PREPARED IN COOPERATION WITH
THE COMMONWEALTH OF KENTUCKY, UNIVERSITY OF KENTUCKY
KENTUCKY GEOLOGICAL SURVEY
WALLACE W. HAGAN, DIRECTOR AND STATE GEOLOGIST

SYSTEM	SERIES	GROUP	FORMATION	SECTION	THICKNESS, IN FEET	LITHOLOGY	TOPOGRAPHY AND GEOLOGIC SETTING	HYDROLOGY
QUATERNARY	Pleistocene and Recent		Alluvium		0-40	Silt and clay and lenses of sand and gravel in Cumberland and Tennessee River valleys, in places indurated and stratified. Gravel, sand, and silt in the smaller valleys.	Thickest alluvial deposits underlie flood plain of Cumberland River but will be inundated when downstream dam is completed. Thinner alluvial deposits occur along smaller streams.	Alluvial deposits are saturated adjacent to Kentucky Lake and along the Cumberland River and its tributaries. Most of the alluvium along the Cumberland River will be flooded upon completion of Barkley Dam 1½ miles downstream and north of this quadrangle. Most alluvial deposits that are not flooded lie within the boundaries of the Kentucky and Barkley Reservoirs. Alluvial deposits lying outside the reservoir boundaries are in low boggy areas that are generally inaccessible.
	Pleistocene		Loess		0-5	Yellowish-orange tp yellowish-brown sandy, argillaceous silt. Sand component consists of fine angular quartz grains.	Windblown deposit on tops of ridges and on upland areas.	Not an aquifer. When saturated, transmits water to underlying units.
TERTIARY	Pliocene (?)		Gravel and sand[1]		0-55	Yellowish- to reddish-brown round to angular chert pebbles, scattered white to orange rounded quartz pebbles, and fine-grained clayey sand.	Underlies loess in uplands west of Kentucky Lake. Thickest deposits underlie ridge half a mile southwest of Holland Cemetery.	Not an aquifer. All gravel deposits lie above main zone of saturation. No gravel deposits are known to lie on impermeable formations, and perched water is not likely to occur in the gravel.
CRETACEOUS	Upper Cretaceous		McNairy Formation		0-70	Brown fine-grained silty clayey sand and scattered mica flakes interbedded with silty to very sandy micaceous clay. Locally contains iron concretions and flattened clay pellets.	Present beneath ridges west of Kentucky Lake. Thickest deposits underlie ridge south of King Creek.	Small amounts of perched water may be available from thin beds of sand overlying clay along the western border of quadrangle. Small amounts of water may be available from sand beds along shore of Kentucky Lake. A test hole south of King Creek penetrated 30 feet of saturated sand of the McNairy Formation.
			Tuscaloosa Formation		0-150	Orange to light-gray rounded chert pebbles; contains scattered lenses of chert sand and tripoli.	Thickest deposits underlie ridges east of Kentucky Lake. Crops out in places along lake shore. Fills channels and depressions in eroded surface of Paleozoic rocks.	Important water-bearing formation under ridges east of Kentucky Lake. Deposit is water bearing where base of unit extends below local water table and is an excellent aquifer in areas where formation fills deep channels and depressions in eroded surface of Paleozoic rocks. Water from the Tuscaloosa is soft or moderately hard, and one sample contained 4.2 ppm (parts per million) of iron. A concentration of iron of more than 0.3 ppm causes staining of clothes and utensils and imparts a disagreeable taste to water.
CARBONIFEROUS MISSISSIPPIAN	Meramec		St. Louis Limestone[2]		140+	All rocks below the Cretaceous are of Paleozoic age and are the "bedrock" of well drillers. Gray thick-bedded argillaceous limestone containing fossil fragments interbedded with cherty limestone. Deeply weathered to a gravel or cobble-size rubble of residual chert, and gray tripolitic clay.	Weathered chert rubble crops out on ridges south of Cumberland River. Beds of limestone crop out along ends and sides of ridges southeast of Boyds Landing.	Deeply weathered chert rubble yields water to one spring in northeastern part of area. Solutional openings in limestone may yield adequate amounts of water to wells for domestic use. Water from the chert rubble is soft and contains iron in concentrations up to 2-3 ppm. Water from solutional openings in limestone may be hard or very hard.
