DEPARTMENT OF THE INTERIOR
UNITED STATES GEOLOGICAL SURVEY
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THE COMMONWEALTH OF KENTUCKY, UNIVERSITY OF KENTUCKY
KENTUCKY GEOLOGICAL SURVEY
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GENERALIZED COLUMNAR SECTION AND WATER-BEARING CHARACTER OF GEOLOGIC FORMATIONS

SYSTEM	SERIES	GROUP	FORMATION	THICKNESS (IN FEET)	LITHOLOGY	TOPOGRAPHY AND GEOLOGIC SETTING	HYDROLOGY
QUATERNARY	Pleistocene and Recent		Alluvium excluding valley of Mississippi and Ohio Rivers	0–50+	Gray silt and sand grading downward into gravelly sand, derived from the Pliocene(?) gravel and sand and clay of Eocene age.	Flood plain and glacial outwash deposits filling the valleys of the Mississippi and Ohio Rivers; subject to flooding annually. Flood plain and terrace deposits in Mayfield Creek and in many tributaries.	Water bearing in most of area 1. Will furnish an adequate supply for domestic use, and an adequate supply for local industrial and public needs. Water from the alluvium is generally hard to very hard and contains an objectionable amount of iron. More than 0.3 ppm (part per million) of iron imparts a disagreeable taste and may cause staining of textiles and fixtures.
			Alluvium in valley of Mississippi and Ohio Rivers	0–208	Brown to gray silt and sand grading downward into lignitic pebbly sand. Material is derived from glacial outwash and consists of greenish-blue or red igneous or metamorphic grains or pebbles. Two auger holes in Missouri indicate that very clayey coarse-grained sand with various colored fine to coarse grains of igneous or metamorphic rocks occur below the pebbly sand.		
	Pleistocene		Loess	0–24+	Tan to gray clayey silt. May contain calcareous concretions.	Windborne deposits mantle the upland and drape down the hillsides.	Yields little or no water to wells. Transmits some water from rainfall to underlying aquifers.
QUATERNARY / TERTIARY	Pliocene		Gravel and sand[1]	5–76+	Reddish-brown gravel and sand. Upper part may be reddish-brown silty sand.	Continental terrace deposits lying on an irregular surface cut into sediments of Eocene age. The pre-Pliocene(?) surface consists of channels and terraces cut by an intricate drainage system.	Yields sufficient water to most large-diameter bored wells in area 2. Some wells may yield little or no water along the southern edge of the availability area.
TERTIARY	Eocene, undifferentiated		Sand and clay (380–665)	0–80	Pinkish-red silty clay. Reddish-brown fine to coarse sand; locally silty. Light-gray silty clayey sand; locally, a medium-grained sand at base.	Crops out in road cuts and creeks between Back Slough and Bardwell. Scattered remnants south and southeast of Wickliffe.	The upper aquifer contains two sands separated by a clayey sand and yields sufficient water to most drilled wells. Owing to the unconformable surface on which the lower sand rests, the two sands may be thin. Where the underlying clay is high, the lower sand is missing and the upper sand may be thin; where the clay is low, both sands may be present and will yield sufficient water for domestic wells. One auger hole indicates the upper sand may be too silty locally to finish a well.
				150–170	Dark-gray clay and sandy clay. Beds of lignite.	Crops out in road cuts and creeks in the area north and east of Wickliffe. Occurs at shallow depth at Carlisle County.	Non-water bearing. Scattered sand lenses may yield small amounts of water for domestic supply. Clay retards the movement of water between the upper and lower aquifers.
				160–290	Coarse-to fine-grained sand. Lenses of gray clay.	Top of unit is about 160 feet above sea level at the southern edge of the quadrangle and about 220 feet above sea level at the north edge.	Water bearing beneath the entire quadrangle. It is considered the main zone of saturation. Yields abundant supply of ground water to drilled wells. The depth to water is more than 100 feet below land surface in much of the upland. Zone of saturation is more than 200 feet thick. Sufficient water is available for either municipal or industrial needs. The water is soft to moderately hard and is slightly acidic. Objectionable amounts of iron may be present; most iron is probably due to the reaction of the acidic ground water and the steel well casing and pump apparatus.
				70–125	Gray lignitic clay and thin beds of sand. Basal fine- to coarse-grained sand and minor clay.	Top of unit is about 100 feet below sea level at the south edge of the quadrangle and about 60 feet above sea level at the north edge.	No wells tap this horizon. Will yield sufficient water for many uses.
	Paleocene	Midway	Porters Creek Clay	125–130	Dark-gray to black micaceous clay containing thin beds of clayey glauconitic fine-grained sand in upper part. Gray to greenish-gray, very glauconitic clayey sand or sandy clay at base.	Marine deposits beneath the sediments of Eocene age. Top of unit is about 280 feet below sea level at the south edge of area and about 60 feet below sea level at the north edge.	Not an aquifer. Retards descending water in the overlying sands of Eocene age and confines the water in deeper aquifers.
CRETACEOUS	Upper Cretaceous		McNairy Formation[2]	24–300	Dark-gray to black clay. Fine- to very fine-grained sand at the top of formation. Mica and lignitic material are common.	Occurs at moderate depth throughout the area. Thickness may be affected by faulting during, and before, the deposition of the Cretaceous.	Water bearing beneath the entire quadrangle. Locally may yield large amounts of water for municipal and industrial needs. Wells drilled in areas that are below 335 feet altitude will flow. Water has a hardness of 87 ppm and 227 ppm of dissolved solids. Iron may be present in objectionable amounts.
			Tuscaloosa Formation	?	White rounded pebbles and cobbles in tripolitic matrix.	Not known to be present. May occur as remnants of channels cut into the bedrock floor.	Water-bearing character is not known. Generally, this unit is a poor aquifer owing to its clayey nature.
DEVONIAN	Middle and Lower Devonian		Clear Creek Chert and Bailey Limestone	300–800	The rocks that underlie the Cretaceous beds are of Paleozoic age and are called bedrock of drillers. The upper surface of the bedrock locally may be deeply weathered forming a chert rubble. This rubble consists of angular or subangular chert fragments in a matrix of tripolitic clay. Coarsely crystalline dolomitic limestone and chert. Sandstone beds may be present.	Consolidated marine sediments underlying Cretaceous deposits. The pre-Cretaceous erosional surface slopes southward on truncated subcrop of northeastward-dipping Paleozoic rocks. Locally, the slope on the erosional surface on top of the Paleozoic rocks is modified by fault blocks. Glenn (1906) and other sources reported bedrock in several wells at Cairo; the interpretation of the Paleozoic rocks is questionable.	Yields large quantities of water to drilled wells in Cairo, Ill. One well flows at a reported 1,500 gpm. Water is hard to very hard and may contain an objectionable amount of iron.
SILURIAN			Silurian rocks undifferentiated	150–300+	Shale and siliceous limestone. Red color prominent in lower part. Sandstone beds may be present.		

