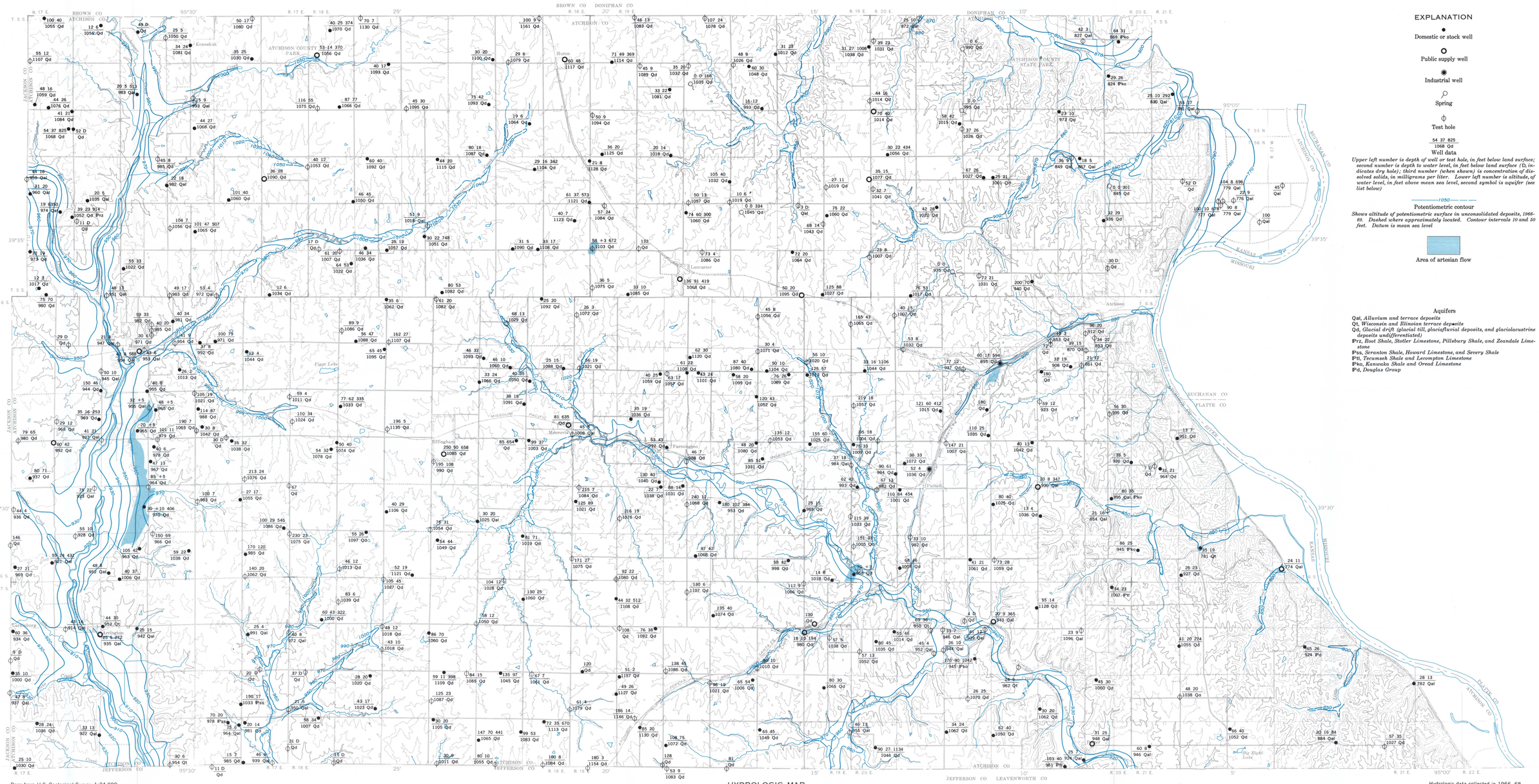
DEPARTMENT OF THE INTERIOR
UNITED STATES GEOLOGICAL SURVEY

PREPARED IN COOPERATION WITH THE
STATE GEOLOGICAL SURVEY OF KANSAS
KANSAS STATE DEPARTMENT OF HEALTH
KANSAS STATE BOARD OF AGRICULTURE

HYDROLOGIC INVESTIGATIONS
ATLAS HA-467 (SHEET 2 OF 2)

HYDROLOGY AND WATER QUALITY



EXPLANATION

- Domestic or stock well
- Public supply well
- Industrial well
- Spring
- Test hole

