DEPARTMENT OF THE INTERIOR
UNITED STATES GEOLOGICAL SURVEY
THOMAS B. NOLAN, DIRECTOR

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	THICKNESS, IN FEET	LITHOLOGY	TOPOGRAPHY AND GEOLOGIC SETTING	HYDROLOGY
QUATERNARY	Pleistocene and Recent		Alluvium	0–45′	Gray to tan micaceous clay, silt, sand, and gravel; sandy or clayey gravel in lower part.	Flood-plain deposits along the West Fork of Clarks River, Middle Fork Creek, and their tributaries. Thickness in major flood plain averages less than 40 feet; thinner deposits in tributaries.	Water bearing in availability area 1. Yields adequate domestic supplies to large-diameter dug or bored wells. The water table fluctuates in response to seasonal rainfall, and wells that do not penetrate water-bearing alluvium deeply may go dry in late summer. Analysis of one water sample shows the water is soft and contains only minor amounts of iron.
	Pleistocene		Loess	0–10′	Gray to tan noncalcareous unstratified silt and clay; contains small black to brown concretions in lower part. Reworked into gravel at base.	Windborne deposits on flat uplands and draped down hillsides. As thick as 10 feet on uplands, eroded thin in places, and removed in most upland tributary valleys.	Nearly impermeable. Probably transmits some rainfall to underlying aquifers. Yields little or no water to wells.
TERTIARY	Pliocene(?)		Gravel and sand[1]	0–45′	Micaceous poorly sorted gravel and sand that contains red to brown angular to rounded chert pebbles and cobbles. Crossbedded sand lenses, iron-cemented zones, and pink silty clay beds in places. Sand is tan to red quartz or chert and contains minor amounts of heavy minerals.	Old stream deposits in the flat uplands and lower terraces. Commonly concealed by a cover of loess but exposed in hillsides and roadcuts. Thickness is as great as 45 feet on the tops of hills in the southeastern part of the quadrangle.	Water bearing in availability area 2. Yields adequate domestic supplies to large-diameter dug or bored wells less than 50 feet deep. Generally adequate for power pump and pressure-distribution system. Water commonly is soft but may be moderately hard; iron content is rarely objectionable. In places, possibly due to pollution, nitrate (NO_3) is present in excess of 45 ppm. More than this amount of nitrate in water fed to infants is harmful.
	Eocene (undifferentiated)		Sand and clay	0–150′	Light- to dark-gray clay and white sand; coarse-grained basal sand is overlain by clay conglomerates in a clayey fine-grained sandy matrix. Plant stems, silicified wood, lignitic particles, and weathered gray clay fragments in lower clayey part. Upper sand is medium grained, crossbedded, and oxidized to shades of red in exposure.	Continental deposits exposed in stream valleys in western part of quadrangle below gravel at altitudes as high as 490 feet in places. May be 100 feet thick along west border of quadrangle; thins rapidly to the east; and is absent outside availability area 3 (fig. 1).	Water bearing in availability area 3. Yields adequate domestic supplies to dug or bored large-diameter wells as deep as 90 feet. Probably an adequate supply for power pump and pressure-distribution system. Water commonly is soft or moderately hard. The concentration of iron in the water is rarely objectionable.
	Paleocene	Midway	Porters Creek Clay	0–220′	Light- to dark-gray or black micaceous commonly massive clay; breaks with a conchoidal fracture. Fine-grained gray micaceous glauconitic thin sand beds in upper part. Numerous sand-filled fractures, called sandstone dikes, confined to northern half of area; sand is fine grained, micaceous, and usually indurated. Gray to greenish-gray glauconitic to very glauconitic sand and clay or micaceous clayey sand at base.	Marine deposits exposed in stream valleys beneath gravel in availability area 4 (fig. 1). Removed by erosion along Bee Creek; as thick as 135 feet near Harvey; and underlies the Eocene Series in the western half of quadrangle where deposit may be 220 feet thick. Shallow marine deposit exposed in base of Porters Creek Clay near Bee Creek. Thickness of basal glauconitic zone may be as great as 20 feet in subsurface.	Generally not water bearing. Significant only to retard downward percolating water and to confine deeper water. Sandstone dikes may contain minor supplies for domestic use. Lenses of sand yield water slowly to wells. Water is soft to moderately hard and may have an objectionable iron content in places. Greater concentrations than 0.30 ppm of iron in water, considered to be the objectionable limit, may stain plumbing fixtures and laundry.
CRETACEOUS	Upper Cretaceous		McNairy Formation[2]	200–300′	Gray to white slightly micaceous fine- to medium-grained sand stained red to tan on exposure; interlaminated with black or dark-gray massive micaceous and lignitic clay.	Deltaic deposits exposed along Bee Creek beneath Porters Creek Clay. Concealed in remainder of quadrangle by overlying sediments. Interlaminated clay facies may predominate in much of subsurface. Thickness probably as great as 300 feet in places.	Water bearing in entire quadrangle at depths ranging from less than 20 feet in availability area 5 to more than 500 feet in southwestern part of quadrangle. Yields a plentiful supply of water to both large-diameter dug or bored wells and small-diameter drilled wells. Water is confined outside of availability area 5 and rises in wells to altitudes of about 430 feet above sea level (see fig. 3). Wells in McNairy Formation may flow where altitude of land surface is below 430 feet. Water is very hard and generally contains iron in objectionable amounts.
			Tuscaloosa Formation	0–50′	Gravel containing white well-rounded tripolitic chert pebbles and cobbles.	Stream deposits concealed in the area and probably absent in places. Fill depressions and channels in eroded Paleozoic bedrock surface. Recorded thickness of 50 feet.	Probably will yield a sufficient supply of water to drilled wells. Not tapped in area. Water is probably hard and may have an objectionable iron content in places.
DEVONIAN	Lower and Middle Devonian		Devonian rocks (undifferentiated)	500′+	All rocks below the Cretaceous are of Paleozoic age and are the "bedrock" of well drillers. Light-gray to white tripolitic chert and limestone; well-fractured chert rubble in upper zone; gray crystalline cavernous limestone at depth. Underlain by dolomite, limestone, sandstone, and shale of early Paleozoic age.	Consolidated marine deposits concealed at depth. Old eroded surface, weathered and leached, during pre-Cretaceous time. Chert rubble may be as much as 400 feet thick in places.	Probably contains an abundant supply of ground water in entire quadrangle. Water occurs in chert rubble or in solution crevices and caverns in limestone. The depth ranges from about 350 feet in northeastern part of quadrangle to possibly over 800 feet in southwestern part. Water is probably hard, may contain high concentrations of dissolved solids and objectionable amounts of iron.

