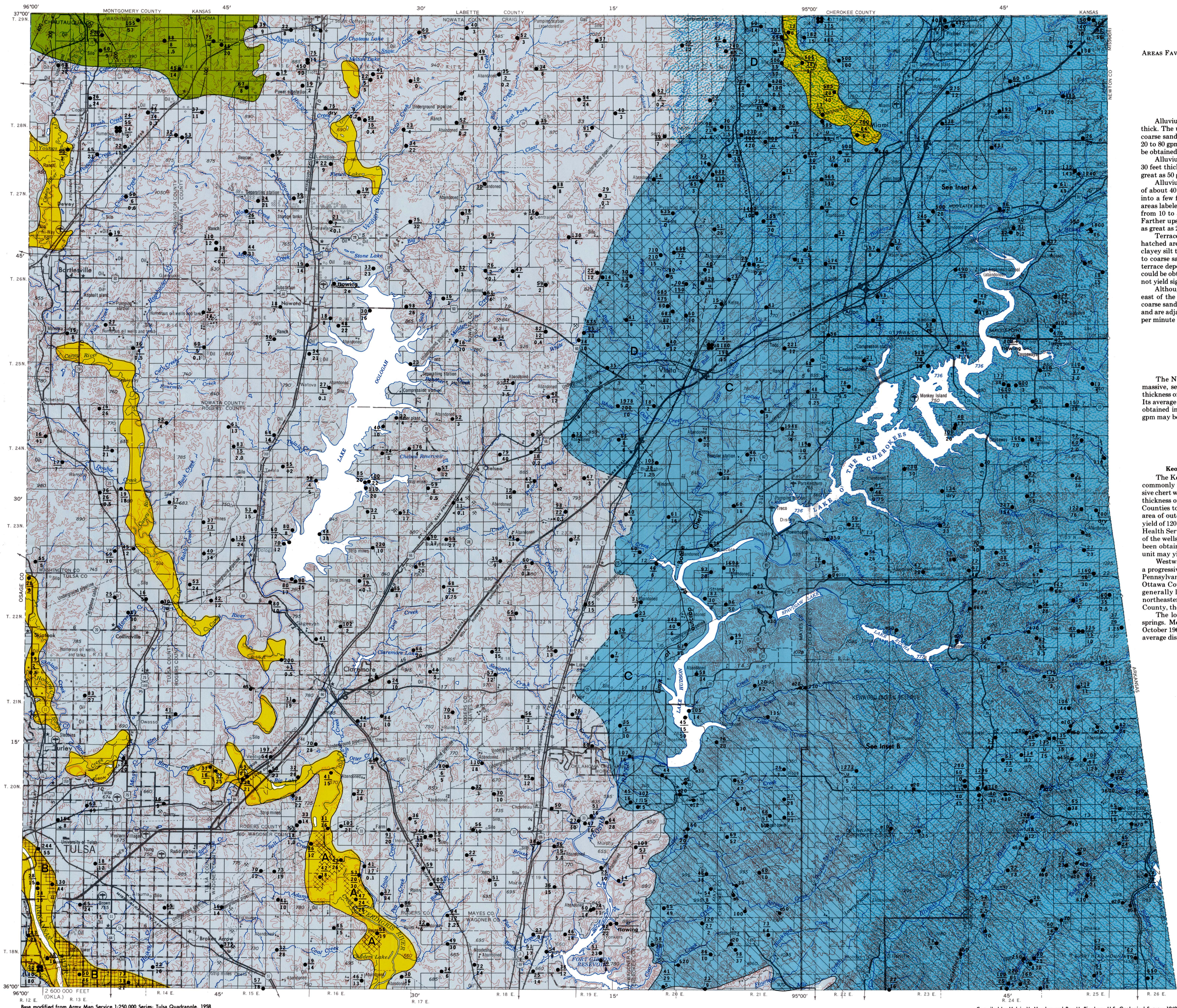


Base modified from Army Map Service 1:250,000 Series: Tulsa Quadrangle, 1958

Compiled by Melvin V. Marcher and Roy H. Bingham, U.S. Geological Survey, 1969

Scale 1:250,000

5 0 5 10 15 20 Statute Miles

5 0 5 10 15 20 25 30 Kilometers

Contour interval: 100 feet
Supplementary contours at 50-foot intervals
Datum: Mean sea level

