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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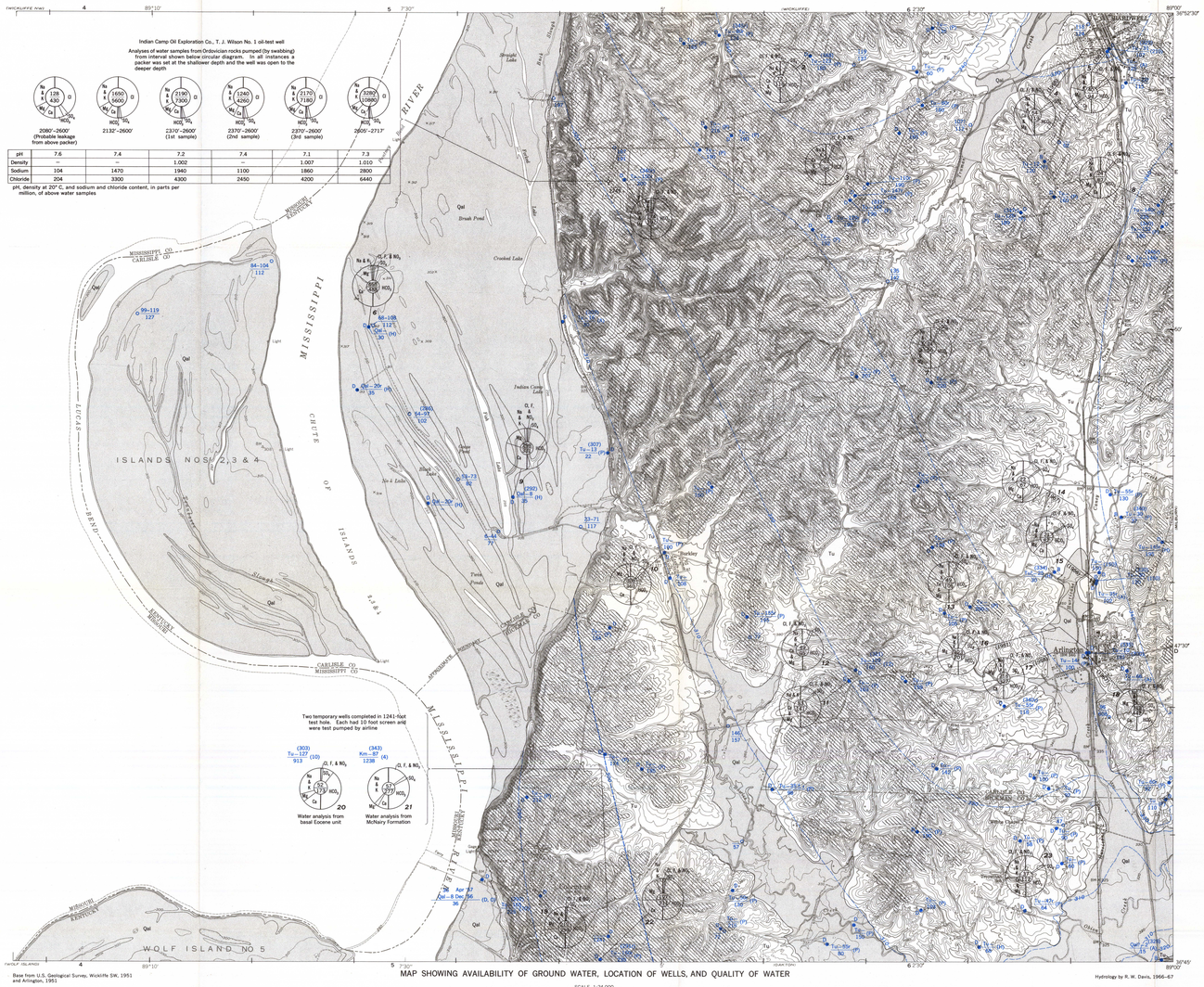
HYDROLOGIC INVESTIGATIONS
ATLAS HA-183

