DEPARTMENT OF THE INTERIOR
UNITED STATES GEOLOGICAL SURVEY
WILLIAM T. PECORA, DIRECTOR

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

HYDROLOGIC INVESTIGATIONS
ATLAS HA-167

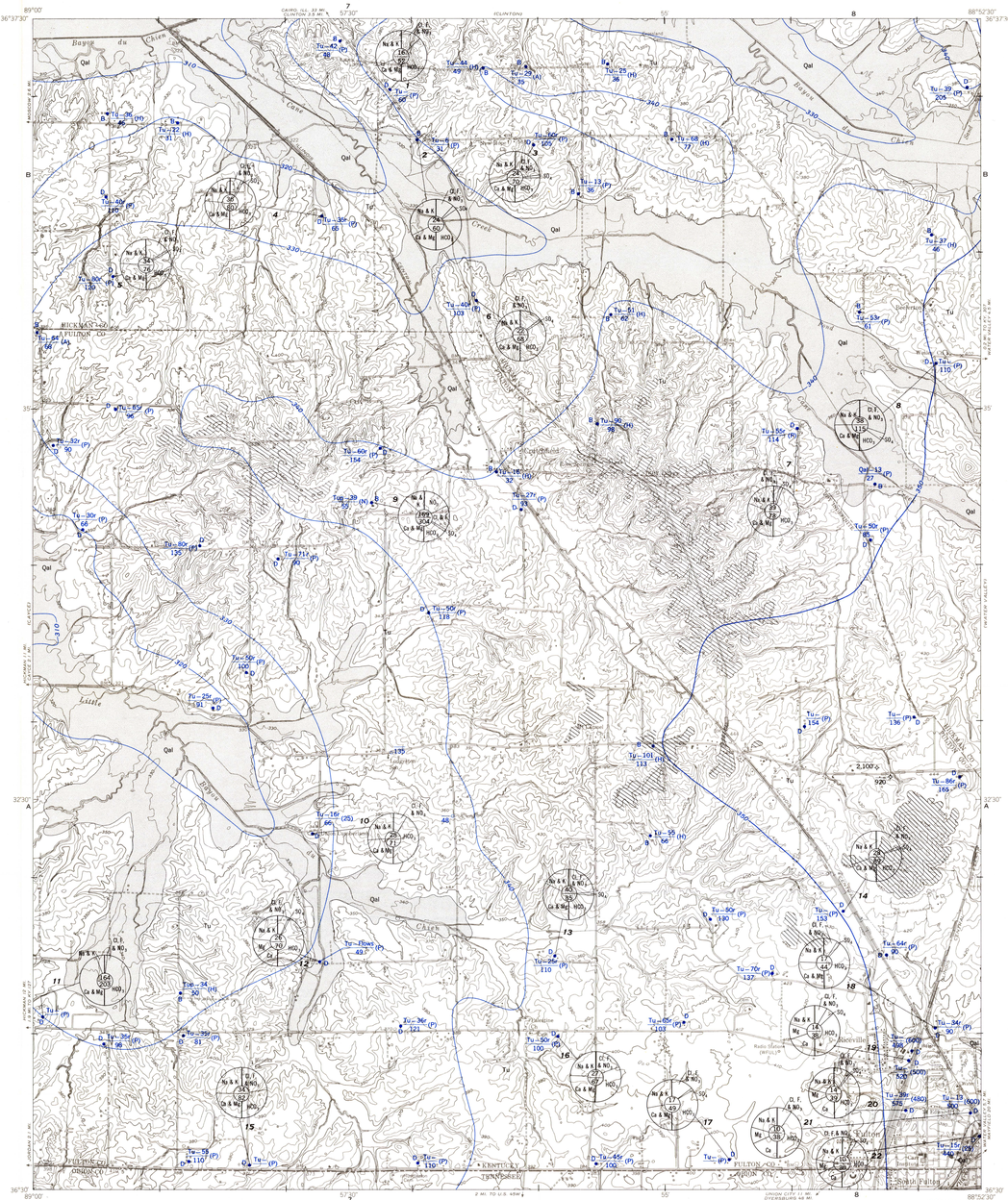
GENERALIZED COLUMNAR SECTION AND WATER-BEARING CHARACTER OF GEOLOGIC FORMATIONS

SYSTEM	SERIES	GROUP	FORMATION	SECTION	THICKNESS (FEET)	LITHOLOGY	TOPOGRAPHY AND GEOLOGIC SETTING	HYDROLOGY
QUATERNARY	Pleistocene and Recent		Alluvium		0-43'	Gray to brown clayey silt and sand	Recent flood-plain deposits in the valleys of the larger streams and their tributaries. Maximum known thickness, 43 feet, is in the valley of Cane Creek. About 30 feet thick in the valley of Bayou du Chien. Thin, or absent along smaller streams.	Few wells tap the alluvium in the quadrangle. In the tributary valleys, the alluvium is above the main zone of saturation; where present, water is perched above lenses of clay. In the larger valleys, yields from bored wells may be sufficient for domestic use. Yields from the silt will be small; larger yields can be had from the underlying Eocene sand. Downstream from the 330-foot water-level contour, the stream channels intersect the water table, and ground-water discharge maintains streamflow throughout the year.
	Pleistocene		Loess		0-26'	Tan to reddish-brown unstratified clayey silt	Wind-blown deposits covering all upland areas.	Above the main zone of saturation. When saturated by precipitation, transmits water to underlying aquifers.
	Pliocene(?)		Gravel, silt and sand[1]		0-30'	Red, brown, or yellow gravel, silt, and sand. Near Fulton, dominantly fine- to medium-grained sand and few small gravel lenses.	Continental deposits overlying Eocene sediments in uplands.	Above the main zone of saturation; where present, water is perched above lenses of clay.