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

EXPLANATION

Gravel, Sand, Loess, Clay or shale, Mica, Glauconite, Lignite, Chert rubble, Limestone, Cherty limestone

AVAILABILITY OF GROUND WATER IN THE PARTS OF THE WICKLIFFE AND WICKLIFFE NW QUADRANGLES IN JACKSON PURCHASE REGION, KENTUCKY

The Wickliffe area has large supplies of water readily available, both on the surface and below the ground. Although surface water in the area is an important resource for man's use, ground-water resources in the area are significant also but have not been fully developed. Both sources of water can be further developed in the future for increasing farm and industrial needs. This atlas, one of a series that includes the entire Jackson Purchase region in western Kentucky, presents information about ground water in an area near Wickliffe and Bardwell, Kentucky.

The water-availability map is a graphic representation of the occurrence and quality of ground water in the shallowest aquifer that may yield sufficient water in adequate amounts for domestic use. The availability of ground water at a particular site may be determined from the pattern on the map and a study of a data on nearby wells. Chemical quality is shown by circular diagrams.

At the present time only minor amounts of ground water are withdrawn for domestic, farm, and municipal uses. Several aquifers are available for development in the area, but two aquifers, the Pliocene(?) gravel and alluvium, are restricted to certain areas. Important aquifers are the chert and limestone of Paleozoic age, sands of Late Cretaceous age and of early Eocene age, and gravelly sand of Pleistocene age; it is doubtful that 150,000 gpd (gallons per day) of ground water are withdrawn from these aquifers. Many farms still use cisterns for their source of supply; a large percentage of them catch the runoff of water from roofs.