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 that of the Mississippi River	0-60±	Clay or silt near the surface, grading downward into clayey sand or silt with gravel, about 5 to 10 feet thick in large areas; gravel, sand, silt, and clay in small areas; indistinguishable from loess in adjacent uplands and may be continuous.	About 60 feet thick in the valley of Bowles Creek. Estimated to be similar thickness in other parts of area 1.	Water bearing in most of Area 1. Will furnish a sufficient supply for domestic use. Only slightly used because the valleys are mostly unmapped.
			Alluvium, in valley of Mississippi River	0-120	Clay, silt, or sand at the surface, overlying medium- to very coarse-grained sand with gravel beds and much pebble-size gravel intermixed with sand. Rounded fragments of coal and blue-green igneous or metamorphic rocks or minerals common in lower part.	Present in the valley of the Mississippi River. About 120 feet thick near the river; thins toward the edge of the valley. A test hole at Fish Lake penetrated only 6 feet of sand and gravel. In areas where a part of thin sand and gravel may continue parallel with the lake.	Water bearing in Area 1. Slightly used at present. The thick sand and gravel deposits in the Mississippi River valley are large irrigation and other uses. Thickness of sand and gravel is variable and should be tested by drilling to find suitable deposits before planning large withdrawals. Near the edge of the valley and in other places may supply only an adequate domestic supply. Water is hard, contains less than 500 ppm dissolved solids, is very hard, has a pH of 7.2, and the iron content in most of the area is probably more than 0.3 ppm. An iron content of more than 0.3 ppm imparts a disagreeable taste to water and may cause staining of clothes and utensils.
	Pleistocene		Loess	0-25+	Tan to gray unstratified silt or clay.	Covers all upland areas and the gently sloping sides of stream valleys. Well exposed along the bluffs of the Mississippi River.	Not an aquifer. When saturated by rainfall transmits water to lower aquifer.
	Pliocene(?)		Gravel and sand[1]	0-25+	Tan, red, or brown chert gravel, commonly sandy and clayey grading upward into clay or silt. Mississippi River. Best exposures are along the bluffs of the Mississippi River.	Overlies Eocene sediments in most of the quadrangles. Not present in the valley of the Mississippi River. Best exposures are along the bluffs of the Mississippi River.	The water table is below the base of the gravel in the areas where the gravel is present; therefore, the gravel is not an aquifer.
Tertiary	Eocene		Sand and clay	100-300	Clay, silt, very fine- to coarse-grained sand and pebbles. Pebbles consisting of chert, quartz, and quartzite. Lignite outcrops along bluffs of Mississippi River and in areas not covered by loess and may be part of a unit younger than Eocene.	Underlies Pliocene(?) gravel, loess, or Quaternary alluvium in all the area, except in the valley of the Mississippi River where it has been almost completely removed by erosion. Not well exposed. Best exposed in creek beds and some road cuts in the northern part of the map and along the bluffs at Columbus below the State Park.	A good aquifer in Area 2. Yields of 500 gpm may be obtained from this unit in the Columbus area depending on the sand and thickness. At present, the shallow aquifer is the only Eocene unit that is tapped for ground-water supplies in the quadrangle. The water in most of Area 2 is soft, contains less than 0.3 ppm of iron, and is slightly acidic. In the area of Columbus, 10 miles east, east of and parallel with the bluffs of the Mississippi River, the water quality is different. In this zone the water is hard to very hard, contains less than 0.3 ppm of iron, and is slightly alkaline. This quality change may be caused by water from the underlying Paleozoic rocks, by effluent, or from the river, which enters the aquifer and moves eastward during high river stages. The contact between the two types of water appears transitional in a somewhat restricted zone.
			Blue-gray, gray to black, soft to very hard clay.	40-200	Contains scattered beds of fine- to medium-grained sand. Probably lignitic at places.	Underlies Quaternary alluvium in the Mississippi River valley and the shallow Eocene aquifer in the rest of the quadrangles. The contact between the two Eocene units appears to be quite unconformable. Possibly exposed at the base of the bluffs north of Laketon. Encountered in test holes in both quadrangles.	Sand beds within the clay may yield water to wells, but in general the unit is not considered to be an aquifer.
