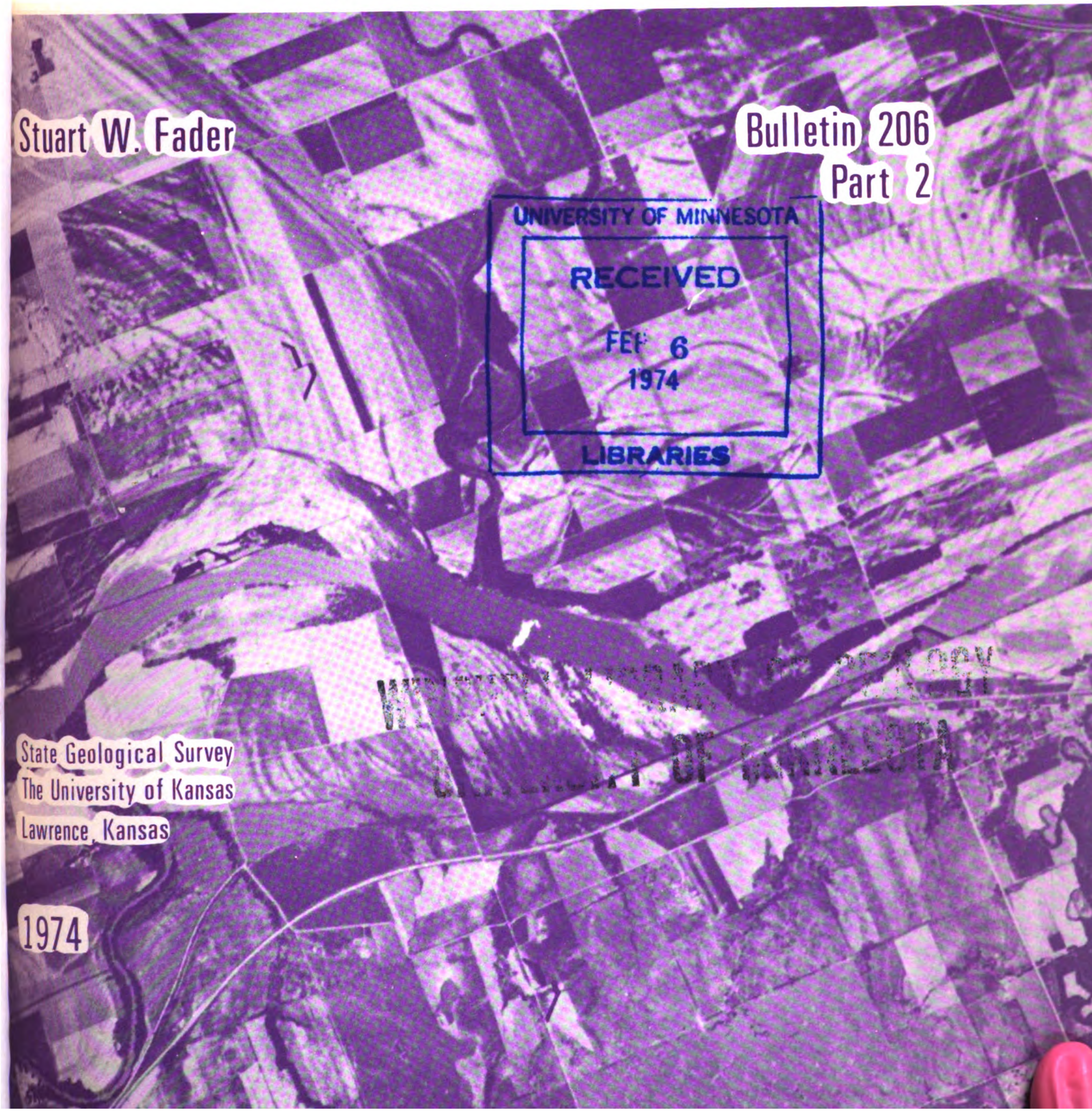
Ground Water In The KANSAS RIVER VALLEY

Junction City To Kansas City, Kansas



Stuart W. Fader

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Ground Water in the Kansas River Valley Junction City to Kansas City, Kansas

By

Stuart W. Fader

Prepared by the State Geological Survey of Kansas and the United States Geological Survey, with the cooperation of the Division of Water Resources of the Kansas State Board of Agriculture and the Division of Environmental Health of the Kansas State Department of Health.

