PREPARED IN COOPERATION WITH
THE COMMONWEALTH OF KENTUCKY, UNIVERSITY OF KENTUCKY
KENTUCKY GEOLOGICAL SURVEY
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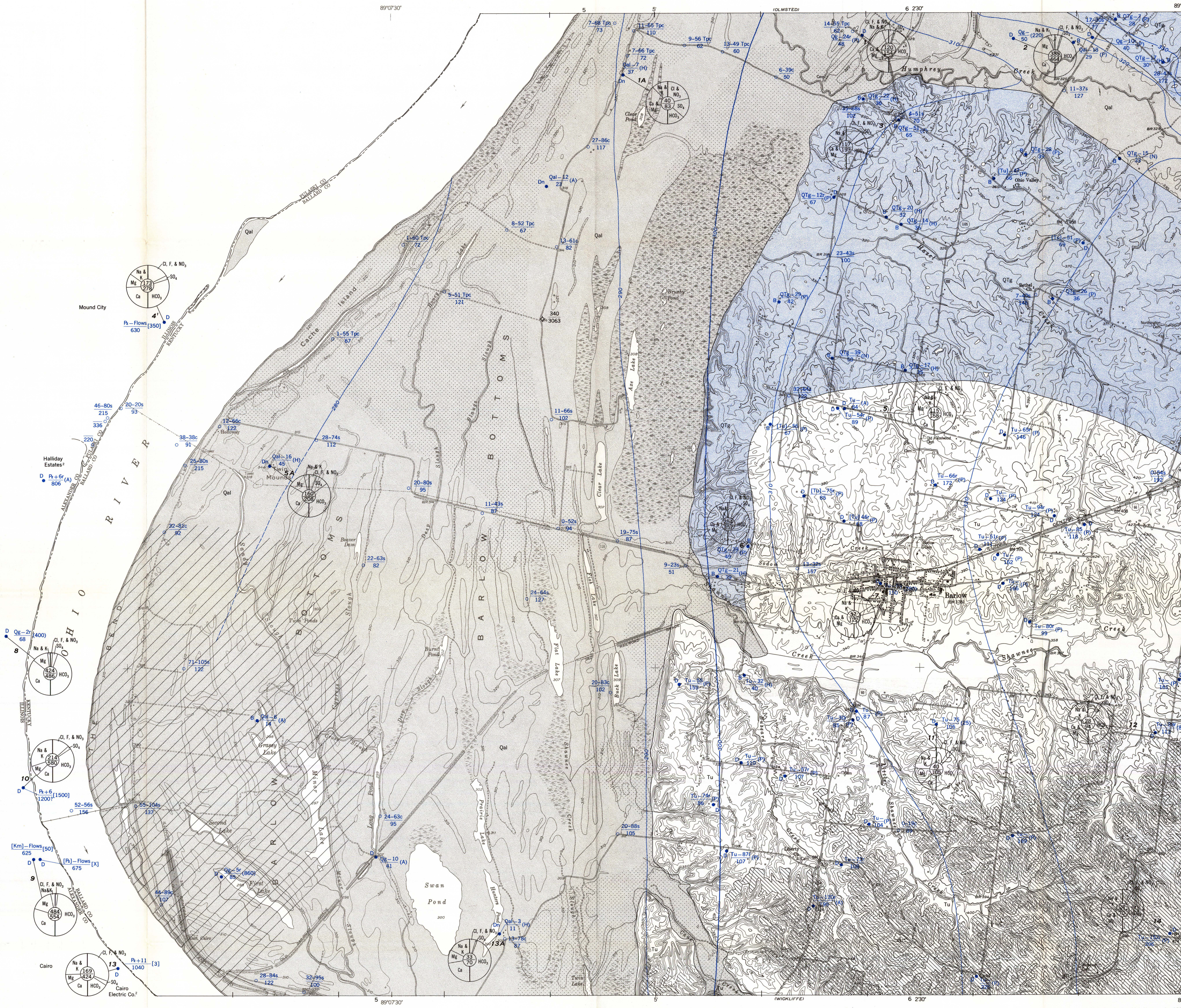
SYSTEM	SERIES	GROUP	FORMATION	SECTION	THICKNESS, IN FEET	LITHOLOGY	TOPOGRAPHY AND GEOLOGIC SETTING	HYDROLOGY
QUATERNARY	Pleistocene and Recent		Alluvial clay, silt, and sand		0–68	Gray, grayish-brown, or yellow-brown silty clay or clayey silt and some very fine- to medium-grained sand. Some layers of clay; a few streaks of coarse-grained sand. Locally, lignitic and micaceous. In the valley of Humphrey Creek, gray silty clay having maximum known thickness of 29 feet.	Flood-plain deposits in the valleys of Humphrey Creek and the Ohio River. Most of the alluvium is of Recent age; some of the sands in the lower part of this unit may be of Pleistocene age.	Yields from driven wells may be adequate for domestic use where sand layers are abundant in the zone of saturation. Larger yields may be had from the underlying alluvial sand and gravel except near Clear Lake and Cache Island. The water is soft to hard and generally contains 80 to 200 ppm (parts per million) of dissolved solids. The iron content is about one part per million; more than 0.3 ppm of iron makes water taste bitter and stains fabrics and fixtures.
QUATERNARY	Pleistocene		Alluvial sand and gravel		0–71	Medium-gray to grayish-brown coarse- to very coarse-grained sand, and fine-grained gravel and some fine- to medium-grained sand. Usually lignitic; slightly micaceous. The sand is mostly quartz, the gravel predominantly chert. The thickness is variable, even in short distances.	Underlies the alluvial clay and silt. North of Shawnee Creek, it appears to be in contact with the gravel of Pliocene(?) and Pleistocene ages where it was deposited against valley walls eroded in the Pliocene(?) gravel. Probably, it was deposited by the melt water of the Pleistocene continental glaciers. The drainage system shifted laterally at frequent intervals to deposit the sand and gravel in irregular thicknesses.	Yields from wells are adequate for domestic and/or stock use except near Clear Lake and Cache Island. Drilled wells may yield as much as 1400 gpm (gallons per minute) for irrigation where the sand and gravel is thickest. The sand and gravel is thickest west of Sandy Slough and Minor Lake. The well at First Lake yields 860 gpm and has a reported specific capacity of 45 gpm per foot of drawdown. The water is very hard and contains about 450 ppm of dissolved solids. The iron content is several parts per million.