54 37 825
1068 Qd
Well data

Upper left number is depth of well or test hole, in feet below land surface; second number is depth to water level, in feet below land surface (D, indicates dry hole); third number (when shown) is concentration of dissolved solids, in milligrams per liter. Lower left number is altitude, of water level, in feet above mean sea level, second symbol is aquifer (see list below)

1050
Potentiometric contour

Shows altitude of potentiometric surface in unconsolidated deposits, 1966–69. Dashed where approximately located. Contour intervals 10 and 50 feet. Datum is mean sea level

Area of artesian flow

Aquifers

Qal, *Alluvium and terrace deposits*
Qt, *Wisconsin and Illinoian terrace deposits*
Qd, *Glacial drift (glacial till, glaciofluvial deposits, and glaciolacustrine deposits undifferentiated)*
Prz, *Root Shale, Stotler Limestone, Pillsbury Shale, and Zeandale Limestone*
Pss, *Scranton Shale, Howard Limestone, and Severy Shale*
Pti, *Tecumseh Shale and Lecompton Limestone*
Pko, *Kanwaka Shale and Oread Limestone*
Pd, *Douglas Group*

Base from U.S. Geological Survey, 1:24,000
Denton, Effingham, Everest, Horton, Lancaster, Oak Mills, Weston, and Whiting, 1961; Arrington, Atchison East, Nortonville, and Potter, 1960; Atchison NE, Atchison West, Bendena, and Half Mound, 1959

Hydrologic data collected in 1966–68

HYDROLOGIC MAP

SCALE 1:62 500

1 0 1 2 3 4 MILES
1 .5 0 1 2 3 4 KILOMETERS

CONTOUR INTERVAL 50 FEET
DATUM IS MEAN SEA LEVEL

HYDROLOGY

GENERAL CONDITIONS

The topography of Atchison County is very irregular throughout. The hills and adjacent valleys express considerable relief, and many of the valleys have been cut below the potentiometric surface. Several valleys are cut entirely through the saturated unconsolidated deposits. Both topography and texture of the glacial drift exert a strong influence on recharge to and discharge from the aquifers. Most recharge to aquifers in the county is by infiltration and percolation of precipitation. Some recharge to glacial deposits in buried valleys occurs by upward leakage of water from bedrock formations. Discharge from the aquifers is primarily to streams that drain the county. Some discharge occurs from seeps and springs along valley walls and from wells. A few wells in the county flow continuously.

Potentiometric contours are shown on the hydrologic map only in the principal valleys, where the potentiometric surface is continuous. In the uplands, large areas of unconsolidated glacial deposits contain water, but the potentiometric surface, which appears to follow the topography on a subdued scale, is often discontinuous.

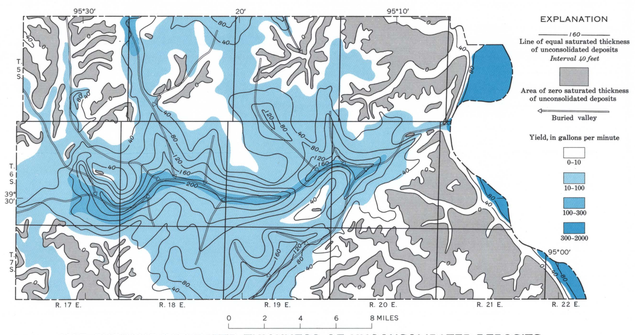
The unconsolidated deposits thin near valley walls, resulting in smaller saturated thicknesses (see map showing saturated thickness). Greatest saturated thicknesses generally are in areas underlain by buried valleys. Locally, however, the valleys are filled by relatively impermeable till, which reduces the hydraulic conductivity. Elsewhere, bedrock highs extend into the till and reduce the saturated thickness to zero in some areas. In most areas where 20 to 30 feet of saturation exists, thin sand or gravel deposits should yield adequate supplies for domestic and stock use.

AQUIFER CHARACTERISTICS

Pennsylvanian rocks are poor aquifers in most of the county. Where a weathered zone occurs near the land surface, well yields may be increased somewhat, but yields generally are restricted by the relative impermeability of the rock units. Therefore, most water must be obtained from wells completed in permeable sandstone or fractured limestone. Yields of only a fraction of a gallon per minute are common. Locally, yields of as much as 10 gpm (gallons per minute) may be obtained from sandstones in the Lawrence Formation, the Stull Shale Member of the Kanwaka Shale, and the Willard Shale. Wells should be constructed in these formations only near the outcrop area, because the water becomes brackish or saline downdip. In relatively impermeable formations, large-diameter wells provide additional storage volume to compensate for the slow flow of water into the well. When small-diameter wells are drilled deep into bedrock for storage volume, the casing should be sealed to prevent mixing in the well of good-quality water from the upper aquifers and impotable water from underlying units. Sealing the casing also will prevent leakage from shallow Pleistocene aquifers into underlying unsaturated bedrock units and a consequent lowering of the potentiometric surface.