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Ground Water in the Kansas River Valley Junction City to Kansas City, Kansas

ABSTRACT

The combined river and alluvial-aquifer systems are the principal source of water for municipal, industrial, and irrigation supplies along the Kansas River valley in northeast Kansas. This report presents current geologic and hydrologic information on the valley-fill deposits and provides quantitative information on ground-water conditions.

The depth to water in the valley-fill deposits ranges from 0 to 50 feet below land surface and averages about 25 feet. The valley-fill deposits contained about 1 million acre-feet of ground water in storage in 1967. Wells yielding more than 1,000 gallons per minute are common. Transmissivity ranges from 5,300 to 48,000 square feet per day and the long-term storage coefficient was estimated to average 0.15. The chemical quality of the ground water is suitable for most uses; however, the water is generally very hard and may contain as much as 58 milligrams per liter of total iron.

INTRODUCTION

Purpose of Investigation

In the northeastern quarter of Kansas, the principal sources of water for municipal, industrial, and irrigation supplies are the combined river and alluvial-aquifer systems in the Kansas and Missouri River valleys. This report is concerned with ground water in the valley-fill deposits of the Kansas River. Although previous reports describing ground-water conditions are available for most of the area of study, current geologic and hydrologic information, as well as more quantitative information, is needed to enable engineers and administrators to make sound decisions regarding the development and management of the resource. The purpose of this report is to provide this quantitative information. The study is part of a continuing program of ground-water investigations in Kansas begun in 1937 by the State Geological Survey of Kansas and the U.S. Geological Survey, in cooperation with the Division of Water Resources of Kansas State Board of Agriculture and the Division of Environmental Health of the Kansas State Department of Health.

Location and General Features of the Area

The Kansas River valley project (fig. 1) includes parts of the following 10 counties: Douglas, Geary, Jefferson, Johnson, Leavenworth, Pottawatomie, Riley, Shawnee, Wabaunsee, and Wyandotte. The west end of the area studied includes the reaches of the Republican River downstream from U.S. Highway 77 and of the Smoky Hill River downstream from Interstate Highway I-70. The valley averages 2.6 miles wide and extends 138 miles from Junction City to Kansas City, Kans.; about 170 miles of river are included within this area. The surface area of the valley-fill deposits in the study area (pls. 1 and 2) is 360 square miles.

The topographic features pertinent to ground water in the study area are the broad flood plain of the Kansas River, the flat terraces bordering the flood plain, and the bluffs along the edge of the valley. The datum of the stream-gaging station at Fort Riley is 1,034.69 feet above mean sea level, and at Bonner Springs is 741.06 feet. Thus, the slope of the valley is about 2 feet per mile along the 148-mile reach of the river between the gages.

Methods of Investigation

The information presented in this report results from the analysis of geologic and hydrologic data collected during 1966-69, data contained in published