QUATERNARY	Pleistocene		Loess		0–50	Yellow-brown to medium-gray silty clay or clayey silt. Thickest southwest of Shawnee Creek and Little Shawnee Creek.	Windblown deposits covering all the upland, draping down slopes as colluvium, and merging with alluvium along edges of gently sloping valleys.	Above the zone of saturation. When saturated by rainfall, transmits some water to underlying aquifers.
TERTIARY	Pliocene(?)		Gravel sand, silt, and clay[1]		0–35±	Yellow-brown to red-brown sandy chert gravel, in matrix of sandy clay; locally, brown to gray silty clay. Locally, thin layers of clay.	Continental deposits overlying Eocene strata in upland. Drapes down slopes as colluvium, commonly mixed with loess.	Yields from bored wells may be adequate for domestic and/or stock use west of State Highway 1105. East of Highway 1105, the gravel is thin and may have a clay matrix; it may not yield enough water to supply a modern home. Larger yields are available from the sand in the underlying Eocene sediments. The water is hard and contains between 150 and 300 ppm of dissolved solids.
TERTIARY	Eocene, undifferentiated		Clay and sand		0–125 (25–350)	White, light-gray, or pink clay, silty clay, or clayey silt with a few layers of yellow to white fine-grained sand.		Throughout Area 3, wells may be completed in this unit between about 250 and 220 feet altitude. The water is soft and contains about 75 to 110 ppm of dissolved solids.
TERTIARY	Eocene, undifferentiated		Clay and sand		0–108 (25–350)	Brown, yellow, or white very fine- to coarse-grained sand and a few layers of pink, white, or gray clay or silty clay.	Coastal-plain sediments underlying either continental deposits or alluvium in the entire area.	In the upland, wells may be completed in this unit between about 250 feet altitude near Humphrey Creek and about 220 feet along the south edge of the map. In Barlow Bottoms, the unit is present south of State Highway 118; wells may be completed at about 200 feet altitude. Near Barlow, where the unit appears to be thickest, it may yield as much as 500 gpm; the municipal well at Barlow yields 280 gpm and has a specific capacity of 9.5 gpm per foot of drawdown. The water is soft to moderately hard and contains about 150 ppm of dissolved solids.