			Warsaw Limestone		200-220	Gray fossiliferous crossbedded limestone interbedded with gray shaly cherty limestone. Weathers to brown silty clay and porous brown blocky chert.	Weathered chert rubble crops out on many ridges. Beds of limestone crop out at a few places along shore of Kentucky Lake and along sides of ridges south of Cumberland River.	Deeply weathered chert rubble yields water to several large-diameter wells in area east of Kentucky Lake. Small-diameter wells ranging in depth from 92 to 248 feet yield water from solutional openings in limestone. Although all wells are reported adequate for domestic purposes, yields of as much as 30 gallons per minute may be possible from solutional openings in limestone. Water from the limestone is very hard and generally has an iron content of less than 0.3 ppm. A conspicuous spring horizon occurs at an altitude of 340 feet along the valley walls of several northward-flowing tributaries of the Cumberland River. This spring horizon will be flooded upon completion of the dam on the Cumberland River.
	Osage		Fort Payne Limestone		300+	Dark-gray fine-grained cherty limestone and lenses of light-gray coarse-grained crossbedded limestone composed of broken fossil fragments. Weathers deeply leaving layers of interbedded residual chert and tripolitic clay.	Weathered chert rubble crops out on ridges and along shore on west side of Kentucky Lake. Beds of limestone crop out along east shore of Kentucky Lake near O'Brien Branch.	Deeply weathered chert rubble yields water to both large- and small-diameter wells. Water from the chert rubble ranges from soft to hard and generally contains iron in excess of 0.3 ppm. Many small-diameter wells yield water from solutional openings in limestone, and as much as 30 gallons per minute is reported from one well. Water from the limestone is very hard and generally has an iron content of less than 0.3 ppm. Wells that penetrate the Fort Payne Formation beneath a thick section of tight, dry Warsaw Limestone generally yield little or no water, or yield water of poor quality. One well that penetrated 205 feet of the Fort Payne beneath 213 feet of dense Warsaw Limestone yields very hard water that contains 7.9 ppm of hydrogen sulfide ("sulfur water") and 2.8 ppm of fluoride. Fluoride in drinking water reduces the incidence of tooth decay in children; however, it may cause mottling of the teeth when present in excessive amounts. The maximum concentration of fluoride recommended should not exceed 1.5 ppm.
			New Providence Shale		15+	Brown to yellow shale and lenses of greenish-gray siltstone.	Small exposure on east side of Kentucky Lake in a fault zone half a mile north of Pilgrim Rest Church.	Not an aquifer.
DEVONIAN	Upper Devonian		Chattanooga Shale		100+	Black micaceous carbonaceous shale.	Not exposed in quadrangle. Present at depth beneath all of quadrangle except in fault zone south of Little Bear Creek, where removed by erosion.	Fracture zones and joints in the shale yield sufficient water for a domestic supply. The water is soft but may contain an objectionable amount of iron. Wells in the Chattanooga are limited to a small fault zone on the southeast side of Little Bear Creek.
	Lower and Middle Devonian		Devonian rocks undifferentiated		100+	Gray to reddish-brown thin-bedded chert containing abundant fossils in several zones. Fine to coarsely crystalline cherty limestone at depth below the deeply weathered zones.	Exposed in fault zone south of Little Bear Creek. Present at depth throughout quadrangle.	Deeply weathered chert rubble yields water to one drilled well in a small fault zone on the southeast side of Little Bear Creek (analysis number 7). Water from this well is hard and contains an objectionable amount of iron. Deep wells in this area may encounter solid limestone below the weathered chert residuum.

