DEPARTMENT OF THE INTERIOR
UNITED STATES GEOLOGICAL SURVEY
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PREPARED IN COOPERATION WITH
THE COMMONWEALTH OF KENTUCKY, UNIVERSITY OF KENTUCKY
KENTUCKY GEOLOGICAL SURVEY
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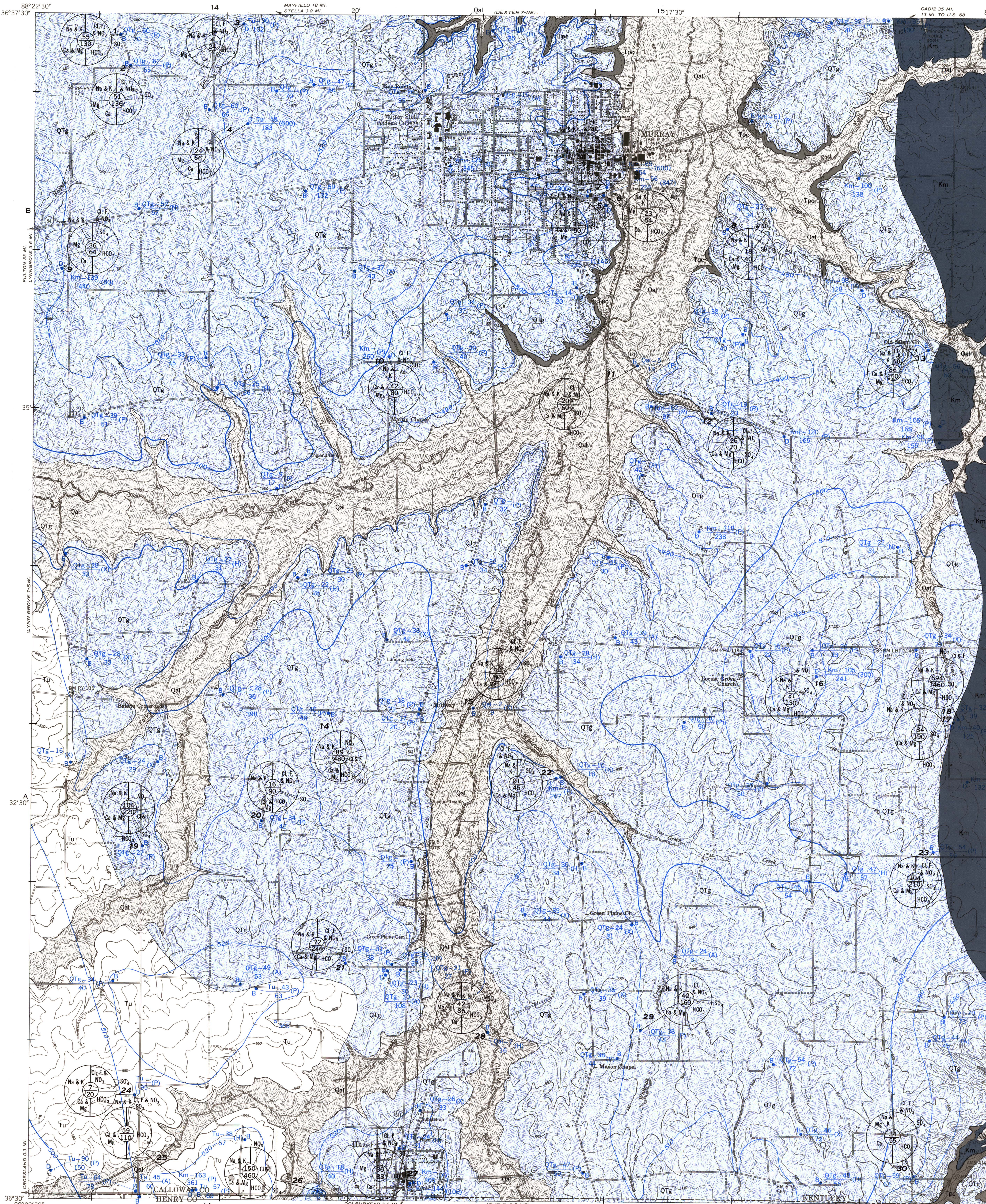
SYSTEM	SERIES	GROUP	FORMATION	THICKNESS, IN FEET	LITHOLOGY	TOPOGRAPHY AND GEOLOGIC SETTING	HYDROLOGY
QUATERNARY	Pleistocene and Recent		Alluvium	0–30′	Tan to gray silt and clay near surface. Grades downward into silty and sandy gravel.	Occurs along the larger streams and their tributaries. The thickest deposits are approximately 30 feet thick and are in the valley of Clarks River near Murray; deposits are thin or not present along smaller streams.	Underlies availability area 1. Few wells yield water from alluvial deposits in the quadrangle. Large-diameter wells in the valleys of East and Middle Forks Clarks River should yield an adequate supply of water. The water is generally soft, slightly acidic, and may contain iron in excess of 0.3 ppm (part per million). An iron content of more than 0.3 ppm imparts a disagreeable taste to water and may cause staining of clothing and utensils.
QUATERNARY	Pleistocene		Loess	0–20′	Tan to gray unstratified silt or clay.	Covers all upland areas but is absent along Clarks River and larger tributaries.	Not an aquifer. When saturated by rain transmits water to underlying formations.
QUATERNARY / TERTIARY	Pleistocene / Pliocene(?)		Gravel, sand, and clay[1]	0–80′	Brown to red chert gravel in a matrix of sand, angular chert fragments, and clay. Grades upward to brown to yellow clayey pebbly sand.	Overlies eroded surface of Tertiary and Cretaceous sediments. Deposit underlies loess in upland areas and underlies alluvium in Clarks River, except near Murray where deposit has been removed by erosion.	Underlies availability area 2. Supplies adequate amounts of water to most large-diameter wells as deep as 72 feet. Some wells in western part of this availability area penetrate Eocene sand below the gravel and yield water from both aquifers. Some wells near eastern edge of the availability area penetrate only a few feet of water-bearing sediments and may be dry during droughts. The water ranges from soft to hard, is slightly acidic, and may contain excessive amounts of iron and nitrate. Water containing more than about 45 ppm of nitrate may cause methemoglobinemia ("blue baby" disease) in infants, sometimes fatal, and should not be used to prepare infants formulas.
TERTIARY	Eocene (undifferentiated)		Sand and clay	0–150′	Brown to light-gray fine- to coarse-grained sand and light-gray sandy clay. Small amounts of lignite, mica, and heavy minerals present in some sand and clay beds.	Underlies the Pliocene(?) deposits and overlies the Porters Creek Clay in the northwestern and southwestern parts of the quadrangle. Only exposure in quadrangle is in a small stream valley north of Murray.	Underlies availability area 3. Supplies adequate amounts of water to most large- and small-diameter wells 57 to 150 feet deep. Water is soft, slightly acidic, and the iron content is usually less than 0.3 ppm. Underlies Pliocene(?) gravel and sand in availability area 2 in the uplands west of Murray. One irrigation well yields 600 gallons per minute from Eocene sand-filled channel beneath these uplands.