TERTIARY	Eocene, undifferentiated		Clay and sand		0–250 (25–350)	Light-gray to blue-gray silty clay, light gray clayey silt and very fine-grained sand, or fine- to medium-grained sand with interbedded sandy clay. Commonly micaceous and/or lignitic. Locally, there may be a basal sand.		Wherever the basal sand of this unit is present, it may be an adequate aquifer for domestic use.
TERTIARY	Paleocene	Midway	Porters Creek Clay		15–200	Dark-gray clay, commonly silty and micaceous. Locally, layers of greenish-gray clayey silt or fine-grained sand. Glauconitic in the upper and basal parts. Pollen from several auger samples in the northern part of the map has been identified to be of Paleocene age (R. H. Tschudy, written communication, 1967).	Marine deposits underlying Eocene sediments or alluvium in the entire area.	Not an aquifer. Retards ground-water movement between the Eocene sediments and the underlying McNairy Formation.
CRETACEOUS	Upper Cretaceous		McNairy Formation[2]		19–125	Light- to dark-gray micaceous silty clay interbedded with white, gray, or brown silt or very fine-grained sand. The upper part is predominantly clay; the lower part is mostly micaceous very fine-grained sand.	Deltaic deposits underlying the Porters Creek Clay in the entire area.	Drilled wells may yield enough water for domestic use; a flowing well in Cairo, Ill., yields 50 gpm at high river stage. The water is very hard and contains so much iron that it may need iron-removal treatment to be suitable for many uses.
CRETACEOUS	Upper Cretaceous		Tuscaloosa Formation		0–20	White or light-gray chert gravel with tripolitic clay matrix.	Discontinuous stream-laid deposits overlying post-Paleozoic erosion surface. Not known to be present in this area.	Not an aquifer because of fine-grained matrix and poor sorting.
			Paleozoic rocks undifferentiated[3]		2700+	The Paleozoic consolidated rocks underlying the Cretaceous sediments are the "bedrock" of well drillers. The upper surface of the limestone and chert is weathered to form chert rubble, containing chert blocks in a clay matrix. White or gray coarsely crystalline dolomitic limestone, commonly siliceous, interbedded with chert.	Underlies the Cretaceous sediments in the entire area.	The chert rubble probably is not an aquifer in this area because of its fine-grained matrix. Wells in the consolidated rock may obtain water from fractures and solution openings. In Cairo, Ill., a well flows 1500 gpm at high-river stage. The water is hard or very hard.