The unconsolidated Pleistocene deposits are the best potential sources of ground water in the county. The most favorable areas overlie buried valleys. Although the glacial deposits vary both horizontally and vertically in texture, the coarsest and most permeable deposits are the Nebraskan(?) basal gravel that rests directly on bedrock. The Atchison Formation yields moderate to large supplies of water to wells that have been thoroughly developed so that very fine sand does not clog the slotted pipe or well screens. The sandy glaciofluvial deposits above the Nickerson Till are local in extent but yield moderate to large quantities of water to wells. Sand in these deposits also clogs poorly developed wells. The tills are relatively impermeable and generally yield only small supplies of water to wells. No water is available from till where it thins near present stream valleys or overlies bedrock highs. Local lenses of sand and gravel in the till yield small supplies of water to wells. Because of the isolated nature of these deposits, recharge is not great and prolonged pumping may exhaust the supply. The Nortonville Clay and loess capping the uplands are relatively impermeable and yield no water to wells.

The Illinoian(?) terrace deposits are somewhat sandy and yield small supplies of water. Loesslike deposits high on the valley walls along tributaries of the Missouri River yield no water to wells.



MAP SHOWING SATURATED THICKNESS OF UNCONSOLIDATED DEPOSITS AND GENERALIZED YIELDS, 1966–69

Because the Wisconsin terrace deposits and the alluvium are principally silt and clay throughout most of the county, yields are generally small. However, alluvium along the Missouri River is composed of very permeable sand and gravel from which well yields of 2,000 gpm are possible. An aquifer test made at well 5-21E-29baa (see diagram showing well numbering system and hydrologic map) showed a water-level drawdown of 11.3 feet after pumping 1,305 gpm continuously for 155 minutes. The specific capacity for the test was 115 gpm per foot of drawdown. The hydraulic conductivity was about 2,050 gallons per day per square foot.

ARTESIAN FLOW

Four areas exist where water flows at the surface due to artesian pressure. The largest of these is south of Muscotah on the east side of the Delaware River valley (see geologic sections, sheet 1). The major aquifer is sand and gravel, probably of the Atchison Formation. Relatively impermeable till and alluvium above this unit and relatively impermeable bedrock below act as confining layers. Bedrock rises steeply east of the Delaware River valley along the major buried-valley wall. Recharge in this area results mainly from rainfall, and hydraulic pressure is created as the water percolates downward into the aquifer. Because the overburden has been removed in the river valley, wells penetrating 30 to 40 feet of alluvium on the east side of the valley now have natural flows from the underlying sand deposits. Continued use of the water has reduced natural flows from about 20 gpm in the early 1900's to a maximum of 5 gpm in 1969. Wells in the same area have been pumped at a rate of 100 gpm.

Other areas with artesian flows are near Lancaster, Cummings, and Atchison, where the geologic and hydrologic conditions are similar to those near Muscotah. These other areas are shown on the hydrologic map.

WATER QUALITY

Complete chemical analyses were performed on 39 water samples from domestic, stock, and industrial wells, and on 13 samples from three public-supply wells. A few complete analyses were available for samples collected prior to this study. In addition, 21 partial analyses were made on water from domestic and stock wells. The various wells are completed in bedrock, glacial drift, and alluvial aquifers. A summary of the concentrations of selected dissolved-mineral constituents is shown on the correlation of stratigraphy and water-quality diagram. Most of the water is of the calcium bicarbonate type. Although hard, it generally can be softened by simple treatment. The analyses indicate that water flows from bedrock containing saline water to glacial deposits deep within the buried valleys, although water from the glacial deposits is sufficiently low in chloride content to be suitable for domestic and stock use. Iron often occurs in high concentrations in water from buried valleys. Water in the alluvium is often high in iron content, and concentrations of as much as 24 mg/l (milligrams per liter) were reported in water from alluvium beneath the Missouri River valley.

High nitrate concentrations occur in water from relatively shallow wells in Nickerson Till or younger deposits. Thirteen analyses showed nitrate concentrations greater than 45 mg/l, with the highest being 359 mg/l. In some of the wells the high concentrations of nitrate result from manmade contamination, but in others natural causes should be considered. In areas where the nitrate content of water is known to exceed 45 mg/l, the public should be warned of the potential dangers of using the water for infant feeding (U.S. Public Health Service, 1962).