TERTIARY	Paleocene	Midway	Porters Creek Clay	0–210′	Light- to dark-gray micaceous clay and lenses of fine- to medium-grained micaceous sand, commonly glauconitic, in upper part. Light- to dark-gray glauconitic clay and thin beds of micaceous glauconitic sand in lower part.	Underlies Eocene sediments in the northwestern and southwestern parts of the quadrangle. Underlies Pliocene(?) deposits in most of the remainder of the quadrangle. Unit thins eastward and is missing along a narrow strip on eastern edge of quadrangle.	Underlies availability area 4. Generally not an aquifer, although sand beds in upper and lower parts may yield water to a few wells. The clay holds up water in the overlying Pliocene(?) and Eocene deposits and retards the upward movement of water in the underlying McNairy Formation.
CRETACEOUS	Upper Cretaceous		McNairy Formation[2]	200–300′	Fine- to medium-grained commonly micaceous sand. Upper part of formation generally interlaminated with dark-gray to black, often lignitic clay. Generally the thickest sand beds are in the lower part of the formation.	Underlies entire quadrangle. Overlain by Porters Creek Clay in all of quadrangle except narrow strip along eastern edge where formation is overlain by Pliocene(?) deposits. Only exposure of formation is in small stream valley in southeastern corner of quadrangle.	Underlies availability area 5. Supplies adequate amounts of water to most small-diameter wells 125 to 168 feet deep. Most domestic wells penetrate the upper part of the formation. Wells finished in the upper part of the formation may yield water of high iron content. Deep drilled wells west of availability area 5 yield 80 to 1,145 gallons per minute from the McNairy Formation. Formation is capable of large yields suitable for municipal, commercial, and irrigation purposes in entire quadrangle. Water is generally soft, slightly acidic, and contains iron in excess of 0.3 ppm.
CRETACEOUS	Upper Cretaceous		Tuscaloosa Formation	0–50′	Rounded chert pebbles in a sand or clay matrix.	Not exposed. Present farther east below the McNairy Formation and above the Paleozoic rocks. May be absent or thin in this quadrangle.	Not penetrated by wells in this quadrangle. Water-bearing characteristics not known.
DEVONIAN			Devonian rocks undifferentiated		All rocks below the Cretaceous are of Paleozoic age and are the "bedrock" of well drillers. Chert and limestone, commonly weathered with solutional openings near the top, grading downward into more massive chert and limestone.	Not exposed. Present beneath the McNairy or Tuscaloosa Formations throughout the quadrangle. Penetrated in wells in nearby quadrangles.	Not penetrated by wells in this quadrangle. Water-bearing characteristics not known. Weathered zone at top of the Paleozoic rock and solutional openings deeper in the Paleozoic limestone probably will yield adequate amounts of good-quality water.