[1] Age undetermined; estimates of age range from Pliocene or older to Pleistocene
[2] Upper part may be of Clayton age
[3] The oil-test well east of Honey Lake penetrated rock of Devonian age; the bedrock tapped by wells at Cairo, Ill., is of undetermined age

EXPLANATION

Gravel Sand Silt Loess Clay Mica Glauconite Lignite Cherty limestone Dolomite



Base from U.S. Geological Survey, 1954
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

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

SCALE 1:24 000
CONTOUR INTERVAL 10 FEET
DATUM IS MEAN SEA LEVEL

APPROXIMATE MEAN DECLINATION, 1968

QUADRANGLE LOCATION

Hydrology by Arnold J. Hansen, Jr., 1966

EXPLANATION

Each availability area on this map shows the occurrence and availability of ground water in the shallowest aquifer that may yield enough water for domestic use. This report considers that an adequate aquifer will yield at least 500 gallons per day to a well equipped with a power pump and pressure-distribution system. The shallowest aquifer is underlain by other aquifers which are described in the generalized columnar section

Qal

AREA 1
Water in Quaternary alluvium
Pattern indicates the saturated thickness of the alluvial gravel; dotted, less than 10 feet thick, diagonal ruling, more than 30 feet thick

Except near Clear Lake and Cache Island, yields from wells are adequate for domestic and/or stock use. Where the alluvial gravel is more than 10 feet thick, drilled wells may yield enough water for irrigation or industrial use. The alluvial gravel is thickest west of Sandy Slough and Minor Lake; yields from properly constructed wells may be as much as 1400 gpm (gallons per minute). The well at First Lake is reported to have a specific capacity of 45 gpm per foot of drawdown when pumped at 860 gpm

Where the gravel is thin, throughout most of the area approximately between State Highway 118 and the road along Humphrey Creek, the shallowest aquifer that may supply irrigation or industrial wells probably is the Paleozoic limestone

Driven wells may yield enough water for domestic use from the alluvial silt and sand

QTg

AREA 2
Water in gravel of Pliocene(?) and Pleistocene ages

West of State Highway 1105, the gravel may be thickest; yields from bored wells may be adequate for domestic and/or stock use.

East of State Highway 1105, the saturated gravel is thin and may have a matrix of sandy clay; it may not yield enough water for domestic use. To obtain larger yields wells can be drilled into the sand in the underlying Eocene strata.

Throughout Area 2, the sand of Eocene age probably is the shallowest aquifer that may yield enough water for irrigation or industrial use

Tu

AREA 3
Water in Eocene sand
Diagonal ruling indicates areas where the static water level is deeper than 100 feet

In Area 3, yields of all wells in the sands of Eocene age are adequate for domestic and/or stock use. Domestic wells may be completed from about 250 feet altitude near Area 2 to about 220 feet in the south. The sands appear to be thickest near Barlow; properly constructed wells may yield as much as 500 gpm. The municipal well at Barlow has a specific capacity of 9.5 gpm per foot of drawdown when pumped at 280 gpm

Area boundary

Oil-test well

340 — Depth to Paleozoic bedrock, in feet below land surface
3063 — Depth of well, in feet below land surface

Test hole

5-51 Tpc / 121
- Saturated thickness of gravel, in feet
- Depth to base of gravel, in feet below land surface or bed of Ohio River
- Geologic unit underlying gravel (see aquifer symbols below); c, clay of Eocene age, s, sand of Eocene age, Tpc, Porters Creek Clay
- Depth of test hole, in feet below land surface

D
Water well

Dn, *Driven well, generally 1½-inch or smaller pipe with sand point*
D, *Drilled well, generally 4-inch or smaller steel casing with well screen*
B, *Bored or dug well, generally 24-inch concrete tile or 8-inch vitrified clay pipe, open at the bottom*

Tu–55 / 150 (280)
- Aquifer (see below)
- Water level in well, in feet below land surface; + indicates feet above 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 .... Alluvial silt of Pleistocene and Recent age
- Qg .... Alluvial gravel of Pleistocene age
- QTg .... Gravel of Pliocene(?) and Pleistocene age
- Tu .... Sand of Eocene age
- Tpc .... Porters Creek Clay of Paleocene age
- Km .... McNairy Formation of Cretaceous age
- Pz .... Paleozoic rocks, undifferentiated
- [ ] .... Brackets indicate probable aquifers where not known