EXPLANATION

Areas Favorable for Development of Ground-Water Supplies

SHALLOW AQUIFERS

Alluvium and Terrace Deposits

Alluvium along the Arkansas River is known to be at least 30 feet thick. The upper part is silt and fine sand that grades downward into coarse sand and fine gravel in the lower 5 to 10 feet. Wells yield from 20 to 80 gpm (gallons per minute), but yields as much as 125 gpm could be obtained.

Alluvium along the Neosho River in Ottawa County is as much as 30 feet thick with 5 to 15 feet of sand and gravel at the base. Yields as great as 50 gpm are obtainable locally.

Alluvium along the lower Verdigris River has an average thickness of about 40 feet. The upper part is clay and silt that grades downward into a few feet of fine to coarse sand and gravel. In the crosshatched areas labeled A, wells tapping the thicker and coarser beds of sand yield from 10 to 30 gpm, and yields as much as 75 gpm might be obtained. Farther upstream the alluvium is thinner and finer grained, but yields as great as 25 gpm might be obtained locally.

Terrace deposits along the Arkansas River, shown by the cross-hatched areas labeled B, are at least 65 feet thick. The upper part is clayey silt that grades downward into fine sand and then into medium to coarse sand, with fine gravel in the lower 5 to 10 feet. Wells in the terrace deposits yield 20 gpm, but yields as great as 100 gpm probably could be obtained. Elsewhere in the area, terrace deposits probably will not yield significant amounts of water.

Although not shown on the map, alluvium along minor streams east of the Neosho River is as much as 25 feet thick and consists of coarse sand and gravel. Where these deposits are 10 or more feet thick and are adjacent to perennial streams, yields of several hundred gallons per minute probably could be obtained from infiltration galleries.

Noxie Sandstone

The Noxie Sandstone Member of the Chanute Formation is a massive, semifriable, coarse-grained sandstone that has a maximum thickness of about 100 feet in the south-central part of T. 29 N., R. 13 E. Its average thickness is about 50 feet. Yields of 10 gpm probably can be obtained in most of its area of distribution, and yields as great as 50 gpm may be available locally (Oakes, 1940).

Keokuk and Reeds Spring Formations and St. Joe Group

The Keokuk and Reeds Spring Formations and the St. Joe Group, commonly referred to as the "Boone Chert," consist of fractured massive chert with beds of cherty limestone in the lower part. The maximum thickness of the unit ranges from about 250 feet in Adair and Delaware Counties to about 400 feet in Ottawa County. Throughout most of its area of outcrop the unit is a dependable source of water. The average yield of 120 wells, mainly in Delaware County, drilled by the U.S. Public Health Service, was 3.5 gpm, the median yield, 4 gpm. About 10 percent of the wells yield more than 10 gpm, and yields as great as 50 gpm have been obtained. In the vicinity of Miami, Ottawa County, wells in this unit may yield as much as 1,000 gpm.

Westward from its outcrop limit the "Boone Chert" is overlain by a progressively greater thickness of younger rocks of Mississippian and Pennsylvanian age. The area labeled C, extending from northwestern Ottawa County to near Pryor, is underlain by the "Boone" at depths generally less than 200 feet. In the area labeled D, extending from northeastern Craig County southward into northwestern Mayes County, the "Boone" is generally less than 400 feet deep.

The lower part of the "Boone Chert" is the source of numerous springs. Measurements of 25 larger springs made in September and October 1968 show that the discharge ranged from 30 to 3,600 gpm. The average discharge was about 630 gpm, the median, 390 gpm.

Burgen Sandstone

The Burgen is mainly a fine- to medium-grained sandstone, with some beds of shale, limestone, and dolomite. The formation is reported to be 100 feet thick along the Illinois River. Well logs show that the formation is about 25 feet thick in southern Delaware County, although locally it is as much as 80 feet thick. Wells penetrating the Burgen yield as much as 15 gpm; the average yield is about 5 gpm. Yields as great as 25 gpm might be available locally.