The geologic formations underlying the Wickliffe area, shown in the geologic and columnar sections, are discussed according to their relative ages, the oldest first.

The Paleozoic bedrock is an aquifer in the Wickliffe area and may be a large potential source of ground water. At Cairo, Ill., a reported 1,200 foot well tapping the Paleozoic bedrock, flows about 1,500 gpm (gallons per minute) and has a measured water level about 9 feet above land surface. The water has a hardness of 214 ppm (parts per million) and total dissolved solids of 564 ppm. Several other wells in Cairo may have tapped the Paleozoic bedrock below 600 feet and are reported to have flowed about 100 gpm. However, these wells were not maintained and were destroyed. Fresh water was obtained also from the bedrock in an oil-test hole near the head of Gray Creek in the Arlington quadrangle (south of report area) from a depth of 2,000 feet.

The Tuscaloosa Formation has slight importance as an aquifer in the Wickliffe area. It occurs in thin irregular pockets on the Paleozoic bedrock surface and consists of gravel mixed with a tripolitic clay matrix.

The McNairy Formation is a minor aquifer throughout the area. Better aquifers occur above the McNairy Formation. Logs of an old oil-test well at Wickliffe, dirlled about 1900, and of an oil-test hole at Cunningham in Blandville quadrangle (east of report area), drilled in 1966, indicate the McNairy Formation is a hard compact clay and has a thin sand at the top of the formation. The oil-test well at Wickliffe was left as a water well. It flows 1.2 gpm and has a static water level about 9 feet above land surface (333 feet altitude). L. C. Glenn (1906, p. 125-126) reported the well to be flowing about 5 or 6 gpm. He believed the flow came from the 600-foot level. The water has a hardness of 87 ppm and total dissolved solids of 227 ppm. The temperature of the water is 57°F.

The Porters Creek Clay of Paleocene age is not an aquifer. The clay is a barrier to the movement of ground water between the younger and older aquifers.

The most important aquifers in the area are the sands of Eocene age. They will yield large quantities of good-quality water. The aquifers are divided into three units and are referred to as the shallow aquifer, the lower aquifer, and the basal aquifer. The basal aquifer is unimportant at this time owing to its thinness and depth.

The relation between the Eocene sands in Ballard and Carlisle Counties is uncertain. The base of the shallow aquifer crops out in the upland of Ballard County and slopes southward in Carlisle County where it occurs below the level of the flood plain of the Mississippi River. The aquifer appears to rest on an irregular surface of clay. Large-diameter bored wells tap the water in the shallow aquifer perched above clay in Ballard County, while drilled wells tapping the shallow aquifer in Carlisle County are as deep as 160 feet. Yields in Carlisle County may be as much as 200 gpm. L. C. Glenn (1906, p. 125) reported dug wells, probably in the shallow aquifer, in Wickliffe between 40 and 50 feet deep.

A black to bluish-grey lignitic clay separates the shallow aquifer from the more important lower aquifer and the clay has a reported thickness of 150 to 170 feet. No sand units in the clay are known in the Wickliffe area, but they may be present to the south and southeast. The clay retards the downward movement of water in the area, and numerous spring seeps are reported near Wickliffe. The clay, weathered white, underlies the alluvial deposits of the Mississippi River and Mayfield Creek and their tributaries and acts as a barrier to the upward movement of water from the deeper aquifers.

The lower and most important aquifer is a massive body of fine to coarse sand that underlies the clay. Many wells tap this lower aquifer and range in depth from 100 feet north of Wickliffe to 500 feet west of Bardwell. The potential yield of this aquifer is more than 1,000 gpm. The largest user of water from this aquifer is the town of Wickliffe; the average distribution for the town is slightly more than 20,000 gpd.

There are three different water surfaces in the Eocene aquifers in the Wickliffe area. The difference in water levels between the shallow and lower aquifers ranges from 13 to 70 feet and increases from east to west. The water level in the shallow Eocene aquifer shows the effect of topographic situation; the topographic site does not affect the water level in the lower and basal aquifers. Water levels in the shallow aquifer indicate that the water table slopes away from the Mississippi River toward Bardwell. The main area of the shallow Eocene aquifer is in Carlisle County. The altitude of the water surface is from 330 to 370 feet and is highest near the Mississippi River. The water surface slopes toward the Mayfield Creek drainage and discharges into the alluvial deposits. The water surface in the alluvium is a continuation from the Eocene and ranges from 330 feet to below 280 feet altitude near the river. The shallow Eocene aquifer is not believed to be present beneath the alluvium of the Mississippi River and Mayfield Creek.