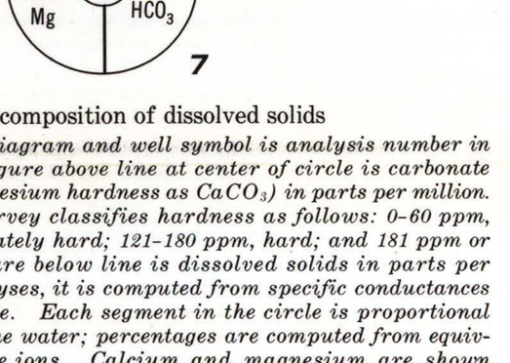
YIELD OR ADEQUACY

- [50] .... Gallons per minute, flowing
- (280) .... Gallons per minute
- (P) .... Reported adequate for power pump for domestic and/or stock supply
- (H) .... Reported adequate for bailer or hand pump
- (N) .... Inadequate
- (A) .... Abandoned or destroyed
- (X) .... No yield data available

300
Water-level contour

Shows altitude of water in the zone of saturation. Dashed where approximately located. Contour interval 10 feet; datum is mean sea level. The depth to water is the difference between the land-surface altitude and the water-level contour. Water levels measured in August 1965. South of Shawnee Creek, contours interpreted from sparse data

QUALITY



Chemical composition of dissolved solids

Figure between circular diagram and well symbol is analysis number in table at end of text. Figure above line at center of circle is carbonate hardness (calcium magnesium hardness as $CaCO_3$) in parts per million. The U.S. Geological Survey classifies hardness 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; in partial analyses, it is computed from specific conductances and is only approximate. Each segment in the circle is proportional to the ion dissolved in the water; percentages are computed from equivalents per million of the ions. Calcium and magnesium are shown together as one segment in partial analyses

AVAILABILITY OF GROUND WATER IN PARTS OF THE CAIRO AND BARLOW QUADRANGLES IN JACKSON PURCHASE REGION KENTUCKY

Ground water for domestic, irrigation, and industrial use is abundant in the parts of the Cairo and Barlow quadrangles in Kentucky. This atlas, one of a series for the entire Jackson Purchase region, describes the ground-water resources of western Ballard County.

The availability map shows the occurrence and quality of ground water in the shallowest aquifer that may yield an adequate domestic water supply. Ground-water availability at any site is shown by the map pattern and the data for nearby wells and test holes. Chemical quality is shown by circular diagrams.

The principal aquifers are the alluvial gravel of Pleistocene age, the gravel of Pliocene(?) and Pleistocene ages, and the sands of Eocene age. Alluvial gravel of Pleistocene age underlies alluvial clay and silt of Pleistocene and Recent ages throughout area 1 except near Clear Lake and Cache Island. Throughout Area 2, saturated Pliocene(?) gravel underlies loess in the upland and alluvial clay and silt in the valley of Humphrey Creek. Sand of Eocene age underlies the entire upland south of Humphrey Creek and Barlow Bottoms south of State Highway 118. Other aquifers are the McNairy Formation and the bedrock of Paleozoic age.

In area 1, except for most of the area approximately between State Highway 118 and the road along Humphrey Creek, the saturated thickness of the alluvial gravel ranges from 10 to 71 feet. In the area between these roads, the saturated thickness is less than 10 feet, except where an apparent channel deposit is shown on the map. North of Shawnee Creek, the alluvial gravel was deposited along valley walls eroded in the Pliocene(?) gravel. Ground water moves freely across the contact between the two deposits. The test borings near Holloway and the railroad bridge on the north edge of Cairo, Ill., indicate that the Ohio River locally flows on the alluvial gravel and, except at high river stages, that ground water discharges freely into the river. Along Humphrey Creek and south of State Highway 118, where the saturated thickness of the alluvial gravel is greater than 10 feet, drilled wells may yield several hundred gallons per minute; west of Sandy Slough and Minor Lake, yields may be as much as 1,400 gpm (gallons per minute).