DEEP AQUIFERS

(Includes Cotter, Roubidoux, Gasconade, Eminence, and Potosi Formations)

Cotter Formation

In Craig County the Cotter Formation (Lower Ordovician) consists of cherty dolomite and is known to yield up to 60 gpm in T. 26 N., R. 20 E., and up to 30 gpm in T. 29 N., R. 21 E. In both of these areas the top of the Cotter is between 600 and 700 feet below the surface. The formation yields up to 50 gpm locally in Ottawa County; similar yields may be available locally in northern Delaware County.

Roubidoux Formation

The Roubidoux Formation (Lower Ordovician) consists mainly of sandy and cherty dolomite and underlies the eastern part of the Tulsa quadrangle at depths generally between 500 and 1,500 feet. The thickness of the formation ranges from 100 to 200 feet and averages about 150 feet. The formation may be absent locally over peaks of igneous basement rock. In Ottawa County, yields of wells in the Roubidoux range up to 1,000 gpm; the average yield is about 200 gpm. The entire area shown by the pattern on the map seems favorable for development of water supplies from the Roubidoux.

Gasconade Formation

The upper part of the Gasconade Formation (Lower Ordovician) is cherty dolomite, and the lower part, the Gunter Member, is dolomitic sandstone or sandy dolomite. Just east of the map area, in the vicinity of Siloam Springs, Arkansas, the Gasconade yields as much as 400 gpm. In the Tulsa quadrangle the most favorable area for ground water from the Gasconade is in eastern Delaware and southeastern Ottawa Counties. In this area the formation is about 250 feet thick and is generally between 700 and 1,200 feet below the surface. Static water levels in the Gasconade probably are between 100 and 150 feet below the surface; drawdowns in pumped wells probably would be between 100 and 150 feet.

Eminence and Potosi Formations

The undifferentiated Eminence-Potosi Formations (Upper Cambrian) are mainly cherty dolomite that apparently constitute a single hydrologic unit. Just east of the map area, in the vicinity of Southwest City, Missouri, the Eminence-Potosi yields up to 250 gpm. The area with apparent potential for development of this aquifer is in southeastern Ottawa and northeastern Delaware Counties. In this area the Eminence-Potosi is 100 to 400 feet thick and is generally 900 to 1,200 feet below the surface. Static water levels in the Eminence-Potosi probably are between 100 and 150 feet below land surface; drawdowns in pumping wells probably would be 100 to 150 feet.

Area Less Favorable for Development of Ground-Water Supplies

This area is underlain by shale, siltstone, sandstone, and limestone of Pennsylvanian and Mississippian age and local terrace deposits. Most wells yield only a fraction of a gallon to a few gallons per minute. The average yield of wells is estimated at 0.5 gpm. Yields up to 20 gpm have been obtained locally from the thicker sandstone units such as the Warner, Chelsea, and Bluejacket.

Area boundary; dashed where approximately located

Well

Upper number is depth of the well in feet; middle number is depth to water in feet below land surface in 1967 and 1968; lower number is yield of the well in gallons per minute; where only two numbers are shown they are well depth and depth to water; where only one number is shown it is well depth; <0.1 indicates well yield is less than the amount shown; u = unknown.