			Sand and clay	70-90±		Underlies Eocene clay in both quadrangles. Not exposed, but penetrated by deep test hole near Arlington and Columbus and by the oil-test well near Laketon.	No wells tap this lower Eocene aquifer in the quadrangles, but based on drilling information it should be an excellent aquifer in both quadrangles. Yields in the magnitude of 1,000 gpm can be expected in all of the area. Based on one analysis, water from the aquifer in Area 1, at Fulton, contains more than 0.3 ppm of iron, and is slightly acidic.
			Clay	30±	Brown to white coarse- to fine-grained sand with thin beds of clay.		
				100-170±	Two lithologies are known in the quadrangle: (1) Gray to black clay, lignitic, and fine-grained sand; grading downward to medium- to very coarse-grained sand. (2) Gray to brown fine- to coarse-grained sand. Where the upper clay is absent the unit may be indistinguishable from the overlying Eocene sand unit.	Underlies Eocene sand in both quadrangles. Not exposed, but penetrated by the deep test hole near Columbus and by the oil-test well near Laketon.	Appears to be hydraulically connected with the overlying sand unit. At the oil-test well near Laketon the basal Eocene unit appears to be all sand and the two units can be considered one water-bearing unit. Water from the test hole near Columbus penetrated 150 feet of clay above a basal 20 feet of sand. Water pumped from this sand by a temporary well was soft, contained more than 0.3 ppm of iron, and was slightly acidic.
Cretaceous	Upper Cretaceous	Matanuska	Porters Creek Clay	170-300	Light- to dark-gray or black, slightly to very micaceous clay with thin beds of fine-grained glauconitic sandstone and beds in the upper part. Black clay and glauconitic sand, glauconitic clay, or possibly glauconitic limestone at the base.	Not exposed, but underlies Eocene sediments in both quadrangles. Penetrated by the deep test hole near Columbus and by the oil-test well near Laketon.	Generally not an aquifer. The clay is the base of the zone of ground-water circulation in the overlying Eocene sediments and confines ground water in the underlying McNairy Formation.
			McNairy Formation[2]	300±	Dark-gray to black clay interlaminated with fine- and some medium-grained sand; mica and lignitic material common.	Not exposed; but underlies the Porters Creek Clay in both quadrangles. Penetrated by the oil-test well near Laketon. The deep test hole near Columbus penetrated about 20 feet of the formation.	The sand in the McNairy Formation probably could yield a large amount of water of fair to good quality. In the "Bootheel" part of southeastern Missouri, numerous towns are supplied by flowing wells that tap the McNairy. In this area of Kentucky, wells tapping the McNairy that are lower than the Eocene aquifer in the Columbus area may be expected to yield a temporary sand by a temporary well at the deep test hole near Columbus was soft, contained more than 0.3 ppm of iron, and was slightly acidic.
			Tuscaloosa Formation	?	Rounded chert gravel in a clay or sand matrix.	Not exposed. Discontinuous farther north and east below the McNairy Formation and above Paleozoic rocks. The basal 5± feet of Cretaceous sediments in the oil-test well near Laketon may be Tuscaloosa sediments.	Water bearing, but generally not an aquifer because of poor sorting and high clay content.
Ordovician			Limestone and sandstone	1500+	The rocks below the Cretaceous are of Paleozoic age and are the "bedrock" of well drillers. The description of the Paleozoic rocks is based on a study of the well cuttings from the T. J. Wilson No. 1 oil-test well near Laketon. Limestone, white to gray, dense to crystalline, contains sand grains below 1,373 feet. Fine-grained well-rounded frosted sand from 1,430 to 1,472 feet, probably the St. Peter Sandstone. Limestone and dolomite from 1,472 to 2,583 feet. From about 2,100 to 2,583 feet much silty and sandy leached limestone and dolomite and brick-red clay which may be leached fault-gouge or material filling caverns of a karst topography of Ordovician age. The interval from 2,500 to 2,583 feet is fine-grained, well-rounded frosted sandy dolomite, probably the same as the St. Peter Sandstone. The Paleozoic formations penetrated by this well are not accurately known.	Not exposed, but underlies sediments of Cretaceous age in both quadrangles. Penetrated only by the oil-test well near Laketon.	Fractures and cavernous zones in the limestone or dolomite or the sand of the St. Peter Sandstone probably could yield a large amount of water of fair to good quality. Flowing wells in Paleozoic formations yield water of fair to good quality. The Paleozoic rocks are hydraulically connected with the McNairy Formation and may contain fresh potable water to 1,300 feet below sea level. The water level of the upper part of the Paleozoic rocks was measured in the T. J. Wilson No. 1 oil-test well near Laketon. The altitude of the water level of the rocks below 2,605 feet depth was about 309 feet. Apparently in this area, and perhaps in the rest of the Jackson Purchase Region where records are absent, the water level is lower with increasing depth in the Paleozoic rocks.