In Area 2, the principal aquifer is the gravel of Pliocene(?) and Pleistocene ages. East of State Highway 1105 the saturated gravel is thin and clayey and yields from bored wells may be inadequate for domestic use. West of State Highway 1105 the saturated gravel is thicker and should yield enough water to domestic wells. Where yields are inadequate, larger yields are available by drilling wells into the underlying sand of Eocene age.

In Area 3 the sands of Eocene age are the shallowest aquifers. In the uplands south of Humphrey Creek, wells may be completed in the Eocene sands from about 250 feet altitude north of Shawnee Creek to about 220 feet altitude in the southern part of the map. In Barlow Bottoms (Area 1) sand of Eocene age is present south of State Highway 118. Wells in this area may be completed at about 200 feet altitude. Near Barlow, where the sand seems to be thickest, properly constructed wells may yield as much as 500 gpm. The municipal well at Barlow yields 280 gpm and has a specific capacity of 9.5 gpm per foot of drawdown.

The water level in the saturated zone slopes westward from about 325 feet altitude along the east edge of the map east of Barlow to about 280 feet at the Ohio River.

The Porters Creek Clay of Paleocene age which underlies the Eocene strata, although not an aquifer, is hydrologically significant because it retards the movement of ground water between the Eocene beds and the underlying Cretaceous sediments. The clay is between 15 and 200 feet thick. Its upper surface slopes from about 270 feet altitude at the northeast corner of the map to about 50 feet below mean sea level at the southwest corner.

The McNairy Formation of Cretaceous age below the Porters Creek Clay may yield enough water for domestic use to drilled wells throughout the area. A well in Cairo, Ill., penetrating the McNairy Formation, flows 50 gpm at high river stage. The McNairy Formation is between 19 and 125 feet thick and overlies the limestone and chert bedrock of Paleozoic age.

The Paleozoic bedrock may yield enough water for irrigation or industrial use where wells penetrate openings enlarged by solution. A well in Cairo, Ill., penetrating the Paleozoic bedrock, flows 1,500 gpm at high river stage. The water level is about 320 feet altitude in wells tapping the pre-Tertiary rocks.

Although the quantity of water available from most aquifers is adequate for domestic and larger supplies, the quality is not always satisfactory without treatment. The water in the alluvium of Pleistocene age contains so much iron that iron-removal treatment may be required for most uses. The water in the alluvium of Barlow Bottoms is soft to hard and generally contains 80 to 200 ppm (parts per million) of dissolved solids. Elsewhere, the water in the alluvium is very hard and contains about 475 ppm of dissolved solids. The quality of water in the gravel of Pliocene(?) and Pleistocene ages is satisfactory for most uses without treatment. The water is hard or very hard and contains about 150 to 300 ppm of dissolved solids. It is about neutral, pH generally about 7.0. The nitrate content is about 20 ppm. The water in the Eocene strata generally is soft and contains 75 to 150 ppm of dissolved solids. The water has a pH generally about 6.5 and may be corrosive. The temperature generally ranges from 59° to 61°F. The iron content generally is about 1.0 ppm. The water in the McNairy Formation and the Paleozoic bedrock is hard or very hard and usually contains more than 0.3 ppm of iron.

