherty or calcareous.	Ledges between shale slopes above and below.	
			BRODHEAD FORMATION[2]	195-270		Silty shale interbedded with limestone lenses and laminated siltstone in upper part; massive siltstone in lower part.	Main part of Mississippian escarpment and many knobs. Shale forms dissected slopes, massive siltstone forms cliffs, and limestone forms ledges on slopes.	
			NEW PROVIDENCE FORMATION[1]	275-300		Massive shaly siltstone overlying argillaceous to silty shale with siltstone layers above evenly bedded siltstone with shale partings, and argillaceous shale at the base in eastern Bath and Fleming Counties; argillaceous shale above, and silty shale and siltstone below, in southern Bath and southeastern Montgomery Counties.	Dissected lower slopes of knobs, and flat, broad valleys.	
			SUNBURY SHALE	15		Black highly fissile carbonaceous shale similar to the Ohio shale.		Similar to Ohio shale described below.
			BEDFORD SHALE	5-25		Laminated bluish-gray to nearly black silty clay shale with thin beds of greenish fine-grained sandstone.		Similar to Borden group described above.
DEVONIAN	UPPER DEVONIAN		OHIO SHALE	150±-185		Thick uniform beds of black highly fissile carbonaceous shale with green shaly layers locally, and thin sandy and calcareous layers toward the base. Small amounts of fine quartz grains, pyrite, and other minerals, and black organic material.	Broad, flat-bottomed valleys extending deep into New Providence outcrop area; nearly flat upland surfaces away from streams, and steep dissected slopes along streams	Yields 100 to 500 gpd to drilled wells in broad valley bottoms, and may yield as much to some wells on upland; yields little water to drilled wells on hillsides and hilltops; yields water to small springs. Water locally contains iron, salt, sulfate, and hydrogen sulfide in objectionable amounts.
	MIDDLE DEVONIAN		BOYLE LIMESTONE[3]	0-15		Massive dolomitic limestone containing chert and silicified coral. Contains oolitic hematite at many places in Bath County. It thins eastward in Bath County and is commonly absent in Fleming County.	Prominent ledges along hillsides and lower edges of valleys.	Yields almost no water to wells, but yields water to many small perennial springs. Water is hard but has a low mineral content.
SILURIAN		CRAB ORCHARD[4]		55-100		Thin- to medium-bedded lumpy bluish-gray and green clay shale containing some thin layers of thin- to medium-bedded dolomitic limestone. The shale, in places, contains epsom salt and selenite (clear gypsum) crystals.	Steep, dissected slopes, flat valley bottoms, and dissected upland surfaces.	Yields 100 to 500 gpd to wells in broad valley bottoms, but almost no water to wells on hills; yields water to small springs. Water is hard and locally contains calcium and magnesium sulfate.
			BRASSFIELD LIMESTONE	9-15		Fossiliferous medium-crystalline to coarsely crystalline dolomitic limestone that is gray to pink on fresh surfaces and sandy brown on weathered surfaces; contains oolitic hematite at many places in Bath County.	Discontinuous ledges along hillsides.	Yields almost no water to wells, but yields water to small springs. Water is hard but otherwise of good quality.
ORDOVICIAN	UPPER ORDOVICIAN	RICHMOND	ELKHORN AND WHITEWATER FORMATIONS UNDIFFERENTIATED	65		Thick shale and thin limestone beds interlayered. Locally, is alternating limestone and shale.	Gently to moderately rolling upland except along large streams, where there is considerable dissection that leaves steep slopes littered with thin limestone slabs. In places the thick limestone beds crop out in ledges on slopes, form steep bluffs along large streams, and underlie broad, flat valleys in upland.	Yields more than 500 gpd to drilled wells in valley bottoms of large streams, but almost no water to drilled wells on hillsides and ridges; yields 100 to 500 gpd to wells in thick limestone beds along streams in upland; yields water to small springs. Water is hard and in valley bottoms may contain salt or hydrogen sulfide. The shale exerts a strong control on the amount of water available to wells and springs in alternating limestone and shale such as is found in much of the Richmond and Maysville groups. Shale has small, poorly connected openings which inhibit downward movement of ground water to underlying limestone beds. Where ground water has ready access to thick limestone beds along streams, wells and springs have larger yields.
			LIBERTY FORMATION	27-65		Dolomitic limestone and thin beds of calcareous shale interlayered.		
			WAYNESVILLE LIMESTONE	40-70		Alternating argillaceous limestone and calcareous shale.		
			ARNHEIM FORMATION	38-70		Fossiliferous rubbly limestone, dolomitic claystone, and argillaceous limestone and shale interbedded.		
		MAYSVILLE	MC MILLAN FORMATION	62-150		Alternating argillaceous limestone and calcareous shale above, in upper part, thin-bedded fossiliferous limestone with a few thin shale partings (Bellevue limestone member) in lower part.	Gently to moderately rolling upland except along major streams, where there is considerable dissection that leaves steep slopes. Thick limestone beds crop out in ledges on slopes, form steep bluffs along large streams, and underlie flat valleys, where solution has caused formation of small sinkholes and minor subsurface drainage.	Yields 100 to 500 gpd to drilled wells in valley bottoms of large streams, but almost no water to drilled wells on hillsides and ridgetops; yields 100 to 500 gpd to wells drilled into thick limestone beds along streams in upland, and thick limestone beds capping hills on upland. Thick limestone beds yield water to small springs along valley bottoms and hillsides. Water is hard and in valley bottoms may contain salt or hydrogen sulfide.
			FAIRVIEW FORMATION	110-125		Fossiliferous limestone with interbedded shale in upper part, and alternating limestone and shale with thin beds of fine-grained sandstone or siltstone at base in lower part.		
			UNNAMED SANDSTONE MEMBER					
		EDEN	GARRARD SANDSTONE	25-50		Thin beds of fine-grained sandstone and siltstone intercalated with sandy limestone and shale; grades upward and downward into rocks typical of the Maysville and Eden groups.	Prominent ledges in steep slopes and bluffs along large streams.	Yield 100 to 500 gpd to drilled wells in valley bottoms, but almost no water to wells on hillsides or ridgetops and almost no water to springs. The well-cemented siltstone and fine-grained sandstone do not provide many openings for water. Water is hard.
				90±		Gray to bluish-gray lumpy calcareous shale with interlayered beds of thin limestone; some thin shaly and limy sandstone or siltstone in upper part and more limestone in lower part.	Steep, narrow ridges and valleys.	Yields 100 to 500 gpd to drilled wells in broad valley bottoms, but almost no water to drilled wells on hillsides or ridgetops; yields water to small springs. Water is hard and in valley bottoms may contain salt or hydrogen sulfide.
	MIDDLE ORDOVICIAN		CYNTHIANA FORMATION	100+ EXP.		Bluish-gray crystalline fossiliferous limestone with thin beds of shale; may be quite shaly locally, especially in upper part.	Broad, flat valley bottoms along the Licking River and a few larger tributaries in Fleming County.	Yields 100 to 500 gpd to wells drilled in broad valley bottoms in Fleming County; yields water to small springs. Water is hard and may contain salt or hydrogen sulfide.

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[1]As used by Stockdale (1939). [2]Of Stockdale (1939). [3]Of Foerste (1906) as used by Savage (1930). [4]As used by Foerste (1935).

GENERALIZED COLUMNAR SECTION AND WATER-BEARING CHARACTER OF THE ROCKS IN BATH, FLEMING, AND MONTGOMERY COUNTIES, KENTUCKY (COUNTY GROUP 18)

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