TERTIARY	Eocene, undifferentiated		Sand and clay		25-275' ±	Brown, yellow, or red clayey sand and sandy clay and brown to white fine- to coarse-grained sand.	Coastal plain deposits underlying gravel deposits of Pliocene(?) age in the entire quadrangle. Upper unit crops out along the tributary valleys.	Yields of all properly constructed wells in the main zone of saturation are sufficient for domestic purposes. Most domestic wells, less than 200 feet deep, are completed in the upper two units; yields may exceed 50 gallons per minute. Perched water bodies probably are too small to furnish an adequate water supply. The water generally is soft, acidic, and contains less than 0.3 parts per million of iron.
					300' ±	White to red fine- to coarse-grained sand and clay. Some sands have clay matrix. Numerous small clay lenses as much as 10 feet thick. Occasional clayey silt lenses as much as 100 feet thick.		
					300' ±	Brown to white fine- to coarse-grained sand and gray to brown clay. In lower part, white fine- to coarse-grained sand.		Industrial wells, from 400 to 600 feet deep, are finished in the third unit; yields may exceed 1,000 gallons per minute.
					300' ±	Gray lignitic clay and fine sand.		The water is soft, acidic, and generally contains less than 0.3 parts per million of iron. No wells tap the lowest unit.
	Paleocene	Midway	Porters Creek Clay		300' ±	Gray micaceous clay. Upper and basal parts are micaceous glauconitic clayey sand.	Marine deposit underlying Eocene deposits in the entire quadrangle. Thickness variable owing to pre-Eocene erosion surface.	Not an aquifer. Retards the movement of water between the Eocene formations and the underlying sediments.

[1]Age undetermined. Estimates of age range from Pliocene or older to Pleistocene

EXPLANATION

Gravel · Sand · Clay · Silt · Loess · Mica · Glauconite · Carbonaceous material, mostly lignite



EXPLANATION

Qal.....Alluvium of Quaternary age
QTg.....Gravel and sand of Pliocene(?)and Pleistocene
Tu.....Sand and clay of Eocene age, undifferentiated
Tpc.....Porters Creek Clay of Paleocene age

GENERALIZED GEOLOGIC SECTION THROUGH UNION CUMBERLAND CHURCH AND BEELERTON

MAP SHOWING AVAILABILITY OF GROUND WATER, LOCATION OF WELLS, AND QUALITY OF WATER

Base by Tennessee Valley Authority and U.S. Geological Survey, 1952
The Grid 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