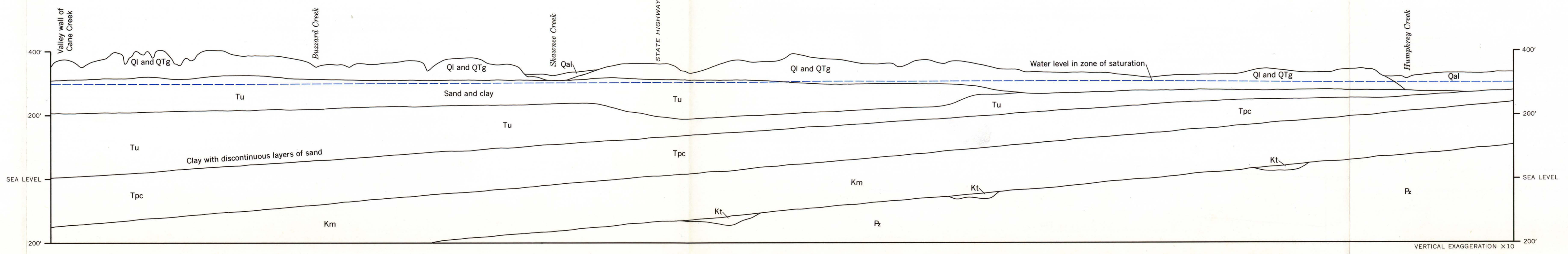
The following table lists the iron content, in parts per million, and the hydrogen-ion concentration, as pH, of the water analyses on the availability map. A pH of 7.0 indicates neutrality. Values higher than 7.0 denote alkalinity; lower values indicate acidity. Below 7.0, corrosiveness generally increases as pH decreases.

Analysis number	1	1A	2	3	4[1]	5	5A	6	7	8
Iron content	0.25	0.11	12	0.06	1.0	0.65	1.0	0.10	1.6	6.2
pH	7.5	5.9	6.7	6.7	7.7	7.5	6.4	7.1	6.5	7.6

Analysis number	9	10	11	12	13	13A	14
Iron content	16	1.0	1.0	0.76	1.1	0.76	11
pH	7.0	7.8	6.3	7.0	8.0	6.1	6.4

[1] Illinois State Water Survey, 1950, Public ground-water supplies in Illinois: Bull. no. 40, Lab. no. 113,261.

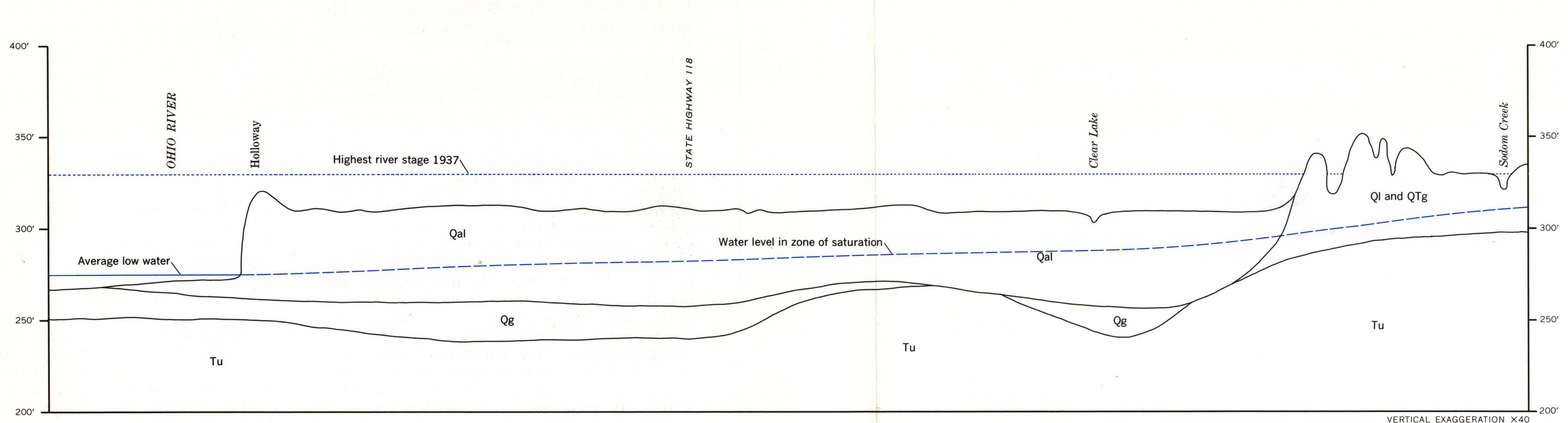
[2] Glenn, L. C., 1906, Underground waters of Tennessee and Kentucky west of Tennessee River and of an adjacent area in Illinois: U.S. Geol. Survey Water-Supply Paper 164, p. 150-151.