Dissolved-solids concentrations are generally high, but acceptable (less than 1,000 mg/l). Concentrations greater than 1,000 mg/l were reported for three of the water samples analyzed. The highest concentrations of dissolved solids are in water from thick glacial deposits.

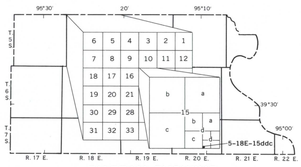
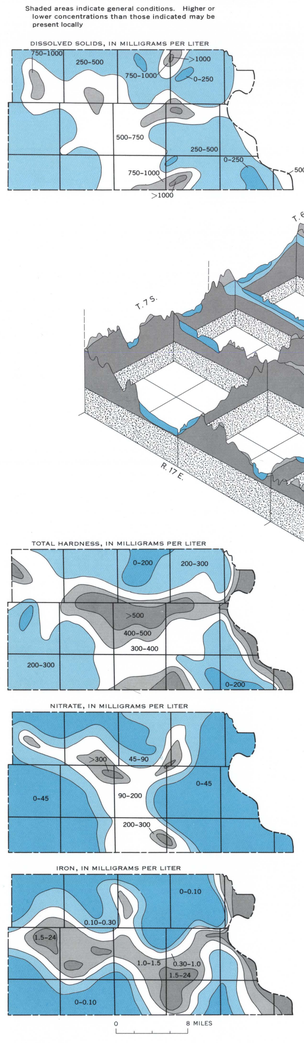
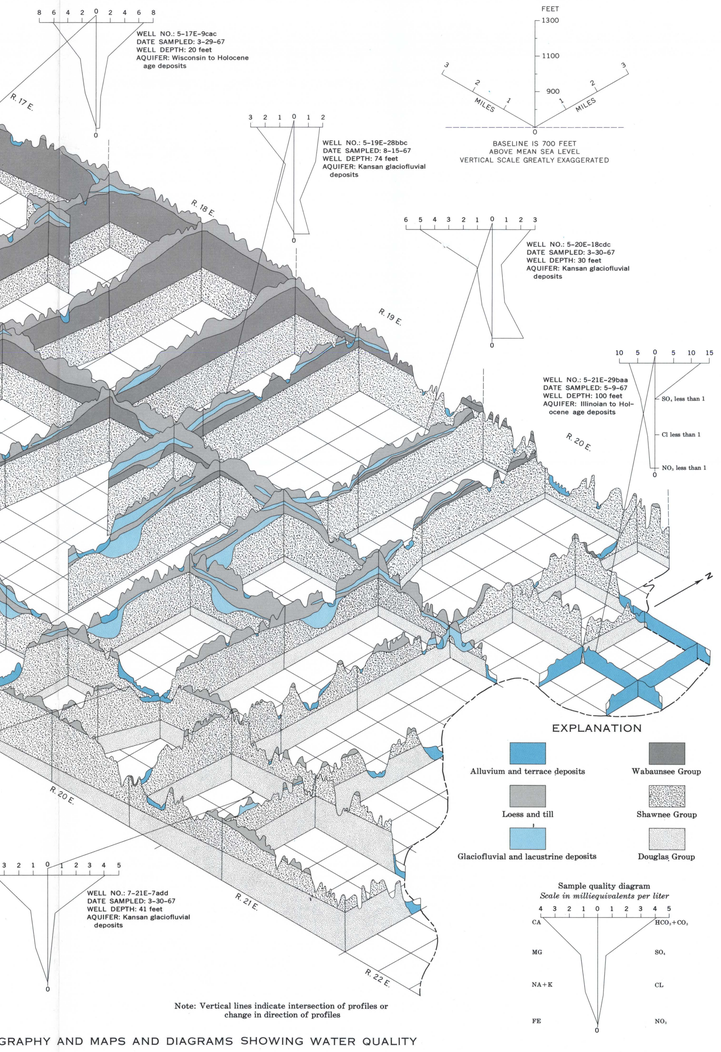


DIAGRAM SHOWING WELL-NUMBERING SYSTEM





FENCE DIAGRAM SHOWING CORRELATION OF STRATIGRAPHY AND MAPS AND DIAGRAMS SHOWING WATER QUALITY

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GEOHYDROLOGY OF ATCHISON COUNTY, NORTHEASTERN KANSAS

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