The water surface in the lower Eocene aquifer, as shown by the blue contours on the water-availability map, slopes to the Mississippi River from about 325 feet altitude along the east edge of the quadrangle to about 290 feet altitude along the bluffs of the river. Deep wells tapping the lower Eocene aquifer in the bottom lands of the Mississippi River and Mayfield Creek may flow. Recharge to the lower aquifer is to the east in eastern Blandville and Lovelaceville quadrangles. No wells penetrate the basal Eocene aquifer at this time. Future wells penetrating the aquifer in the bottom lands of the Mississippi River and Mayfield Creek may flow.

The Pliocene(?) gravel is a minor aquifer in the Wickliffe area. Several bored wells between Bardwell and Winford Junction tap the Pliocene (?) gravel at depths less than 50 feet. One well southeast of Wickliffe taps the Pliocene above lignitic clay of Eocene age. Yields are reported adequate for domestic use; however, the saturated thickness of the Pliocene may be too thin for a domestic supply in the southern part of availability area 2.

The alluvium of Quaternary age is a potential aquifer of major industrial importance for the Wickliffe area. Saturated thickness of the alluvium ranges from 18 to 64 feet. There are no wells in use in the bottom lands of the Mississippi River or Mayfield Creek. Several dug or bored wells occur in the bottom lands of Shelton and Buckheart Creeks.

Development of ground-water supplies in the area along the alluvial valley faces two problems. One is the annual spring flooding of the bottom lands; the second is the high iron and manganese content of the water from the alluvium that may limit the use of untreated water. Water of better quality may be obtained at greater depths from the Eocene sands.

Present withdrawals of ground water from the Eocene and the alluvial aquifers in the area are insignificant compared to the vast quantity of water that is available for use. Large-capacity wells tapping the Eocene and alluvial aquifers would probably be capable of supplying all industrial, public, farm, and domestic needs in the forseeable future. Excess ground water drains from the perched Eocene aquifers, recharging the minor alluvial aquifers and maintaining the perennial flows of certain creeks in the area.

The temperature of ground water in the Wickliffe area ranges from about 58° to 62°F and may be more useful in the summer as a coolant than Mississippi River water whose temperature ranges from 33° to 82°F at Cairo. Ground water contains little or no sediment and is generally uniform in quality throughout the year.

The chemical quality of ground water is generally good except that the concentration of iron and maganese in the water from some aquifers is more than 0.3 ppm. More than this amount may cause staining of textiles and porcelain, imparts a disagreeable taste, and limits the use of untreated water for some applications. Water collected from wells near the Mississippi River has a wide range of hardness and total dissolved solids.

The high iron content in water sampled from the Eocene aquifers is a special problem. It is believed that the content is not typical of the natural water from the aquifer, but that the iron results from corrosion of steel well casings by the slightly acidic water. Water samples from the Eocene aquifers collected from plastic-cased wells are noted to have a much lower iron content than those from steel-cased wells. It may also be possible that the iron content of the water from the Eocene aquifers may be increasing downdip.