[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 or shale · Carbonaceous material · Mica · Glauconite · Chert rubble · Limestone · Dolomite · Crystalline limestone · Cherty limestone · Cherty dolomite

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

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

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

Hydrology by J. H. Morgan, 1961

SCALE 1:24 000

CONTOUR INTERVAL 10 FEET
DATUM IS MEAN SEA LEVEL

APPROXIMATE MEAN DECLINATION, 1964

QUADRANGLE LOCATION

EXPLANATION

The water-availability areas on this map show the occurrence and availability of ground water in the shallowest aquifer that can 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

The alluvium, water bearing at depths commonly less than 10 feet, is underlain in most of the quadrangle by the Porters Creek Clay. (See fig. 3.) The zone of saturation which continues only down to the underlying clay is probably as thick as 30 feet in the major flood plain but much thinner in the tributaries. Shallow large-diameter dug wells generally terminate in water-bearing alluvium but can be deepened into the underlying clay for greater storage capacity. Deeper wells usually furnish sufficient amounts of water for a perennial supply, even in the driest seasons. The alluvium in Bee Creek is underlain by water-bearing McNairy Formation which furnishes an abundance of water

QTg

AREA 2
Water in Pliocene(?) gravel

The Pliocene(?) gravel is water bearing where it is underlain by the Porters Creek Clay, shown as area 2. The zone of saturation, ranging in thickness from about 3 to 9 feet, occurs at the base of the gravel and the water moves along the contact with the underlying clay. Most of the wells are large-diameter bored wells that generally penetrate only a few feet of water-bearing gravel; a few wells are deepened into the Porters Creek Clay, providing additional storage space in the large-diameter casing. In some places in area 2, shallow water is perched above cemented gravel zones. These small bodies of perched water usually have inadequate yields for even a domestic supply. Wells should penetrate through the cemented gravel and enter the main zone of saturation near the base of the gravel to obtain an adequate supply of water