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



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

Hydrology by R. W. Davis, 1966–67

The water-availability areas on this map show the occurrence and availability of ground water in the shallowest aquifer that will yield adequate amounts of water for domestic use in each area. As considered in this report an adequate domestic supply will deliver enough water to meet the needs of a family of five, 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

Area boundary

Oil-test well — *Figure below line is depth of well, in feet below land surface*

Test hole — *Figure below line is depth of test hole; in feet below land surface. Figure above line (where shown) is depth to clay, in feet below land surface. The clay is generally hard. For test holes in the alluvial valley of the Mississippi River, see the following explanation*
- Saturated thickness of alluvial sand and gravel, in feet
- Altitude of water level, in feet above mean sea level
- Depth to base of alluvium (top of Eocene deposits), in feet below land surface
- Depth of test hole, in feet below land surface

Water well
- *D, Drilled or jetted well (includes driven well in Area 1), generally steel or plastic casing with well screen on the lower end*
- *B, Bored or dug well, generally 36-inch concrete tile casing, open at the bottom*
- Aquifer (see below)
- Altitude of water level, in feet above mean sea level; r if reported
- 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
- Tu ..... Sand of Eocene age

YIELD OR ADEQUACY
- (12) ..... Gallons per minute, where known
- (P) ..... Well reported adequate for power pump for domestic and (or) stock supply
- (A) ..... Abandoned
- (D) ..... Destroyed
- (O) ..... Observation well

Water-level contour — *Shows altitude of water level in the saturated zone of the shallow Eocene sand aquifer and in the Quaternary alluvium. Not shown in the Mississippi River valley. Contours drawn from sparse data in upland area and are approximately located. Contour interval 10 feet; datum is mean sea level. Water-level measurements made in fall, 1966*