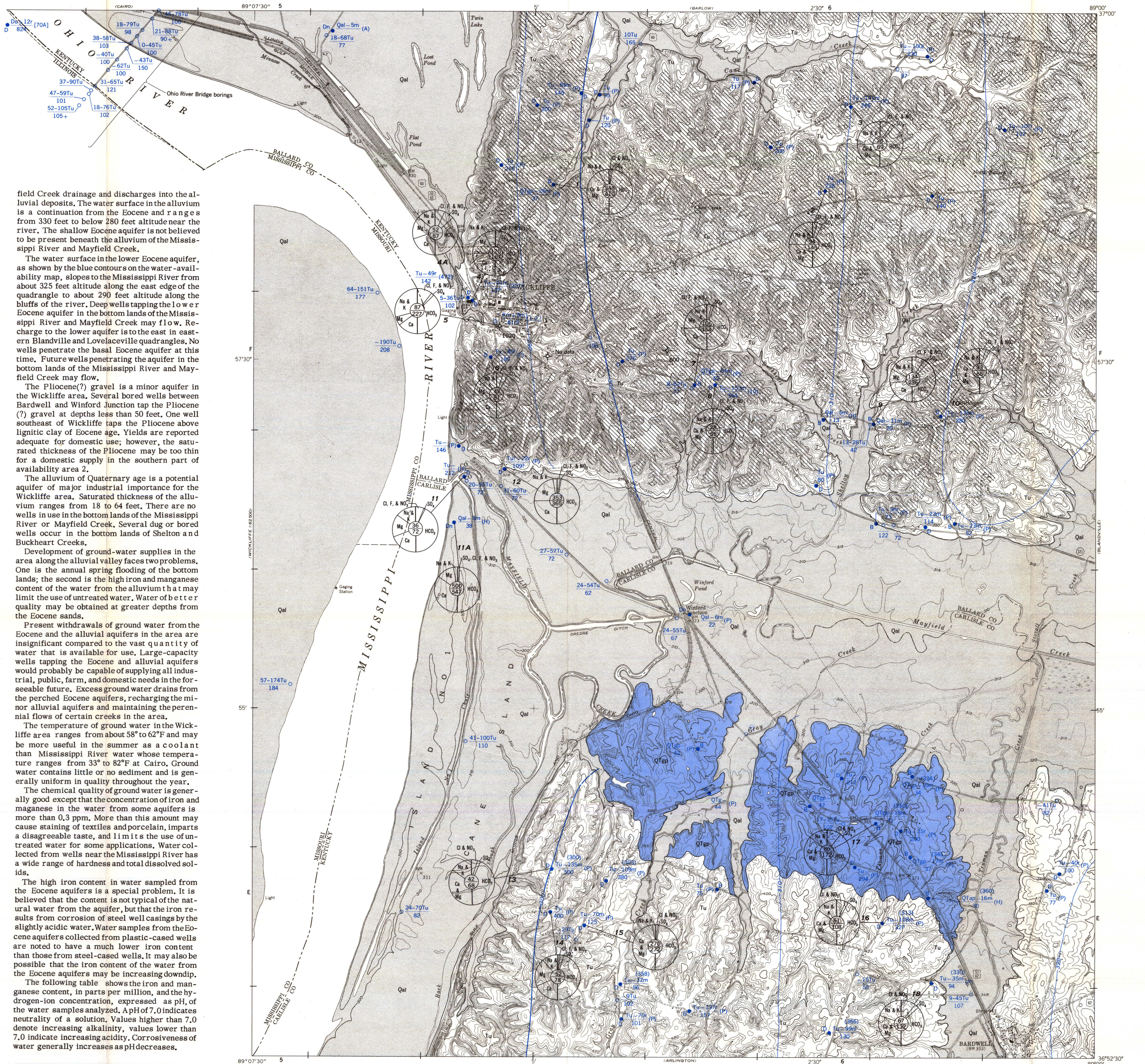
The following table shows the iron and manganese content, in parts per million, and the hydrogen-ion concentration, expressed as pH, of the water samples analyzed. A pH of 7.0 indicates neutrality of a solution. Values higher than 7.0 denote increasing alkalinity, values lower than 7.0 indicate increasing acidity. Corrosiveness of water generally increases as pH decreases.

Analysis number	1	2	3	4	5	6	7	8	9	10
Iron content	0.12	0.51	0.19	0.91	1.3	0.06	0.01	0.42	0.13	2.3
Manganese content	—	—	—	.32	.00	.02	.01	—	.00	—
pH	7.0	6.8	6.2	6.5	7.7	6.3	7.8	6.0	6.9	6.7

Analysis number	11	12	13	14	15	16	17	18
Iron content	10	0.09	0.30	0.54	0.24	0.00	0.32	0.46
Manganese content	.05	.01	.00	.02	.10	.11	.54	—
pH	6.3	7.2	6.3	6.4	7.3	6.5	6.6	6.4