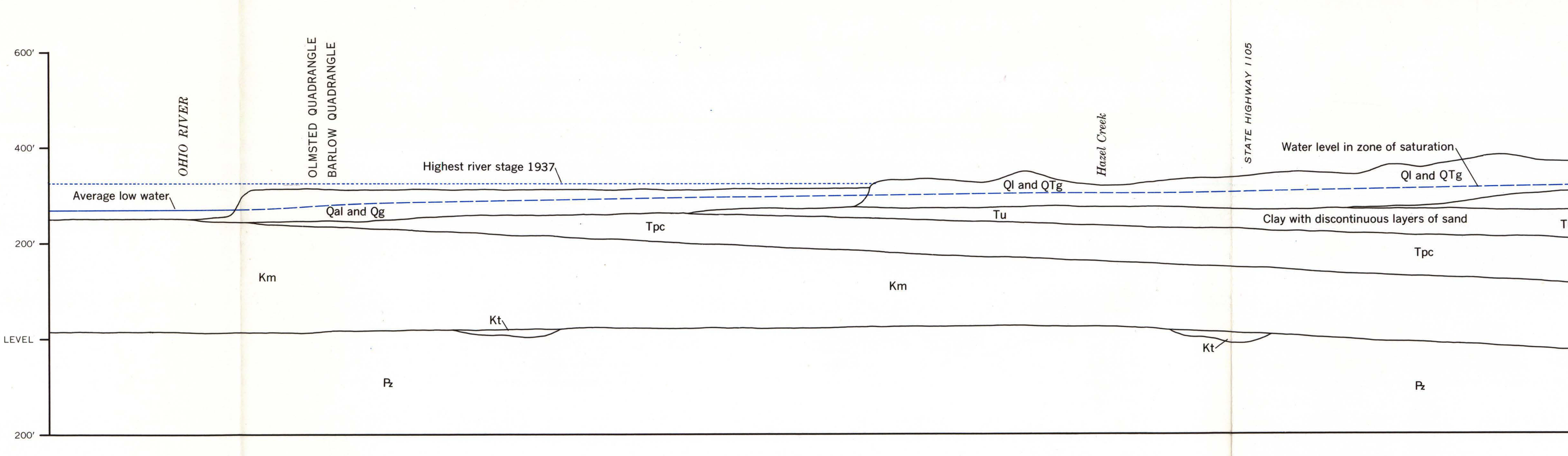
GENERALIZED GEOLOGIC SECTION TRENDING NORTHWARD FROM SOUTH EDGE OF MAP AT VALLEY WALL OF CANE CREEK TO NORTH EDGE OF MAP NEAR HUMPHREY CREEK

EXPLANATION

- Qal .... Alluvium of Quaternary age
- Qg .... Alluvial gravel of Pleistocene age
- Ql .... Loess of Pleistocene age
- QTg .... Sand and gravel of Pliocene(?) and Pleistocene age
- Tu .... Sand and clay of Eocene age, undifferentiated
- Tpc .... Porters Creek Clay of Paleocene age
- Km .... McNairy Formation of Cretaceous age
- Kt .... Tuscaloosa Formation of Cretaceous age
- Pz .... Paleozoic rocks, undifferentiated



GENERALIZED GEOLOGIC SECTION TRENDING EASTWARD THROUGH HOLLOWAY TO NEAR SODOM CREEK



GENERALIZED GEOLOGIC SECTION TRENDING SOUTHEASTWARD FROM THE OHIO RIVER AT THE NORTH EDGE OF THE MAP TO U.S. HIGHWAY 60 NEAR THE EAST EDGE OF THE MAP

AVAILABILITY OF GROUND WATER IN PARTS OF THE CAIRO AND BARLOW QUADRANGLES IN THE JACKSON PURCHASE REGION, KENTUCKY

By
Arnold J. Hansen, Jr.
1968