[1] Age undetermined. Estimates of age range from Pliocene or older to Pleistocene
[2] May contain beds of Clayton age at the top

EXPLANATION

Gravel · Sand · Silt · Loess · Clay · Mica · Glauconite · Carbonaceous material · Chert rubble · Limestone · Cherty limestone

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



Base map by Tennessee Valley Authority and the U.S. Geological Survey, 1951

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

TRUE NORTH · MAGNETIC NORTH · APPROXIMATE MEAN DECLINATION, 1964

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

Hydrology by L. M. MacCary, 1962

SCALE 1:24 000

CONTOUR INTERVAL 10 FEET
DASHED LINES REPRESENT HALF-INTERVAL CONTOURS
DATUM IS MEAN SEA LEVEL

KENTUCKY
QUADRANGLE LOCATION

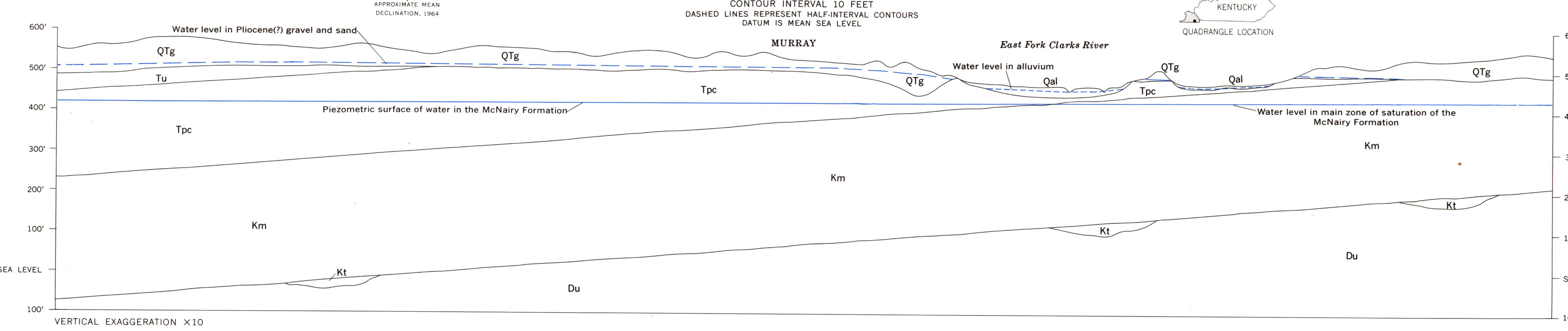


FIGURE 3—GENERALIZED GEOLOGIC SECTION ALONG A WEST-TO-EAST LINE THROUGH MURRAY

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 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 deeper aquifers whose water-bearing properties are described in the generalized columnar section, figure 2

Qal

AREA 1
Water in Quaternary alluvium

Few wells yield water from alluvial deposits in the quadrangle. Large-diameter wells in the valleys of East and Middle Forks of Clarks River should yield an adequate supply of water for domestic use. In other parts of area 1 water levels may fall below the base of the alluvium during droughts and some wells may become dry. If the alluvium is dry or yields only small amounts of water, wells may be deepened to obtain water from an underlying aquifer. Water-bearing Pliocene(?) gravel and sand underlie the alluvium above an altitude of about 500 feet in the western half of the quadrangle. Water-bearing Eocene sand underlies the alluvium in the southwestern part of the quadrangle. Water-bearing sand in the McNairy Formation underlies the entire quadrangle area. The position of the deeper aquifers is shown on figure 3