SELECTED REFERENCES

Glenn, L. C., 1906, Underground waters of Tennessee and Kentucky west of Tennessee River and of an adjacent area in Illinois: U. S. Geol. Survey Water-Supply Paper 164, 173 p.
Fish, H. N., 1944, Geological investigation of the alluvial valley of the lower Mississippi River: U. S. Army Corps of Engineers, 78 p.
Krinitzsky, E. L., and Wire, J. C. 1964, Ground water in alluvium of the lower Mississippi Vally (upper and central areas): U. S. Army Corps of Engineers Tech. Rept. no. 3-658, v. 2.
MacCary, L. M., and Lambert, T. W., 1962, Reconnaissance of ground-water resources of the Jackson Purchase region, Kentucky: U. S. Geol. Survey Hydrol. Inv. Atlas HA-13, 9 p.
Ross, C. A., 1963, Structural framework of southermost Illinois: Illinois State Geol. Survey Circ. 351, 28 p.
Weller, J. M., 1940, Geology and oil possibilities of extreme southern Illinois: Illinois State Geol. Survey Rept. of Inv. no. 71, 71 p.



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

Base from U.S. Geological Survey Wickliffe, 1951 and Wickliffe NW, 1951

Hydrology by T. W. Lambert, 1966

SCALE 1:24 000
CONTOUR INTERVAL 10 FEET
DOTTED LINES REPRESENT HALF-INTERVAL CONTOURS
DATUM IS MEAN SEA LEVEL

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 supply 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 geologic and water-bearing properties are described in the generalized columnar section

Qal

AREA 1
Water in Quaternary alluvium

The alluvium is water bearing in area 1 at depths commonly less than 25 feet, although during the rainy seasons the area is commonly flooded by the Mississippi and Ohio Rivers. No wells are in use. Saturated thickness of the alluvium ranges from 20 to 30 feet at Winford Junction. An increase in saturated thickness should be expected in the area of Island No. 1 and Cane Island. The alluvium in the upper reaches of the tributaries of Mayfield Creek may be water bearing. Water from the alluvium may contain objectionable amounts of iron and manganese and is hard to very hard. Ground water of better quality occurs in the underlying Eocene sand

QTgp

AREA 2
Water in the Pliocene(?) gravel

The Pliocene(?) gravel is water bearing in area 2 northwest of Bardwell. Large diameter bored wells are less than 50 feet deep and are reported to yield sufficient water for domestic use. The southern edge of the availability area is uncertain

Tu

AREA 3
Water in Eocene sand

Diagonal ruling shows areas in Ballard County where the water level in wells is more than 100 feet below land surface

Abundant quantities of ground water are available in the Eocene sands at depths ranging from about 20 to more than 600 feet. Water levels range from a few tens of feet to more than 150 feet in the upland. Wells tap two aquifers separated by a thick clay
Wells in Carlisle County generally tap two hydrologically connected sands above the clay and may be as deep as 160 feet. Locally, these sands are missing or too thin to complete a well; a well must tap the sand below the clay
Wells in Ballard County tap the sand below the clay and range in depth from 80 to 364 feet. Yields of more than 1,000 gallons per minute may be obtained. Several shallow large-diameter bored wells tap sand lenses in the above clay and are reported to yield sufficient water for domestic use
Water from wells cased with steel casing may contain an objectionable amount of iron. Water from wells cased with plastic casing normally does not contain much iron. Water is soft to moderately hard and contains a low concentration of dissolved solids

Area boundary

1020
Oil-test well
Figure below line is depth of test hole, in feet below land surface

Test hole

31-60Tu / 72
- Saturated thickness of alluvial or Pliocene(?) gravel, in feet
- Depth to base of gravel, in feet below land surface
- Geologic unit underlying gravel (see aquifer symbols below)
- Depth of test hole, in feet below land surface

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

(300) Tu–135m (P) / 500
- Aquifer (see below)
- Altitude of measured water level, in feet above mean sea level, in Carlisle County
- Water level in well; m, if measured; r, if reported. A plus sign (+) indicates the water level in feet above land surface; a minus sign (–) in feet below land surface
- Yield, in gallons per minute, or adequacy (see below)
- Depth of well, in feet below land surface

AQUIFER SYMBOLS

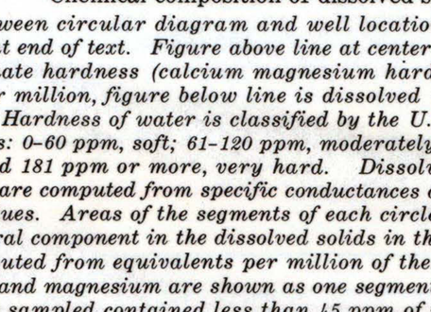
Qal............Alluvium of Quaternary age
QTgp..........Perched water in sandy gravel of Pliocene(?) age
Tu.............Sand of Eocene age, undifferentiated
Km............Sand in the McNairy Formation of Cretaceous age
Du.............Devonian rocks, undifferentiated