Well field

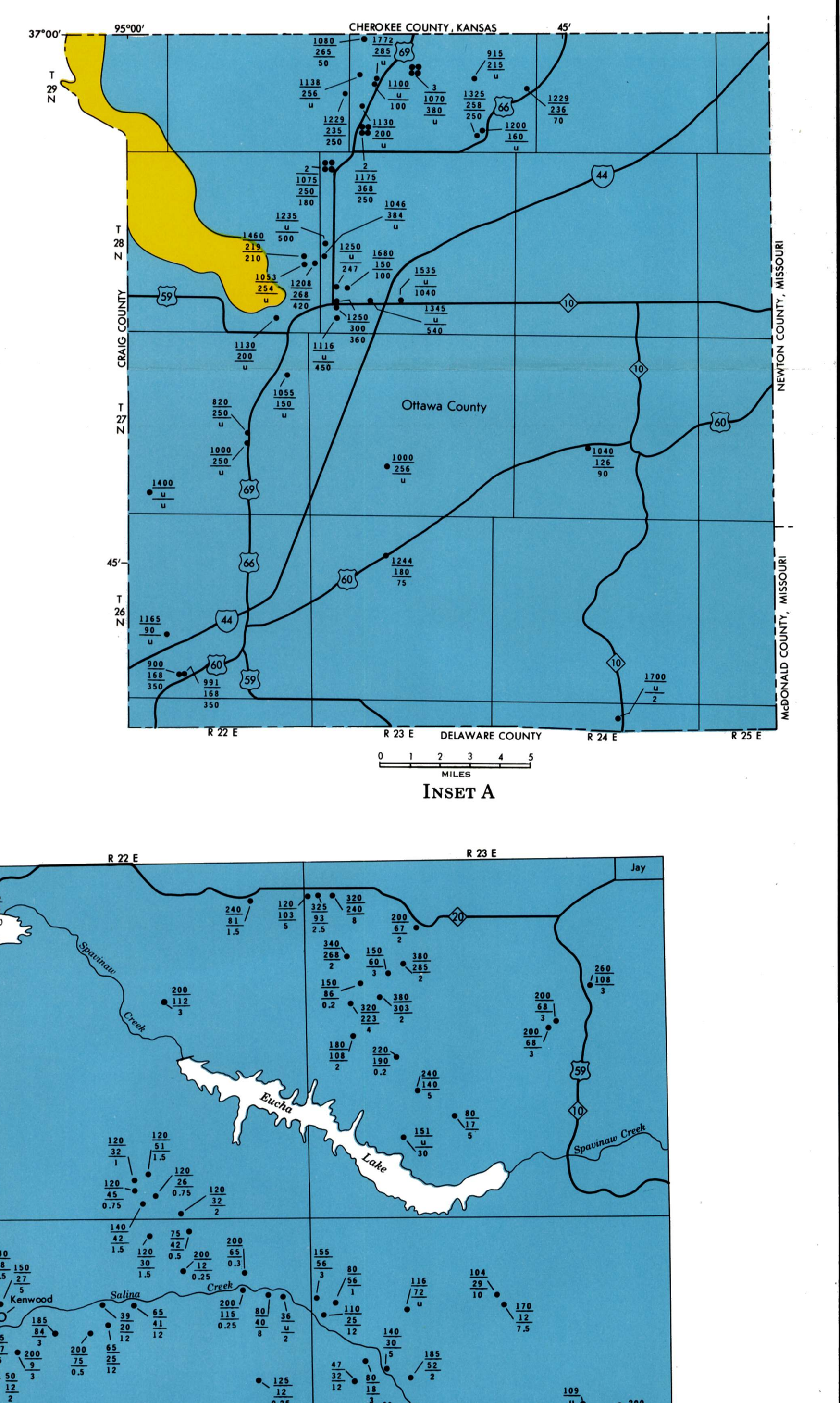
Upper number is number of wells in field; second number is average depth; third number is average water level in feet below land surface; fourth number is average yield per well in gallons per minute; u = unknown.

Spring

Number beside spring symbol is yield in gallons per minute; e = estimated yield. Yield data obtained in 1968.

Line of equal depth to top of Noxie Sandstone

Interval 100 feet



Inset A

AVAILABILITY OF GROUND WATER

In some parts of the Tulsa quadrangle, wells readily yield large amounts of water, whereas, in other parts, supplies of water sufficient for daily household use are difficult to obtain. Differences in well yields are controlled mainly by the type of rock in which a well is completed. Of the various rock formations in the quadrangle, alluvium and terrace deposits along the Arkansas River in Tulsa County, which occupy about 0.5 percent of the total area, are most favorable sources of water. Favorable areas in alluvium along the Verdigris River are of local extent and occupy less than 0.5 percent of the total area. Weathered chert and limestone in the eastern third of the area are moderately favorable for ground-water supplies. Yields of wells in these rocks generally are not large, but the unit is a dependable source of water; an estimated 95 percent of the wells drilled into these rocks yield enough water for household use. These rocks are also the source of numerous springs. Sandstone aquifers of local extent, such as the Noxie, underlie about 1 percent of the area and are moderately favorable for ground-water supplies. The remaining 65 percent of the area is underlain by shale and siltstone, which are least favorable sources of ground water. Although substantiating data are meager, possibly 20 percent of the wells drilled into such rocks will not yield enough water for household use.