[1] Age undetermined. Estimates of age range from Pliocene or older to Pleistocene.
[2] Lower part of the formation includes the Salem Limestone.

EXPLANATION

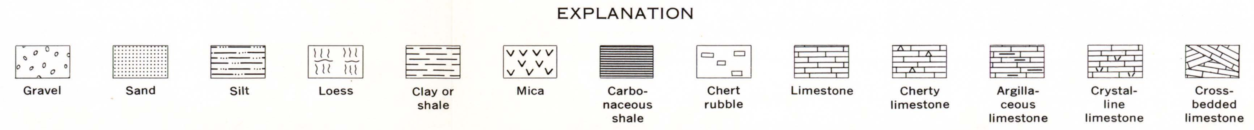
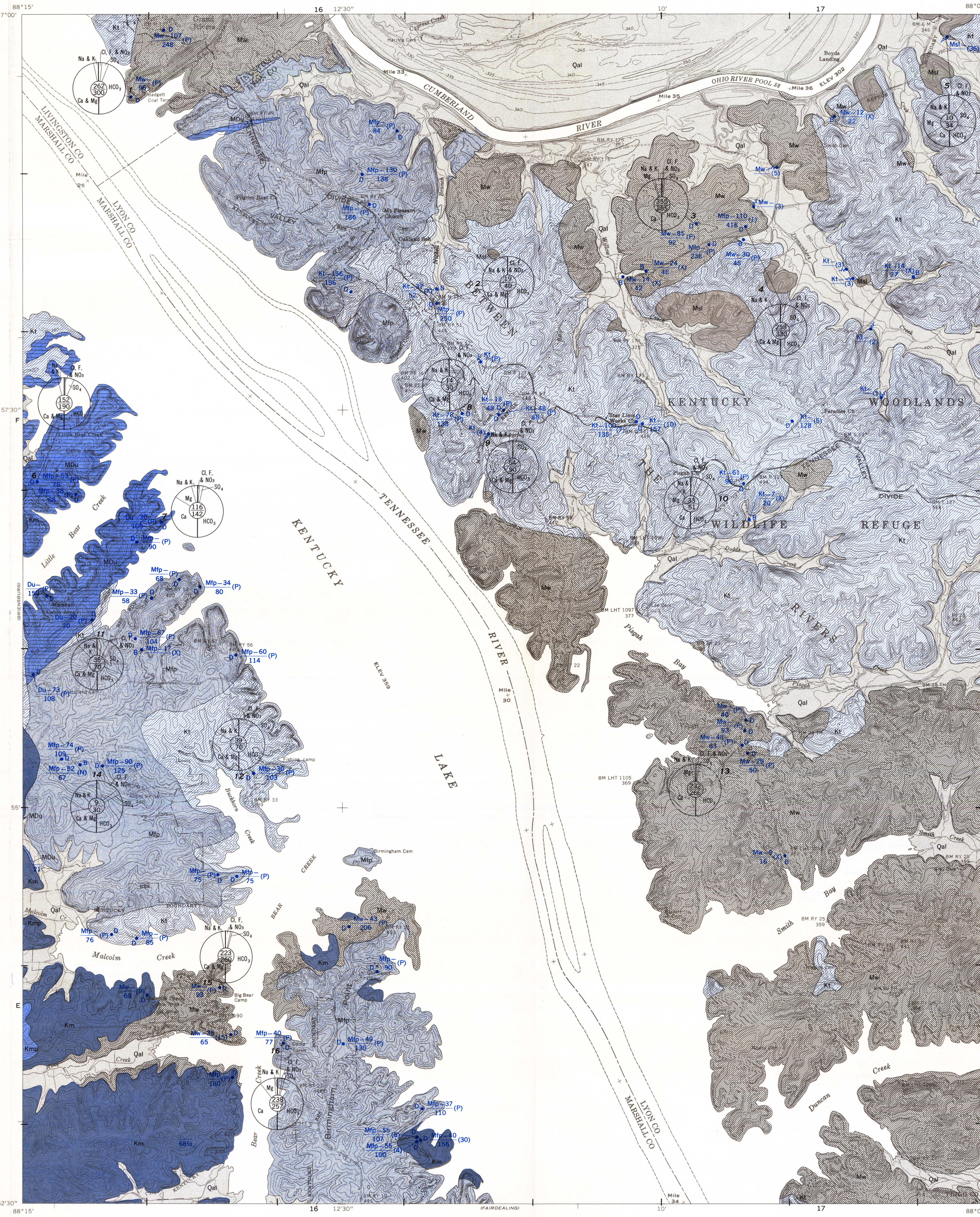


FIGURE 2.—GENERALIZED COLUMNAR SECTION AND WATER-BEARING CHARACTER OF GEOLOGIC FORMATIONS



Base by Tennessee Valley Authority and U.S. Geological Survey, 1955

The Carter Coordinate System letters and numbers used to designate five-minute divisions of latitude and longitude are shown along the margins; tick marks indicate one-minute divisions