YIELD OR ADEQUACY

(170)..........Yield, in gallons per minute
(P).............Well reported adequate for power pump for domestic and(or) stock supply
(H).............Well reported adequate for hand pump or bailer
[1.2]...........Flowing well, measured flow in gallons per minute
(A).............Destroyed or abandoned

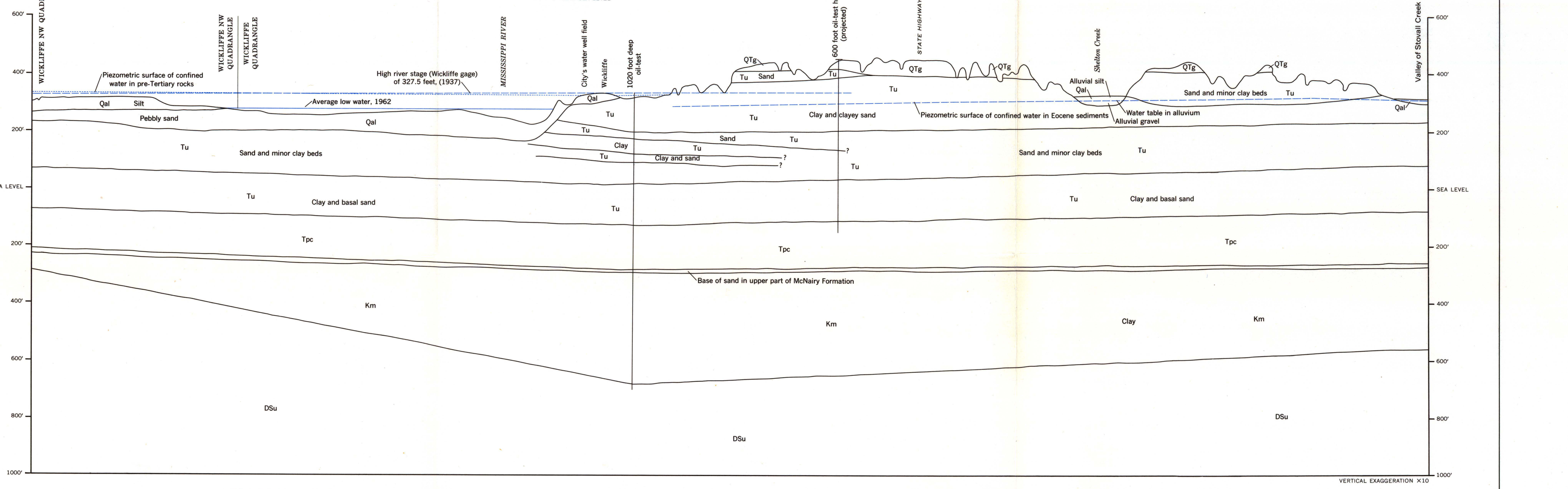
——300— — —
Water-level contour
Shows altitude of water level in the main zone of saturation. Dashed where approximately located. Contour interval 10 feet; datum is mean sea level. The approximate depth to water can be calculated by subtracting the altitude of the water level (as shown by the blue contours) from the altitude of the land surface. The difference will be the minimum depth of the well. Water-level measurements made in the late spring of 1966.

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 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; and 181 ppm or more, very hard. Dissolved solids in partial analyses 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. All wells sampled contained less than 45 ppm of nitrate. 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.



EXPLANATION

Qal..........Alluvium of Quaternary age
QTg..........Gravel of Pliocene(?) age
Tu...........Sand and clay of Eocene age, undifferentiated
Tpc..........Porters Creek Clay of Paleocene age
Km...........McNairy Formation of Cretaceous age
DSu..........Devonian and Silurian rocks, undifferentiated

GENERALIZED GEOLOGIC SECTION ALONG A SOUTHEAST-TRENDING LINE FROM NEAR THE OHIO RIVER BRIDGE TO WICKLIFFE AND SOUTH-EAST TO THE VALLEY OF STOVALL CREEK

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