SCALE 1:24 000
1 0 1 MILE
1 5 0 1 KILOMETER
CONTOUR INTERVAL 10 FEET
DATUM IS MEAN SEA LEVEL

KENTUCKY
QUADRANGLE LOCATION

Hydrology by Arnold J. Hansen, Jr., 1964

EXPLANATION

AREA 1
Water in Quaternary alluvium
Yields from bored wells may be adequate for domestic use. Yields will be small where the alluvium is predominantly silt. Wells can be deepened into the underlying Eocene sand to obtain larger yields

AREA 2
Water in Eocene sand
Diagonal ruling shows where the water level in wells is more than 100 feet below the land surface
Yields of all wells in the main zone of saturation are adequate for domestic use. Most domestic wells are less than 200 feet deep. The specific capacity of a 4-inch well is reported to be 2 gallons per minute per foot of drawdown, after pumping for 60 minutes. The depth of industrial wells varies from 400 to 600 feet. The specific capacity of an industrial well at Fulton is computed to be 20 gallons per minute per foot of drawdown, when pumped at 600 gallons per minute. Ground-water bodies may be perched above lenses of clay; several may be found just west of Crutchfield. Probably, most are too small to furnish an adequate water supply

Boundary of availability area
◇ 2.100 — Oil-test well — *Figure below line is depth of well*
○135 — Test hole — *Figure below line is depth of test hole*
●B — Water well
D, *Drilled or jetted well, generally 4-inch plastic or smaller steel casing with well screen*
B, *Bored or dug well, generally 6-inch vitrified clay pipe, open at the bottom*

Tu–16r / 66 (25)
- Aquifer (see below)
- Water level in well, in feet below land surface; r, if reported
- Yield in gallons per minute, or adequacy (see below)
- Depth of well, in feet below land surface

AQUIFER SYMBOLS
Qal.....Alluvium of Quaternary age
Tup.....Perched water in sand of Eocene age
Tu.....Sand of Eocene age

YIELD OR ADEQUACY
(25).....Gallons per minute where known
(P).....Adequate for power pump for domestic use
(H).....Adequate for bailer or hand pump
(N).....Inadequate
(A).....Abandoned or destroyed

370 — Water-level contour
Shows altitude of water level in main zone of saturation. At any site, the depth to water is the difference between the land-surface altitude and the water-level contour. Water levels measured in July 1964. Contour interval 10 feet; datum is mean sea level

QUALITY

Chemical composition of dissolved solids
Figure between circular diagram and well location refers to analysis number at end of text. Figure above line at center of circular diagram is carbonate hardness (calcium magnesium hardness as $CaCO_3$) in ppm (parts per million). Hardness of water is classified 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. Figure below line is dissolved solids in parts per million; dissolved solids in partial analyses computed from specific conductances and are only approximate. The segments of each circle are proportional to the mineral components dissolved in the water. Percentages are computed from equivalents per million of the anions and cations. Nitrate is shown separately if present in amounts greater than 45 ppm. Water containing more than 45 ppm of nitrate may cause a type of methemoglobinemia in infants("blue baby disease"), sometimes fatal, and should not be used in infants' formulas. Calcium and magnesium are shown as one segment in partial analyses

AVAILABILITY OF GROUND WATER IN THE CRUTCHFIELD QUADRANGLE, JACKSON PURCHASE REGION, KENTUCKY–TENNESSEE

Abundant ground water is available for domestic and industrial use in the Crutchfield quadrangle. This atlas presents nontechnical data about the ground water in this quadrangle northwest of Fulton, Kentucky.

The water-availability map shows the occurrence and quality of ground water in the shallowest aquifer that may yield adequate amounts of water for domestic use in each area. As considered in this report, an adequate domestic supply will deliver approximately 500 gallons per day from a well equipped with a power pump and pressure-distribution system. The shallowest aquifer is underlain by other aquifers whose water-bearing properties are described in the generalized columnar section

The water level in the main zone of saturation, the zone in which the pore spaces are filled with water, slopes westward from about 355 feet above sea level at the eastern edge of the quadrangle to about 305 feet where Bayou du Chien flows out of the quadrangle. The annual range of water-level fluctuation is about 3 feet.