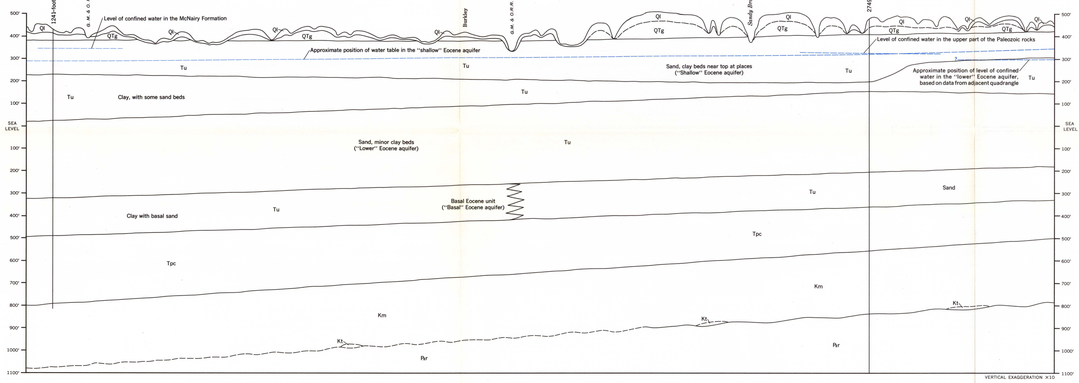
QUALITY
- Na & K, Ca, Mg, Cl, SO_4, HCO_3 — (1967) — 18

Chemical composition of dissolved solids
Figure between circular diagram and well symbol refers to analysis number in table near the end of text. Number in parentheses is year of collection. Diagram is based on chemical analysis. Diagram shows ions at center of circle in carbonate hardness (sodium 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 more than 180 ppm, very hard. Dissolved solids are residue on evaporation at 180° C. Areas of the segments of each circle are proportional to the mineral components in the dissolved solids in the water. Percentages are computed from equivalents per million of the cations and cations. Water from wells sampled contained less than 10 ppm of nitrate. Water from wells sampled contained more 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

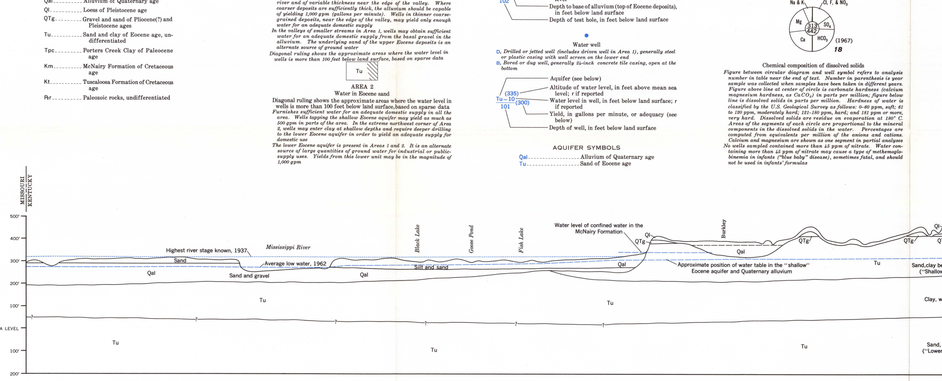
AREA 1
Water in Quaternary alluvium
The alluvium in the valley of the Mississippi River will yield sufficient water for domestic use. The alluvial deposits consist of two lithologies; (1) sand and gravel, generally coarse-grained, and (2) clay, silt, and peat. Test holes along the road from Barkley port Fish and Black Lakes show that the lower, coarser grained deposit is thicker near the river and of variable thickness near the edge of the valley. Where coarser deposits are sufficiently thick, the alluvium should be capable of yielding water to wells in quantities of 100 gpm. In areas where fine-grained deposits, near the edge of the valley, may yield only enough water for an adequate domestic supply.
In the valleys of smaller streams in Area 1, wells may obtain sufficient water for an adequate domestic supply from the basal gravel in the alluvium. The gravel is part of the upper Eocene deposits in an alternate source of ground water.
Diagonal ruling shows the approximate areas where the water level in wells is more than 100 feet below land surface, based on sparse data.