APPROXIMATE MEAN DECLINATION, 1965

SCALE 1:24 000

1 MILE

1 KILOMETER

QUADRANGLE LOCATION

FIGURE 1.—MAP SHOWING AVAILABILITY OF GROUND WATER, LOCATION OF WELLS AND SPRINGS, AND QUALITY OF WATER

Hydrology by L. M. MacCary, 1963

EXPLANATION

The water-availability areas on this map show the occurrence and availability of ground water in the shallowest aquifer that may yield adequate amounts of water for a domestic supply. As considered in this report, an adequate domestic supply will furnish approximately 500 gallons per day from a well equipped with a power pump and pressure-distribution system. The shallowest aquifer is underlain by deeper aquifers whose depths and water-bearing properties are described in the generalized columnar section, figure 2.

Qal

AREA 1
Water in Quaternary alluvium

Large-diameter wells should yield sufficient water for domestic purposes from the alluvium. Most of the alluvial deposits lie within the boundaries of the Barkley and Kentucky Reservoirs and are subject to flooding during high reservoir stages. The alluvial deposits outside the reservoir boundaries are generally inaccessible and may be too thin or may contain too much silt and clay for the development of a satisfactory domestic water supply

Kmp

AREA 2
Perched water in the McNairy Formation

A small area of perched water appears to underlie the western part of the ridge between King Creek and Malcolm Creek. Large-diameter wells ranging in depth from 36 to 73 feet yield adequate amounts of water for domestic purposes from the western extension of this perched zone in the adjacent quadrangle. If only small amounts of water can be obtained from the perched zone, wells may be deepened to obtain water from one of the underlying water-bearing formations

Km

AREA 3
Water in the McNairy Formation

Large-diameter wells should yield sufficient water for domestic purposes in the southwestern part of the quadrangle. A test hole on the ridge south of King Creek penetrated approximately 30 feet of saturated sand in the McNairy Formation. Small areas of the formation along the lake on Birmingham Point peninsula will probably yield enough water for a domestic supply. If only small amounts of water can be obtained from the McNairy, wells may be deepened to obtain water from one of the underlying water-bearing formations

Kt

AREA 4
Water in the Tuscaloosa Formation

Furnishes sufficient water for domestic purposes and stock use to large- and small-diameter wells and several springs east of Kentucky Lake. Although no wells in the Tuscaloosa are known on the west side of the lake, the formation may yield sufficient water for domestic purposes here. Formation contains beds of pulverized chert (tripolite) which will plug screens of small-diameter wells unless wells are surged to remove the fine-grained material. If no water, or only small amounts of water, can be obtained from the Tuscaloosa Formation, wells may be deepened to obtain water from one of the underlying limestone formations

Msl

AREA 5
Water in the St. Louis Limestone

Small-diameter wells should yield sufficient water for domestic purposes in places where formation extends below the local water table. One spring in residuum from the St. Louis has a measured yield of 36 gallons per minute. If an inadequate water supply is obtained from the St. Louis Limestone, wells may be deepened to obtain water from the underlying Warsaw Limestone

Mw

AREA 6
Water in the Warsaw Limestone

Water-bearing zones in limestone yield sufficient water for domestic purposes to a few small-diameter wells ranging in depth from 96 to 246 feet. Many large- and small-diameter wells ranging in depth from 16 to 93 feet obtain adequate water supplies from the deeply weathered chert residuum that lies on top of the limestone. If no water, or only inadequate amounts of water, are found in limestone beds in the Warsaw, the chances of finding an adequate water supply in the underlying Fort Payne Formation are generally poor. Usually tight, dry limestone in the Warsaw is good evidence that the underlying rocks have been protected from ground-water solution and are likely to yield little water or water of poor quality

Mfp

AREA 7
Water in the Fort Payne Formation

Many small-diameter wells yield adequate amounts of water for domestic purposes from the deeply weathered chert residuum that lies above the limestone surface. Wells in the residuum range in depth from 58 to 125 feet. Small-diameter wells drilled in this area generally yield sufficient water from limestone beds. One well completed in a water-bearing zone in limestone has a reported yield of 30 gallons per minute