In the quadrangle, the principal aquifer is the sand of Eocene age. Limited data suggest that the Eocene formations dip southwestward about 35 feet per mile and are from 900 to 1,100 feet thick. Yields from 4-inch wells, generally less than 200 feet deep, may exceed 50 gpm (gallons per minute), Properly constructed wells in the deeper Eocene sand may yield more than 1,000 gpm, Wells that tap the Eocene sand along the valley of Little Bayou du Chien near the 330-foot water-level contour usually flow.

There are numerous layers of clay in the Eocene formations, Clay layers above the main zone of saturation retard downward movement of water and perch water above the main zone, Perched water may be found at many sites just west of Crutchfield, The perched water bodies probably are too small to furnish an adequate water supply, Some perched water bodies may become dry during part of the year, Lenses of clay in the main zone of saturation may require that some wells be drilled deeper than others nearby in order to obtain the same amount of water,

The Porters Creek Clay of Paleocene age yields little water to wells, but retards ground-water movement between the Eocene formations and the underlying sediments, The clay is about 300 feet thick; its upper surface probably slopes southwestward from about 550 feet below sea level at the northeast corner of the quadrangle to about 800 feet below sea level at the southwest corner,

Below the Porters Creek Clay are sediments of the McNairy Formation of Cretaceous age which are from 300 to 400 feet thick, The Cretaceous sediments rest on limestone of Paleozoic age; The bedrock surface probably slopes southwestward from about 1,150 feet below sea level at the northeast corner to about 1,500 feet below sea level in the southwest, An oil-test well near Fulton penetrated Paleozoic limestone at 1,250 feet below sea level, No wells tap either the Cretaceous or Paleozoic formations; the water from these formations is likely to be hard and contain excessive iron and dissolved solids,

The quality of water in the main zone of saturation is satisfactory for most uses, In the shallow Eocene sand, the water is generally soft and has less than 90ppm (partsper million) of dissolved solids, The water is generally acidic, with a pH lower than 6,4, and may be corrosive, The water generally contains less than 0,3 ppm of iron and 13 ppm of nitrate; the temperature is close to the mean annual air temperature, about 60°F,

Most of the water in the shallow Eocene sand that is pumped from small-diameter drilled wells equipped with steel casings and "sucker rod" pumps contains large amounts of iron, Probably, most of this iron is derived from the corrosion of the well casing and pump apparatus by the acidic ground water, Thus, to obtain water more representative of the actual iron content of the ground water, 13 of the 14 samples from drilled wells were collected from wells cased with 4-inch plastic pipe,

In the deep Eocene sand, the water is soft and has less than 45 ppm of dissolved solids, The water is acidic, with a pH generally lower than 5,8, and probably is corrosive, The water generally contains less than 0,3 ppm of iron,

The quality of perched ground water depends on local factors; the one sample available may not be typical of the perched water in the quadrangle, Based on one sample, the perched water is moderately hard and has about 300 ppm of dissolved solids,

The following table lists the iron content, in parts per million, and the hydrogen-ion concentration, expressed as pH, of the water analyses shown by circular diagrams on the availability map, A pH of 7,0 indicates neutrality of a solution, Values higher than 7,0 denote alkalinity; values lower than 7,0 indicate acidity, Below 7-0, corrosiveness of water generally increases with decreasing pH,

Analysis number	1	2	3	4	5	6	7	8	9	10
Iron content	0.17	0.13	0.13	0.10	0.20	0.09	—	0.16	0.08	0.08
pH	6.1	6.1	6.0	6.3	6.2	6.2	6.3	6.2	6.8	6.8

Analysis number	11	12	13	14	15	16	17	18	19	20
Iron content	0.03	0.08	0.06	0.08	0.55	0.03	0.15	0.39	0.22	0.03
pH	6.6	6.7	6.0	6.1	6.1	6.0	6.1	6.2	5.6	5.7

Analysis number	21	22
Iron content	0.07	0.26
pH	6.7	5.5

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AVAILABILITY OF GROUND WATER IN THE CRUTCHFIELD QUADRANGLE, JACKSON PURCHASE REGION, KENTUCKY–TENNESSEE

By
Arnold J. Hansen, Jr.

1966

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