Some of the unexposed formations underlying the eastern part of the Tulsa quadrangle are or may be important sources of water. Few wells have been drilled into these formations outside Ottawa County, thus the availability of water from them is based partly on general geologic conditions and partly on comparison with the same formations in nearby southwestern Missouri and northwestern Arkansas, where they are important aquifers. Additional information on the unexposed formations is provided in reports by McCracken (1964), Clark (1964), and Reed and others (1955).

The unexposed formations, in descending stratigraphic sequence, are:

- Lower Ordovician
  - Cotter Formation
  - Jefferson City Formation
  - Roubidoux Formation
  - Gasconade Formation (includes Gunter Sandstone Member at base)
- Upper Cambrian
  - Eminence and Potosi Formations (undifferentiated)
  - Derby-Doe Run, Davis, and Bonneterre Formations (undifferentiated)
  - Lamotte Formation

Upper Cambrian formations below the Gasconade generally are absent in the southern part of Delaware County. In northern Delaware County and in Ottawa County, the Lamotte, Bonneterre, Davis, and Derby-Doe Run Formations are thin and erratically distributed. Few wells have been drilled into these formations; hence, little is known regarding their water-yielding characteristics.

The Roubidoux Formation is the most significant aquifer, in terms of current use, in the Tulsa quadrangle. Water-bearing beds in the Roubidoux apparently are lenticular and occur near the top, middle, and base of the formation, but locally these beds may be poorly developed or absent. The western limit of the Roubidoux as a potential aquifer cannot be precisely defined. However, a few data suggest that the formation becomes less favorable as a source of water west of the pattern shown on the map.

Formations other than the Roubidoux that have apparent potential as sources of ground water in the Tulsa quadrangle are the Eminence-Potosi and the Gunter Member of the Gasconade. In southwestern Missouri and northwestern Arkansas, yields from the Eminence-Potosi range from 50 to 250 gpm (gallons per minute). In the same areas, yields from the Gunter range from 50 to 400 gpm.

Recharge to the deep aquifers is derived from precipitation falling in their area of outcrop in Missouri, 50 to 100 miles east of the Tulsa quadrangle. The amount of recharge and rate of ground-water movement into the area are unknown. Apparently, structural features such as the Seneca fault obstruct the flow of water into the area, thereby increasing drawdowns in pumped wells. The effect of this fault and other faults or other structural features on ground-water movement into the southeastern part of the area is not known.

Selected References

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McCracken, M. H., 1964, The Cambro-Ordovician rocks of northeastern Oklahoma and adjacent areas: Tulsa Geol. Soc. Digest, v. 32, p. 49-75.