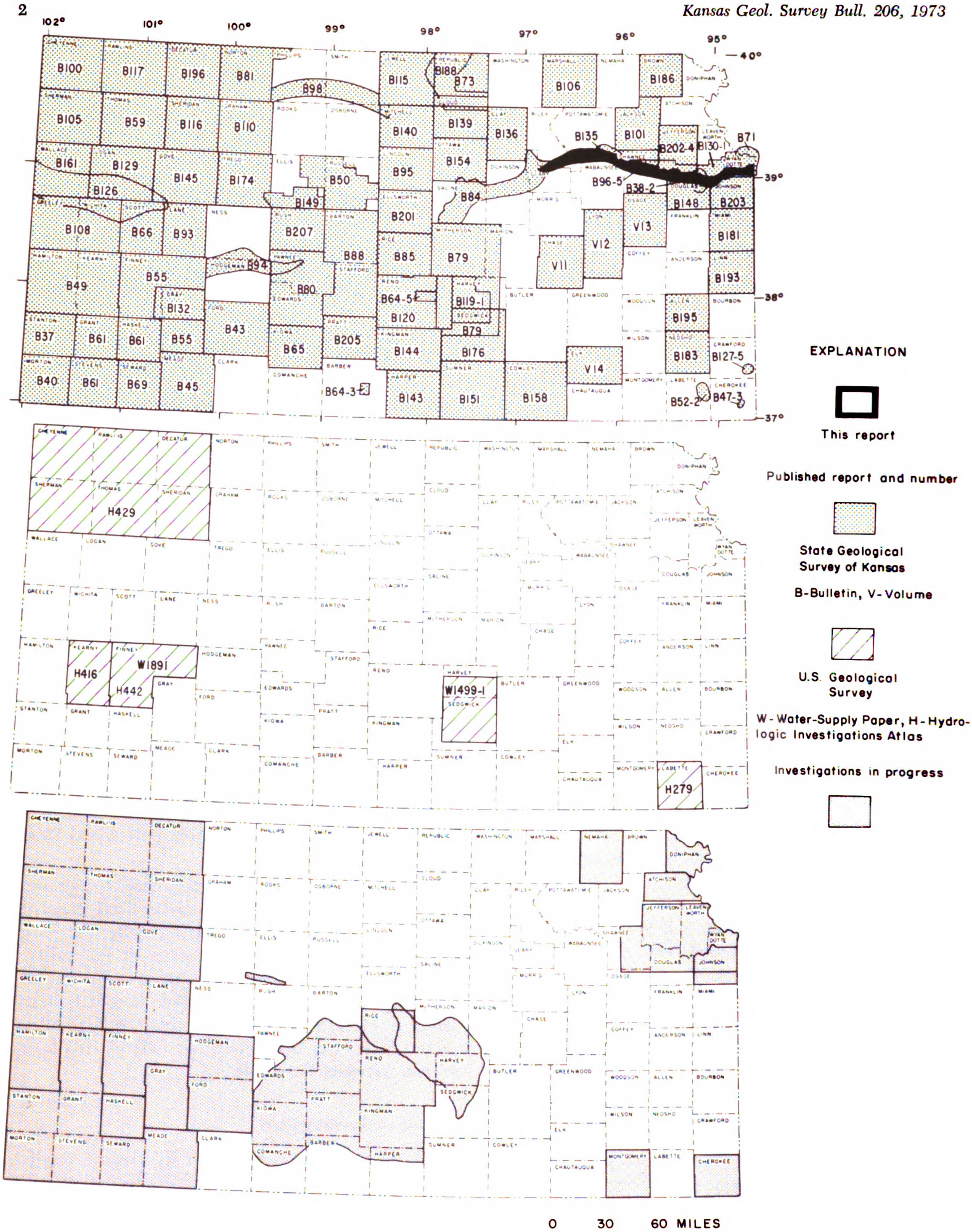

FIGURE 1.—Index maps showing area discussed in this report, and other areas for which ground-water reports have been published or are in preparation.

reports (see selected references), and data in the files of the U.S. Geological Survey and cooperating State agencies.

Information was collected on depth, depth to water, and yield for 1,134 wells and test holes. Well depths and depths to water, together with lithologic logs from 530 wells and test holes, were used to prepare the maps showing saturated thickness of the valley-fill deposits and configuration of the bedrock surface. Data from 55 wells or test holes were used to prepare the geologic sections (pls. 1 and 2).

Transmissivities were computed or estimated from data at 215 well sites. Transmissivity of the valley-fill deposits was computed from aquifer tests at 18 sites and was estimated from specific-capacity tests of wells at 197 sites.

Samples of water have been collected from 359 wells and test holes for complete chemical analysis since 1940. Of these, 126 were collected during this study.

Only a part of the collected data is included in this report as representative data. However, lithologic logs, complete tables of well and test-hole records, transmissivities estimated from specific-capacity tests, chemical analyses of water, and water levels in observation wells are retained in the offices of the State and U.S. Geological Surveys, Lawrence, Kan., and may be examined there.

Well-Numbering System

In this report all wells and test holes are numbered according to the U.S. Bureau of Land Management system of land division. In this numbering system, the first set of digits of a well number indicates the township; the second set, the range; and the third set, the section in which the well is located. Sections are subdivided into quarter section, quarter-quarter section, and quarter-quarter-quarter section. The quadrants are lettered *a*, *b*, *c*, and *d* in a counterclockwise direction beginning in the northeast quadrant. Thus, the first letter denotes the 160-acre tract; the second, the 40-acre tract; and the third, the 10-acre tract. When more than one well is located within the same subdivision, the wells are numbered serially beginning with 2 in the order in which they were inventoried. In Pottawatomie County, for example, well 9-11E-32adb is in the NW¼SE¼NE¼ of sec. 32, T. 9 S., R. 11 E. (fig. 2), and is the first well inventoried in that tract.