MDu

AREA 8
Water in Mississippian and Devonian rocks

Most small-diameter wells yield adequate amounts of water for domestic purposes. This area lies within the several fault blocks that bring Devonian formations to or near the surface. Wells drilled in this area may yield water from basal beds of the Fort Payne Formation, fracture zones in the Chattanooga Shale, or chert beds of Devonian age

Area boundary

○ 68½
Test hole
Figure below line is depth of test hole

● D
Water well
D, *Drilled well, generally steel or plastic casing open at the bottom*
B, *Bored or dug well, generally 24-inch concrete casing open at the bottom*

Spring

Mw–35 / 65 (15)
- Aquifer (see below)
- Water level in well, in feet below land surface
- Yield in gallons per minute, or adequacy (see below)
- Depth of well, in feet below land surface

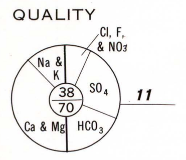
AQUIFER SYMBOLS

Kt .... Tuscaloosa Formation of Cretaceous age
Msl .... St. Louis Limestone of Mississippian age
Mw .... Warsaw Limestone of Mississippian age
Mfp .... Fort Payne Formation of Mississippian age
Du .... Devonian rocks, undifferentiated

YIELD OR ADEQUACY

(30) .... Gallons per minute where known
(P) .... Well reported adequate for power pump for domestic and/or stock supply
(N) .... Well reported not adequate
(X) .... No yield data available

QUALITY



Chemical composition of dissolved solids

Figure between circular diagram and well symbol refers to analysis number in table at end of text. Figure above line at center of circular diagram is carbonate hardness (calcium magnesium hardness, as $CaCO_3$) in parts per million (ppm); figure below line is dissolved solids in parts per million. Hardness of water is classfied by the U.S. Geological Survey as follows: 0-60 ppm, soft; 61-120 ppm, moderately hard; 121-180 ppm, hard; and 181 ppm or more, very hard. Dissolved solids in partial analysis are computed from specific conductances and are only approximate values. Areas of the segments of each circle are proportional to the mineral component in the dissolved solids in the water. Percentages are computed from equivalents per million of the anions and cations. Calcium and magnesium are shown as one segment in partial analyses

AVAILABILITY OF GROUND WATER IN THE BIRMINGHAM POINT QUADRANGLE, KENTUCKY

Adequate amounts of ground water for domestic and some commercial uses are available in the Birmingham Point quadrangle. Most of the cabins, motels, fishing camps, and residences in the area obtain satisfactory water supplies from ground-water sources.

Figure 1, the water-availability map, shows the shallowest aquifers by a color pattern and the chemical quality of the ground water by circular diagrams. The columnar section, figure 2, shows the relative ages and physical and hydrologic characteristics of the geologic units. The generalized geologic section, figure 3, shows the position of these geologic units with respect to the land surface.

The most important aquifers are the Tuscaloosa Formation of Cretaceous age and the Paleozoic limestones with their associated residual chert rubble. The Tuscaloosa gravel and the residual chert rubble are unconsolidated deposits. Water fills the pore spaces in the unconsolidated deposits where they lie below the local water table. In some areas deep channels of Tuscaloosa gravel or residual chert lie below and may be hydraulically connected with Kentucky Lake. Limestone, a dense consolidated rock, usually has few pore spaces but may contain openings developed along fractures and bedding planes by chemical solution. These openings do not occur through the entire body of rock and usually are separated by relatively large volumes of dense dry rock. Within the zone of saturation the openings are filled with water and will yield water to wells that intersect them. The location of water-filled openings in limestone is unpredictable and several holes may be drilled into dry masses of rock before a well intersects a water-filled opening.

Several small springs issue from the Warsaw Limestone and the St. Louis Limestone along tributaries of the Cumberland River south of Boyds Landing. One large spring is reported in the bed of the river downstream from the landing. Prior to the impounding of the Tennessee River, large springs discharged from the Warsaw Limestone between Nickell Cove and Pisgah Bay. A submerged spring near the mouth of Pisgah Creek is reported to keep the head of Pisgah Bay ice-free during the winter.

The McNairy Formation and the alluvium are of less importance as sources of ground water than the Tuscaloosa Formation and the Paleozoic rocks. The McNairy is thin and generally lies above the local water table. Sand beds in the formation may be aquifers in places where clay beds perch water or where the formation extends below the local water table. The alluvium is probably saturated in most places, but most of the deposits along Kentucky Lake lie within the boundaries of Kentucky Reservoir. Most of the alluvial deposits along the Cumberland River either will be flooded or will be within the Lake Barkley Reservoir easement boundary upon completion of Barkley Dam. The alluvium lying outside reservoir boundaries may be too thin or inaccessible for the development of satisfactory domestic water supplies.