Tu

AREA 3
Water in Eocene sand

The Eocene sand is water bearing at depths ranging from 10 feet to 80 feet according to the altitude of the land surface. The zone of saturation, possibly 100 feet thick in some places, extends down to the Porters Creek Clay. (See fig. 3.) Large-diameter dug or bored wells, as deep as 90 feet, terminate only a few feet below the water table, the depth depending on the amount of water desired in the well. The formation yields large supplies to properly constructed wells. In some places shallow water is perched above discontinuous beds of clay in the Eocene Series. The small perched water bodies usually are inadequate for a domestic supply and wells should penetrate through them and enter the main zone of saturation in the underlying sand

Tpc

AREA 4
Water in colluvium above Porters Creek Clay

A thin mantle of colluvium (rock material moved by gravity) occurs above the Porters Creek Clay in area 4 and may be water bearing in some places. This shallow water is generally inadequate for a domestic supply; however, large-diameter wells that are dug or bored several feet into the underlying Porters Creek Clay may provide sufficient storage space for a small supply. Should the colluvium be dry, the McNairy Formation, a deeper aquifer about 200 feet beneath this area, is known to yield a plentiful supply of water. Springs which are common in this area could be developed as a source of water

Km

AREA 5
Water in the McNairy Formation

The McNairy Formation, exposed in area 5, is water bearing at depths commonly less than 20 feet below the land surface. Although much of the formation may be interlaminated clay, there are probably several coarse sand beds present and the zone of saturation is probably 200 or more feet thick. Shallow large-diameter dug or bored wells in this area penerate only a few feet below the water table but could be deepened into the formation and obtain greater amounts of water

Area boundary

3182
Oil-test well
Figure below line is depth of well

82
Test hole
Figure below line is depth of test hole

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

Spring

QTg – 21 / 41 (35)
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

Qal .... Alluvium of Quaternary age
QTg .... Gravel of Pliocene(?) age
Tu .... Sand of Eocene age, undifferentiated
Tpc .... Sand in Porters Creek Clay of Paleocene age
Km .... McNairy Formation of Cretaceous age
[ ] .... Brackets indicate probable aquifer where not definitely known

YIELD OR ADEQUACY

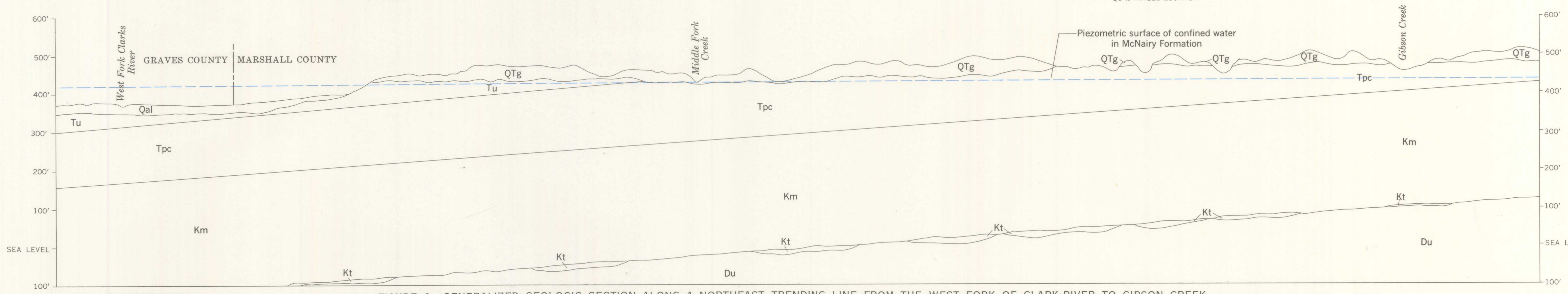
(35) .... Gallons per minute where known
(P) .... Well reported adequate for power pump for domestic and/or stock supply
(H) .... Well reported adequate for hand pump or bailer
(X) .... No yield information available
(A) .... Abandoned

450
Water-level contour
Shows altitude of the water level in the main zone of saturation. Depth to water is the difference in feet between altitude of water-level contour and land surface. Contour interval 10 feet; datum is mean sea level. Water-level measurements taken in March 1961