For the well-numbering system to apply to wells in the Junction City area, a grid was assumed for the unsurveyed or irregularly shaped sections and townships. The light-weight dashed grid lines in this area are the assumed section lines.

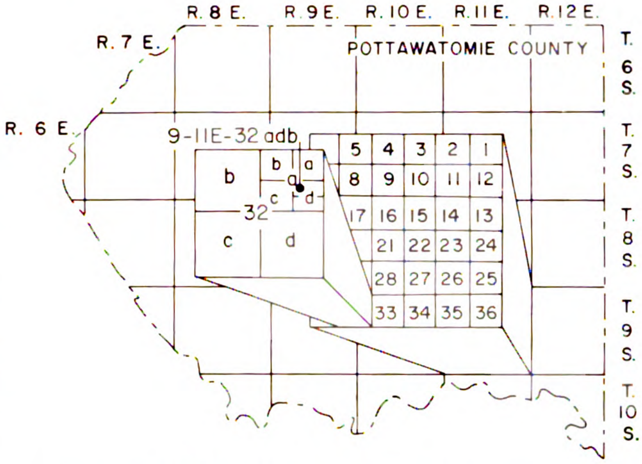

FIGURE 2.—Well-numbering system used in this report.

Precipitation

The normal annual precipitation at selected sites in the Kansas River valley is given in table 1, and the distribution with time of the rainfall at Lawrence and Manhattan is shown on figures 3 and 4. The data were obtained from records of the National Weather Service (formerly U.S. Weather Bureau).

TABLE 1.—Normal annual precipitation in the Kansas River valley.

Weather station	Normal precipitation (inches)
Junction City	33.40
Manhattan No. 2	32.00
Wamego	31.19
Rossville	32.42
Topeka airport	32.36
Lawrence	34.57

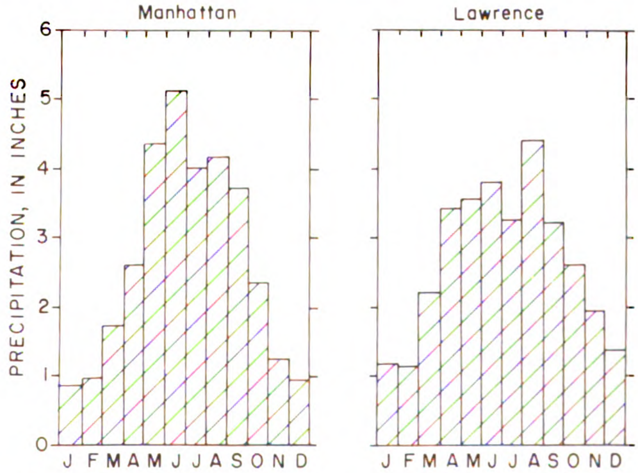

FIGURE 3.—Normal monthly precipitation at Manhattan and Lawrence, 1931-60.