QTg

AREA 2
Water in Pliocene(?) gravel and sand

Furnishes sufficient water for an adequate domestic supply to large-diameter wells as deep as 72 feet. If the saturated gravel is thin or yields only small amounts of water, large-diameter wells may be deepened into the Porters Creek Clay to provide additional water storage. Some wells in the western part of the availability area penetrate Eocene sand below the gravel and may receive additional water from sand beds in the Eocene. If a large supply of water is required in the western part of area 2, wells should be deepened into Eocene sand. Elsewhere in area 2 wells should be deepened into sand of the McNairy Formation to obtain large yields

Tu

AREA 3
Water in Eocene sand

Furnishes sufficient water for an adequate domestic supply to most large- and small-diameter wells 57 to 150 feet deep. Small-diameter wells are drilled below the water table until a sand of sufficient thickness capable of being retained by a well screen is reached. These wells are 95 to 150 feet deep. Large-diameter wells are dug or bored below the water table for storage or below confining clay beds until a water-bearing sand is reached. These wells are as deep as 78 feet.
The potential yield of wells in area 3 is not known; however, properly constructed wells tapping sand beds in the Eocene probably could yield more than 100 gallons per minute except along the eastern limit of the area where the Eocene is thin. The well of largest capacity finished in Eocene sand is an irrigation well 183 feet deep in area 2 west of Murray. This well yields 600 gallons per minute from an Eocene channel deposit of sand beneath the Pliocene(?) deposits.

Tpc

AREA 4
Water in Porters Creek Clay

The Porters Creek Clay is generally not water bearing, although sand beds near the top and at the base of the formation may yield a small amount of water to some wells. Area 4, in general, is the outcrop of the Porters Creek Clay. The outcrops have been concealed, except in excavations and creek beds, by gravel and clay that has been washed down the hillsides (colluvial deposits). The gravel in the colluvial deposits may yield an adequate supply of water to large-diameter wells if the wells are deepened into the Porters Creek Clay to provide additional water-storage area. Generally, an adequate water supply in this availability area must be obtained from the sand in the deeper lying McNairy Formation. The approximate depth to the McNairy Formation is shown in figure 3

Km

AREA 5
Water in the main zone of saturation in the McNairy Formation

Furnishes sufficient water for an adequate domestic supply to small-diameter wells 125 to 168 feet deep. Most domestic wells are finished in the upper part of the formation and may yield water of slightly poorer quality than deeper wells. Properly constructed small-diameter wells as deep as 280 feet probably will yield several hundred gallons per minute in area 5. Large-diameter wells, generally deeper than 100 feet, should furnish sufficient water for an adequate domestic supply in the main zone of saturation in the McNairy Formation.
The wells with the largest yields from the McNairy Formation are located west of area 5 where the water in the formation is under artesian pressure. An artesian well 235 feet deep at Murray yields 1,145 gallons per minute from the McNairy Formation. Other artesian wells at Murray, ranging in depth from 235 to 255 feet, yield from 300 to 847 gallons per minute

Area boundary

○ 365
Test hole
Figure below line is depth of test hole

● D
Water well
D, *Drilled or jetted well, generally steel or plastic casing with well screen on the lower end*
B, *Bored or dug well, generally 24-inch concrete tile casing open at the bottom*

Km – 105 (300) / 241
- Km: Aquifer (see below)
- 105: Water level, in feet below land surface
- (300): Yield in gallons per minute, or adequacy (see below)
- 241: Depth of well, in feet below land surface

AQUIFER SYMBOLS

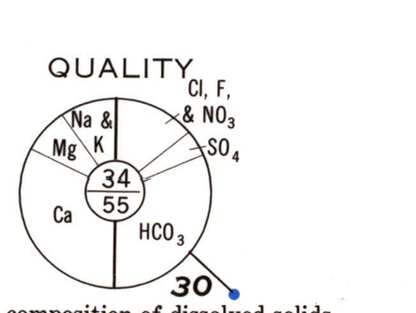
Qal........Alluvium of Quaternary age
QTg........Gravel and sand of Pliocene(?) age
Tu........Sand of Eocene age
Km........Sand in McNairy Formation of Cretaceous age

YIELD OR ADEQUACY

(80)........Gallons per minute where known
(P)........Well reported adequate for power pump for domestic and/or stock supply
(H)........Well reported adequate for hand pump or bailer
(N)........Well reported not adequate
(X)........No yield data available
(A)........Abandoned
(O)........Observation well

—500—
Water-level contour
Shows altitude of water level in saturated zone of the Pliocene(?) and Eocene deposits. Water level measurements taken in September 1962. Contour interval 10 feet; datum is mean sea level.