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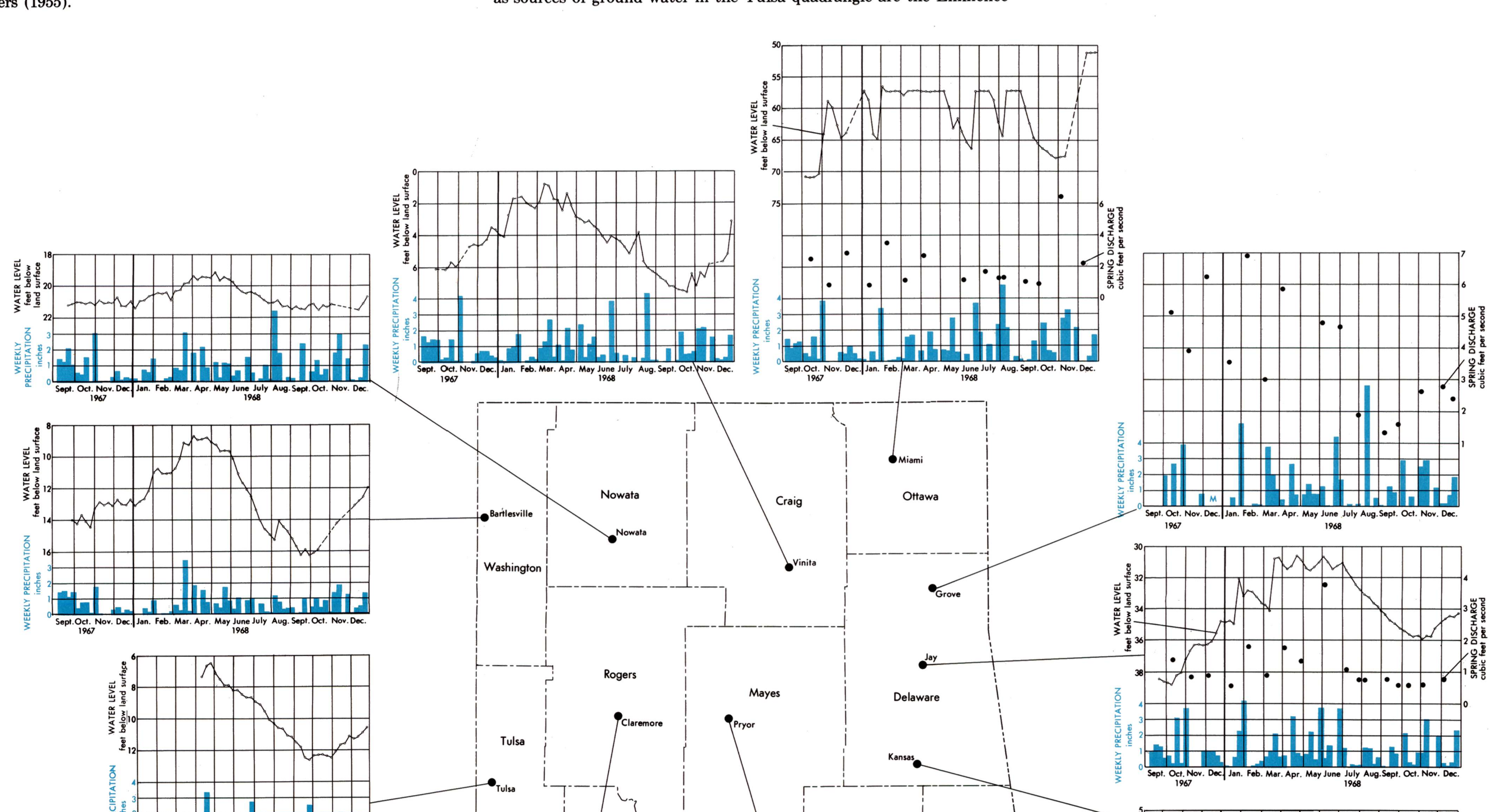
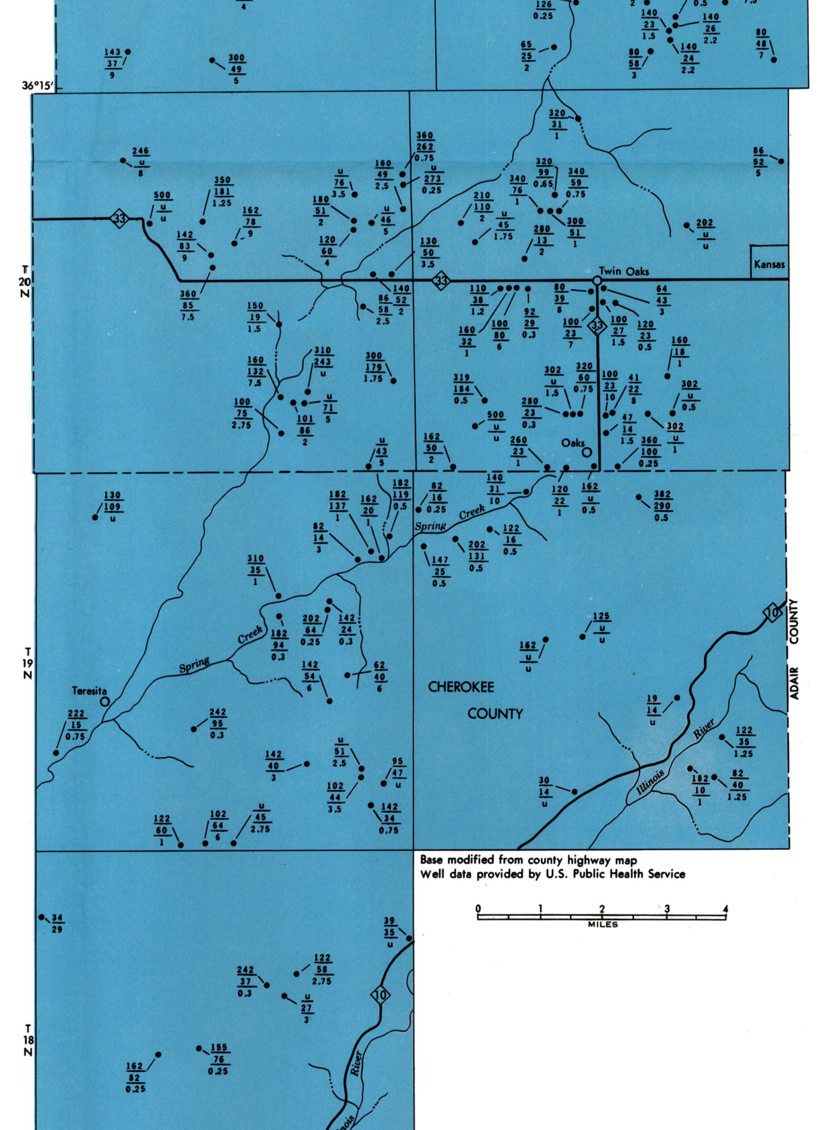
Reed, E. W., Schoff, S. L., and Branson, C. C., 1955, Ground-water resources of Ottawa County, Oklahoma: Oklahoma Geol. Survey Bull. 72, 203 p.