Water from the Tuscaloosa Formation and the residual chert deposits is soft or moderately hard, slightly acidic, and usually contains iron in objectionable amounts. Water from these aquifers may require treatment for iron removal and adjustment of pH before it is suitable for some commercial uses. Water from the limestone aquifers is very hard, slightly alkaline, and usually contains less than 0.3 ppm (part per million) of iron. It may require softening before it can be used for some commercial purposes. In addition, water from some of the deeper limestone beds may contain objectionable concentrations of hydrogen sulfide (sulfur water) and dissolved solids. Hydrogen sulfide imparts the taste and odor of rotten eggs to the water.

The following table shows the iron content, in parts per million, and the hydrogen-ion concentration, expressed as pH, of the water samples represented by circular diagrams on figure 1. A pH of 7.0 indicates neutrality of a solution. Values higher than 7.0 denote alkalinity; values lower than 7.0 indicate acidity. Corrosiveness of water generally increases with decreasing pH.

Analysis number	1	2	3	4	5	6	7	8	9	10
Iron content	0.15	0.96	0.07	0.15	1.0	2.7	15.0	0.86	0.10	[1]4.2
pH	7.6	6.3	7.0	7.8	6.0	6.8	7.0	5.9	6.6	6.5

Analysis number	11	12	13	14	15	16
Iron content	48.0	0.27	0.36	3.6	0.06	0.05
pH	6.3	6.2	7.3	6.2	7.4	7.9

[1] In sediment and solution

EXPLANATION

Qal .... Alluvium of Quaternary age
QTg .... Gravel and sand of Pliocene(?) age
Km .... McNairy Formation of Cretaceous age
Kt .... Tuscaloosa Formation of Cretaceous age
Msl .... St. Louis Limestone of Mississippian age
Mw .... Warsaw Limestone of Mississippian age
Mfp .... Fort Payne Formation of Mississippian age
Mnp .... New Providence Shale of Mississippian age
Dc .... Chattanooga Shale of Devonian age
Du .... Devonian rocks, undifferentiated
U upthrown side / D downthrown side — Concealed fault in bedrock

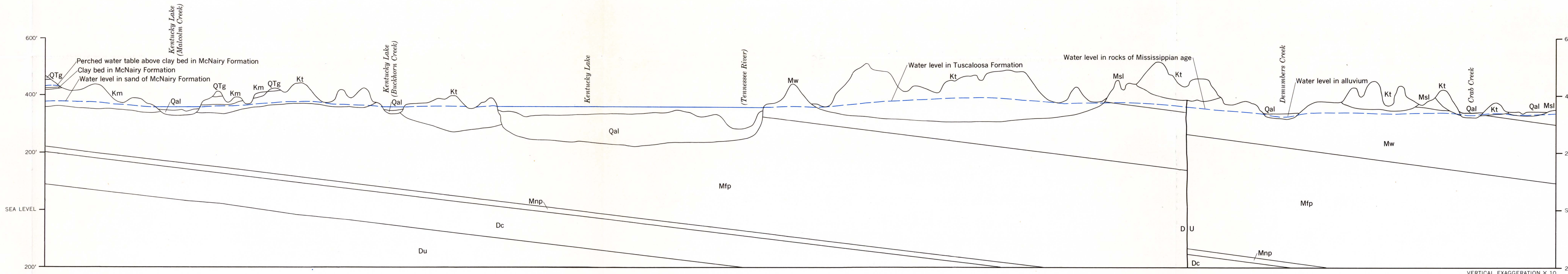


FIGURE 3.—GENERALIZED GEOLOGIC SECTION ALONG A NORTHEAST-TRENDING LINE FROM SOUTH OF MALCOLM CREEK TO NORTH OF CRAB CREEK

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AVAILABILITY OF GROUND WATER IN THE BIRMINGHAM POINT QUADRANGLE, KENTUCKY

By
L. M. MacCary
1965

For sale by U.S. Geological Survey, price 50 cents