AREA 2
Water in Eocene sand
Diagonal ruling shows the approximate areas where the water level in wells is more than 100 feet below land surface, based on sparse data. Wells tapping the shallow Eocene aquifer may yield as much as 500 gpm in parts of the area. In the extreme northwest corner of Area 2, wells may enter clay at shallow depths and require deeper drilling to the lower Eocene aquifer in order to yield an adequate supply for domestic use.
The lower Eocene aquifer is present in Areas 1 and 2. It is an alternate source of large quantities of ground water for industrial or public-supply uses. Yields from this lower well may be in the magnitude of 1,000 gpm

EXPLANATION
- Qal ..... Alluvium of Quaternary age
- Ql ..... Loess of Pleistocene age
- QTg ..... Gravel and sand 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
- Pzr ..... Paleozoic rocks, undifferentiated



GENERALIZED GEOLOGIC SECTION ALONG AN ALMOST NORTH-SOUTH LINE FROM ABOUT HALF A MILE EAST OF COLUMBUS TO ABOUT 1 MILE EAST OF LAKETON



GENERALIZED GEOLOGIC SECTION ALONG A WEST-NORTHWEST LINE FROM ABOUT HALF A MILE SOUTH OF ARLINGTON, THROUGH BURKLEY, TO TOWHEAD NORTHWEST OF ISLANDS NOS 2, 3 AND 4

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

Sufficient supplies of ground water for domestic, public, and industrial needs are available in the area of the Arlington and Wickliffe SW quadrangles in Kentucky. Sand or gravel deposits capable of yielding large amounts of water underlie the entire area. The communities of Arlington, Bardwell, and Columbus tap a shallow deposit for public-supply use. A deeper deposit, capable of larger yields, is presently untapped. This atlas, one of a series being prepared to describe in as much detail as possible the ground-water conditions in the Jackson Purchase region in western Kentucky, presents information about the ground-water resources near Arlington, Bardwell, and Columbus for use by well drillers, landowners, and other well users.

Drilled wells that tap sand of Eocene age are used almost exclusively east of the bluff line of the Mississippi River. In this area wells as deep as 200 feet are common. Shallow driven or jetted wells tapping the alluvial deposits are used in the sparsely inhabited area on the flood plain of the river. Few bored or dug wells are used although this type of well should be capable of supplying enough water for domestic use, especially in the lowlands where the depth to water is not great.

The water-availability map presents information on the occurrence of the shallowest aquifer that may yield an adequate supply of water for domestic use. The map explanation and the columnar section briefly describe the water-yielding properties of the aquifer. The availability of ground water at a particular location may be determined by the area pattern on the map. Depths of nearby wells are an aid in estimating the depth required to complete a satisfactory well. The approximate depth to water can be calculated by subtracting the altitude of the water level (as shown by the water-level contours) from the altitude of the land surface. Because the water-level contours were compiled from sparse data, the altitude of the water level, where measured or believed to be accurately reported, is shown as part of the well symbol. Water-level contours are not shown in the alluvial valley of the Mississippi River because of the large fluctuations of the water table in this area. Chemical composition of water from wells is represented on the map by circular diagrams.

Three water-bearing units are present at moderate depths in the area. They are (1) the alluvium in the valley of the Mississippi River, (2) the shallow Eocene aquifer in the remainder of the area, and (3) a deeper (lower), presently untapped Eocene aquifer underlying all the area.

In the valley of the Mississippi River the alluvial gravelly sands and gravel beds should yield large amounts of water. This aquifer is potentially important for irrigation uses.

The sand in the shallow, uppermost Eocene unit is presently tapped throughout the eastern part of the area by domestic, municipal, and industrial users. The sand ranges from fine to very coarse grained or gravelly near the Mississippi River. Locally, clay beds are common in the upper part of the unit. The thickness of the clay and the quality and amount of saturated sand determine the amount of water available from this unit at a particular location. The largest yield known from this unit is at Arlington where a city-supply well, 101 feet deep, is reported to have yielded 415 gpm (gallons per minute) during test pumping. Wells tapping this unit at a pottery on the north side of Arlington are reported to yield 150 gpm. At Bardwell, a city-supply well, 107 feet deep, is reported to yield about 210 gpm, and has a specific capacity of about 7 gpm per foot of drawdown. At Columbus a city-supply well, 225 feet deep, yields about 70 gpm from this unit. Similar or greater yields appear possible from this unit throughout the Arlington quadrangle, except in the valley of the Mississippi River where most of the unit has been removed by erosion.