Hydrographs Show Seasonal Changes in Water Levels.— Although most rain falls during the spring and summer months, most ground-water recharge takes place during late winter and early spring when vegetation is dead or dormant and evaporation and transpiration are at a minimum. Thus water levels, as shown by the hydrographs, are highest in early spring and begin to decline in late spring or early summer. Water levels continue to decline during the summer until autumn, when they are at their lowest level. In late autumn they begin to rise as evaporation and transpiration decrease. During the summer months, intermittent rains of an inch or so may produce only a slight, temporary rise in water levels.

During the spring months, water levels in fractured and weathered chert rise rapidly in response to rainfall and decline nearly as rapidly, indicating that the permeability of these rocks is sufficient to permit rapid recharge and lateral movement within the ground-water reservoir. The hydrographs of wells in fractured chert near Kansas, Jay, and Miami show this rapid response. In contrast, the water level in a well in shale and sandstone (hydrograph at Nowata) shows little response to rainfall, an indication that fractures through which recharge can enter near the well are few or restricted or that the source of recharge is at a considerable distance from the well. All the hydrographs illustrate seasonal trends in the water level.

Spring-discharge measurements shown on the graphs were made monthly; thus, short-term effects of precipitation are not evident, and the points showing spring discharge are not necessarily consistent with either precipitation or water-level changes in wells. For example, heavy rainfall at Grove in the middle of August 1968 is not reflected by the spring-discharge measurement that was made about 3 weeks later. A measurement made a few days after this period of heavy rainfall undoubtedly would have shown a temporary increase in discharge, as does the measurement made near July 1. However, the spring-discharge measurements show the general seasonal trend in discharge; that is, the rate of discharge is greatest in late winter and early spring and less in late summer and fall.



Base modified from county highway map
Well data provided by U.S. Public Health Service

Inset B

RECONNAISSANCE OF THE WATER RESOURCES OF THE TULSA QUADRANGLE, NORTHEASTERN OKLAHOMA

Melvin V. Marcher and Roy H. Bingham

1971

Cartographer: Marion E. Clark, Oklahoma Geological Survey