QUALITY

Na & K · Cl, F & NO_3 · SO_4 · HCO_3 · Ca · Mg · 14/43 · 15

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; 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. Nitrate shown separately if present in amounts greater than 45 ppm



VERTICAL EXAGGERATION X10

FIGURE 3—GENERALIZED GEOLOGIC SECTION ALONG A NORTHEAST TRENDING LINE FROM THE WEST FORK OF CLARK RIVER TO GIBSON CREEK

EXPLANATION

Qal .... Alluvium of Quaternary age
QTg .... Gravel of Pliocene(?) age
Tu .... Eocene formations, 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 OAK LEVEL QUADRANGLE, KENTUCKY

A plentiful supply of ground water for domestic purposes is available in the Jackson Purchase region in western Kentucky. The increasing demand for water in our expanding economy has required that special consideration be given to the water resources. To encourage wise development and conservation of this resource, the U.S. Geological Survey in cooperation with the Kentucky Geological Survey is conducting scientific investigations to expand the knowledge of the ground water in the region. This report, one of a series that includes the entire Jackson Purchase region, provides detailed information on the availability of ground water in the Oak Level quadrangle.

The shallowest ground-water source that may yield an adequate supply for domestic use is shown on an availability of ground water map (fig. 1). Although a shallow zone of saturation--that part of the rock material that is completely saturated with water--is continuous beneath the entire quadrangle, the upper surface of the zone is in different geologic formations. As an example of the use of the map, near Harvey in the east-central part of the quadrangle, the conditions for area 2 (see explanation of map) are shown. The water table (the upper surface of the main zone of saturation) is in Pliocene(?) gravel, large-diameter wells are present, the saturated zone may be 9 feet thick, and enough water is available for a domestic supply. The probable minimum depth of a well is the difference between the altitude of the land surface and the water table. Near Harvey, the difference is about 30 feet which is the estimated depth to water and the minimum depth of a dependable well.

In a few places, discontinuous beds of clay above the water table retard descending water above them. These local occurrences of ground water above the main zone of saturation, called "perched water," are usually inadequate even for a domestic supply although a few of them may contain a small amount of water for some uses, even in the driest seasons.

Should the shallowest water-bearing formation (aquifer) yield an insufficient supply, deeper formations can be tapped. (See fig. 2). The McNairy Formation is an excellent aquifer, formerly yielding an adequate supply of water to the school at Brewers and still yielding a municipal supply to the town of Benton, Kentucky. The water in the formation, confined by Porters Creek Clay in most of the quadrangle, will rise in wells to altitudes ranging from about 410 feet to 430 feet above sea level. The Tuscaloosa Formation, which is not tapped by wells in this quadrangle, is water bearing in areas where the gravel in the formation has been located. The Paleozoic aquifers are an excellent source of ground water but have not been developed in this area. Near the Ohio River in southern Illinois the Paleozoic rocks furnish water to several homes, small businesses, and for large industry and municipalities. The McNairy, Tuscaloosa, and Paleozoic aquifers are capable of yielding much larger quantities of water than are now being pumped from them.

The quality of water is generally satisfactory for most uses. The water in the shallow aquifers is commonly soft or only moderately hard and the concentration of dissolved solids rarely reaches objectionable limits. The nitrate (NO_3) content exceeds the safe limits of 45 parts per million in some places. The water is slightly acidic and may be considered corrosive for some uses. The temperature of the ground water ranges from about 55° to 60°F. There may be objectionable amounts of iron in the water in a few places, especially in the water in the McNairy Formation.

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	0.40	0.42	0.25	0.11	0.68	0.16	0.16	0.08	0.02	0.96
pH	6.4	6.0	6.1	6.9	6.8	6.1	6.9	5.7	6.3	7.4

Analysis number	11	12	13	14	15	16	17	18	19	20
Iron content	0.08	0.14	0.03	0.09	0.07	0.30	0.43	0.14	0.21	0.06
pH	6.4	6.3	6.1	7.1	6.9	6.7	6.4	6.1	6.8	6.5

Analysis number	21	22	23
Iron content	0.55	0.14	0.05
pH	6.6	6.9	7.2

AVAILABILITY OF GROUND WATER IN THE OAK LEVEL QUADRANGLE, KENTUCKY

By
J. H. Morgan
1964