An unused source of ground water underlying both quadrangles is a deeper Eocene sand about 350 feet thick. The top of this unit is as deep as 400 feet in the upland areas, but is shallower in lower areas. This unit contains a potential supply of large amounts of ground water for industrial or public-supply uses. Yields in the magnitude of more than 1,000 gpm can be expected from the unit. Presently it has been penetrated only by an oil-test well near Laketon and deep geologic-test holes near Columbus and Arlington. This deeper Eocene sand is separated from the shallower aquifers by 50 to 200 feet of clay interspersed with thin beds of sands.

A basal Eocene sand, sands in the McNairy Formation, and the upper part of the Paleozoic bedrock formations are other deeper aquifers capable of yielding water of good to fair quality. Because of the abundance of good-quality water in the shallower Eocene sand, these deeper formations may never need to be tapped for a source of ground water in the quadrangles.

The geologic formations ranging from Cretaceous through Eocene age dip southward in this area, except perhaps locally where a buried eroded surface may dip in another direction for a short distance. Because this area is near or at the axis of the Mississippi Embayment, the eastward or westward component of dip may vary across the quadrangles. There is evidence that, along with the general southward dip, the upper Eocene beds dip slightly westward in the eastern part of the quadrangles and dip slightly eastward in the western part. Deeper drilling is necessary to locate accurately the axis of the embayment.

The water table in the upper (shallow) Eocene sand unit slopes approximately southwestward toward the Mississippi River. Minor variations in the slope of the water table are the result of Truman and Hurricane Creeks cutting down to the upper part of the water table and receiving ground-water discharge which sustains their perennial flow. Water levels in this unit probably fluctuate less than two feet annually. There appears to be no long-term trend toward either a lowering or a rising water table.

The water table in the Mississippi River alluvium fluctuates greatly in response to changes of river stage. Fluctuations in an abandoned observation well at Columbus were almost 28 feet. The water level rose from 278 altitude in December 1956, to 306 feet altitude in April 1957, when the river was at flood stage. Water levels in the alluvium probably rise most rapidly near the river and less rapidly farther away. As the river floods and covers almost all of the bottom lands, the alluvium probably becomes completely saturated. The altitude of the river stage during the highest flood crest on record in 1937 was 321.1 feet above sea level as measured on the Columbus gage.

The quality of the ground water is good, commonly less than 200 ppm (parts per million) dissolved solids, but variable in several components. Water from the shallow Eocene aquifer in the east is soft and low in dissolved solids (from about 20 to 150 ppm dissolved solids). Near the Mississippi River the water from this aquifer is very hard to hard, and contains higher dissolved solids (from about 200 to more than 300 ppm). The major change in chemical composition is a rise in pH and an increase in calcium, magnesium, and bicarbonate ions toward the river, as shown on the circular diagrams on the water-availability map. Since the water in the shallow Eocene aquifer near the Mississippi River is similar in composition to water in the alluvium, part of the change in quality probably is caused by a reversal of the direction of movement of ground water. Normally the water moves toward the river, but during high river stages water levels rise near the valley wall and the direction of movement is reversed or greatly modified due to an intrusion of alluvial and river water into the Eocene unit near the edge of the valley. Part of the increase in hardness also may be caused by leaching of carbonates from the loess.

The iron content of water from the shallow Eocene aquifer probably is less than 0.3 ppm. Water from several wells has an iron content greater than 0.3 ppm but this iron probably is contributed from the plumbing system and not from the aquifer. The temperature of the water is about 59°F.

The quality of the shallow Eocene water from the public-supply wells at Arlington has changed since the U.S. Geological Survey first sampled