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; figure below line is dissolved solids in 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; 181 ppm or more, very hard. Dissolved solids in partial analyses are computed from specific conductance 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. Nitrate shown separately if present in amounts greater than 45 ppm

EXPLANATION

Qal........Alluvium of Quaternary age
QTg........Gravel and sand of Pliocene(?) age
Tu........Eocene sand, undifferentiated
Tpc........Porters Creek Clay of Paleocene age
Km........McNairy Formation of Cretaceous age
Kt........Tuscaloosa Formation of Cretaceous age
Du........Devonian rocks, undifferentiated

AVAILABILITY OF GROUND WATER IN THE HAZEL QUADRANGLE, KENTUCKY–TENNESSEE

This atlas presents nontechnical information about ground water for the use of well drillers, landowners, and others in the area between Murray and Hazel, Kentucky.

The aquifer most used in the area is the gravel and sand of Pliocene(?) age where it overlies the nearly impermeable Porters Creek Clay. Sand of Eocene age is an important aquifer in the northwestern and southwestern parts of the area. The most extensive aquifer is sand of the McNairy Formation, which is at or near the surface along the eastern edge of the quadrangle. It dips westward under younger formations, and its upper surface is as much as 320 feet below the land surface along the western edge of the quadrangle. Some water is obtained from other deposits in the quadrangle, as shown on the water-availability map, figure 1. This map shows the occurrence of ground water in the shallowest aquifer that may yield adequate amounts of water for domestic use.

The availability of ground water at any place can be determined by the color pattern on the availability map; the availability-area color pattern will identify the shallowest aquifer at the site. The map explanation and the columnar section, figure 2, briefly describe the water-bearing characteristics of the aquifer. The chemical composition of water from nearby wells in the same availability area is shown by the circular diagrams. The approximate depth to water in availability areas 2 and 3 and the parts of availability area 1 above an altitude of about 500 feet can be calculated by subtracting the altitude of the water-level contours from the altitude of the land surface. In other availability areas the well data shown for nearby wells will give the approximate depth to water and the depth of a well in the shallowest aquifer. If the prospective water user requires more water than the shallowest aquifer is capable of yielding, he should consider drilling into one of the lower aquifers described in the columnar section and shown in the generalized geologic section, figure 3.

The deeper aquifers in the Hazel quadrangle are capable of furnishing water for public and industrial supplies as well as for irrigation and domestic supplies. An irrigation well west of Murray yields 600 gpm (gallons per minute) from a channel deposit of Eocene sand. City wells at Murray yield 600 to 1,145 gpm from the McNairy Formation. The McNairy yields 106 gpm to a well at the town of Hazel, 300 gpm to an irrigation well near Locust Grove Church, and 80 gpm to a well at a swimming pool west of Murray.

The chemical quality of ground water in the quadrangle is generally good, and the water is usable for most domestic and commercial purposes. Usually the only water treatment required is adjustment of pH and removal of iron when the concentration exceeds 0.3 part per million.

The following table shows the iron content in parts per million and the hydrogen-ion concentration, expressed as pH, of the water analyses shown 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	0.08	0.46	0.07	0.17	0.97	2.3	1.4	0.16	5.0	13.0
pH	6.6	7.6	6.0	5.5	5.9	5.5	5.5	6.1	6.6	6.5

Analysis number	11	12	13	14	15	16	17	18	19	20
Iron content	0.13	0.50	0.04	0.25	0.49	0.96	0.60	0.02	0.70	0.39
pH	5.3	—	7.1	6.3	6.9	6.4	6.4	5.9	—	5.9

Analysis number	21	22	23	24	25	26	27	28	29	30
Iron content	0.15	1.2	—	0.21	17.0	0.14	6.0	0.67	0.13	0.76
pH	6.5	6.0	6.4	5.8	6.7	6.8	7.5	6.5	6.6	6.4

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AVAILABILITY OF GROUND WATER IN THE HAZEL QUADRANGLE, KENTUCKY–TENNESSEE

By
L. M. MacCary

1964

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