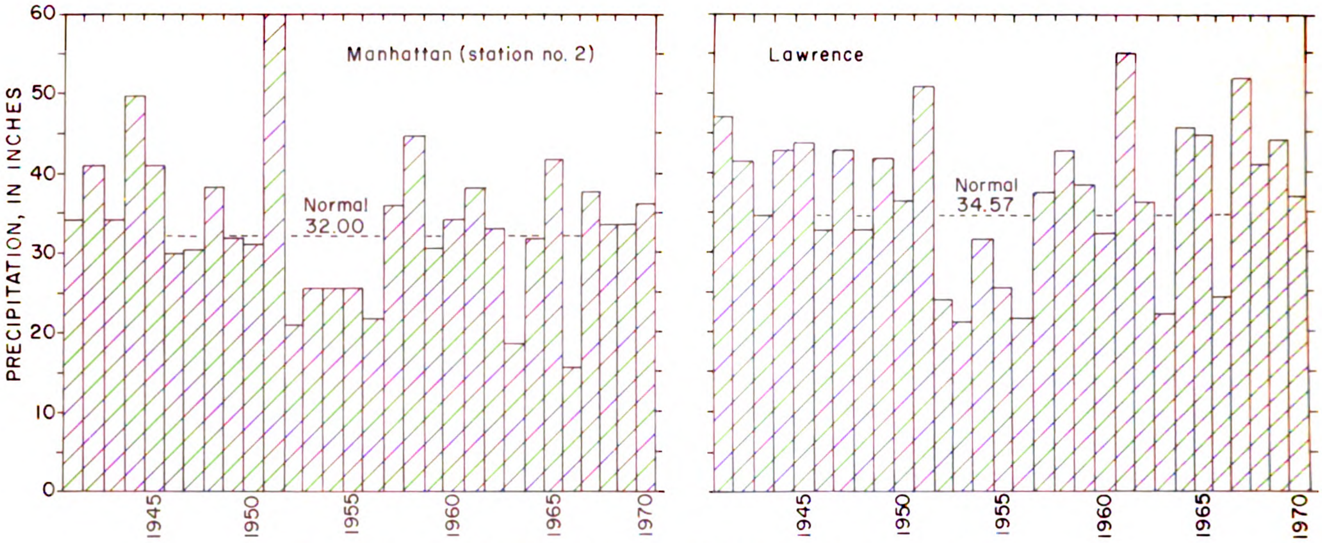

FIGURE 4.—Annual precipitation at Manhattan and Lawrence, 1941-70.

GEOHYDROLOGIC SETTING[1]

This report is concerned chiefly with the geology and the occurrence of ground water in valley-fill deposits (alluvium and terrace deposits) in the Kansas River valley. Except for small amounts of glacial drift of Pleistocene age that underlie the valley near Kansas City and Manhattan, the valley-fill deposits are underlain by rocks ranging in age from Pennsylvanian to Permian. The bedrock formations contribute small amounts of ground water to the valley-fill deposits in the Lawrence and Manhattan areas.

The alluvium adjacent to the Kansas River and the Newman and Buck Creek terrace deposits of Pleistocene age are the major geologic units in the valley. Deposits in buried channels on the bedrock surface, which may be Kansan in age, have not been differentiated from the alluvium and terrace deposits in this report. The important water-bearing materials are the sand and gravel in the alluvium and terrace deposits.

In general, the relative positions of the alluvium and terraces are as follows: alluvium occurs from the river to the first distinguishable escarpment toward the valley wall on either or both sides of the river; Newman terrace from the first escarpment to the next escarpment or change in soil texture toward the valley wall; and Buck Creek terrace adjacent to the valley wall or adjacent to the edge of the mapped area (pls. 1 and 2).

The lithology of the aluvium and the Newman terrace deposits is similar and grades upward from locally derived flat limestone pebbles and boulders on the bedrock surface to brownish-gray arkosic sand and gravel in the lower part to fine sand, silt, and silty clay in the upper part. The Buck Creek terrace deposits grade upward from brownish-yellow sand, sandy silt, and fine gravel in the lower part to reddish-brown and reddish-tan silt in the upper part.

The soils overlying the alluvium generally are tannish-brown sandy silt and silty sand. The soils of the Newman terrace (Davis and Carlson, 1952; O'Connor, 1960) were deposited on a flat surface and generally are poorly drained, silty, clayey, and black. The soils of the Buck Creek terrace are reddish-brown or reddish-tan silt and clay. Meander scars generally are prevalent on the soils overlying the alluvium and absent on the soils overlying the terrace deposits.

Detailed descriptions of the geology pertaining to the occurrence of ground water in the alluvium are given by: Lohman (1941), Fishel (1948), Latta (1949), Davis and Carlson (1952), Fishel, Searcy, and Rainwater (1953), Dufford (1958), Beck (1959), and O'Connor (1960, 1971). The reader is referred to these and other selected references for additional information.

[1] The classification and nomenclature of the geologic units used in this report are those of the State Geological Survey of Kansas and differ somewhat from those of the U.S. Geological Survey.

HYDROLOGY OF AQUIFERS

Water Levels

Water levels in the area are shown by hydrographs for wells (fig. 5), profiles (fig. 6), and contours (pls. 1 and 2). Fluctuations in water levels are generally related to local recharge from precipitation, withdrawals by wells, and stages of the Kansas River. Short-term fluctuations are probably related to local recharge, and long-term fluctuations are more related to the stages of the streams. In general, water levels in wells are higher than the stages of the river at adjacent sites (fig. 6). Where ground water is pumped for irrigation, the water level may be lowered below the stage of the river in localized areas during dry summer months. However, this relationship is temporary, and water levels will quickly return to normal when pumping ceases. Water levels in the valley generally range from 0 to 50 feet below land surface and average about 25 feet.

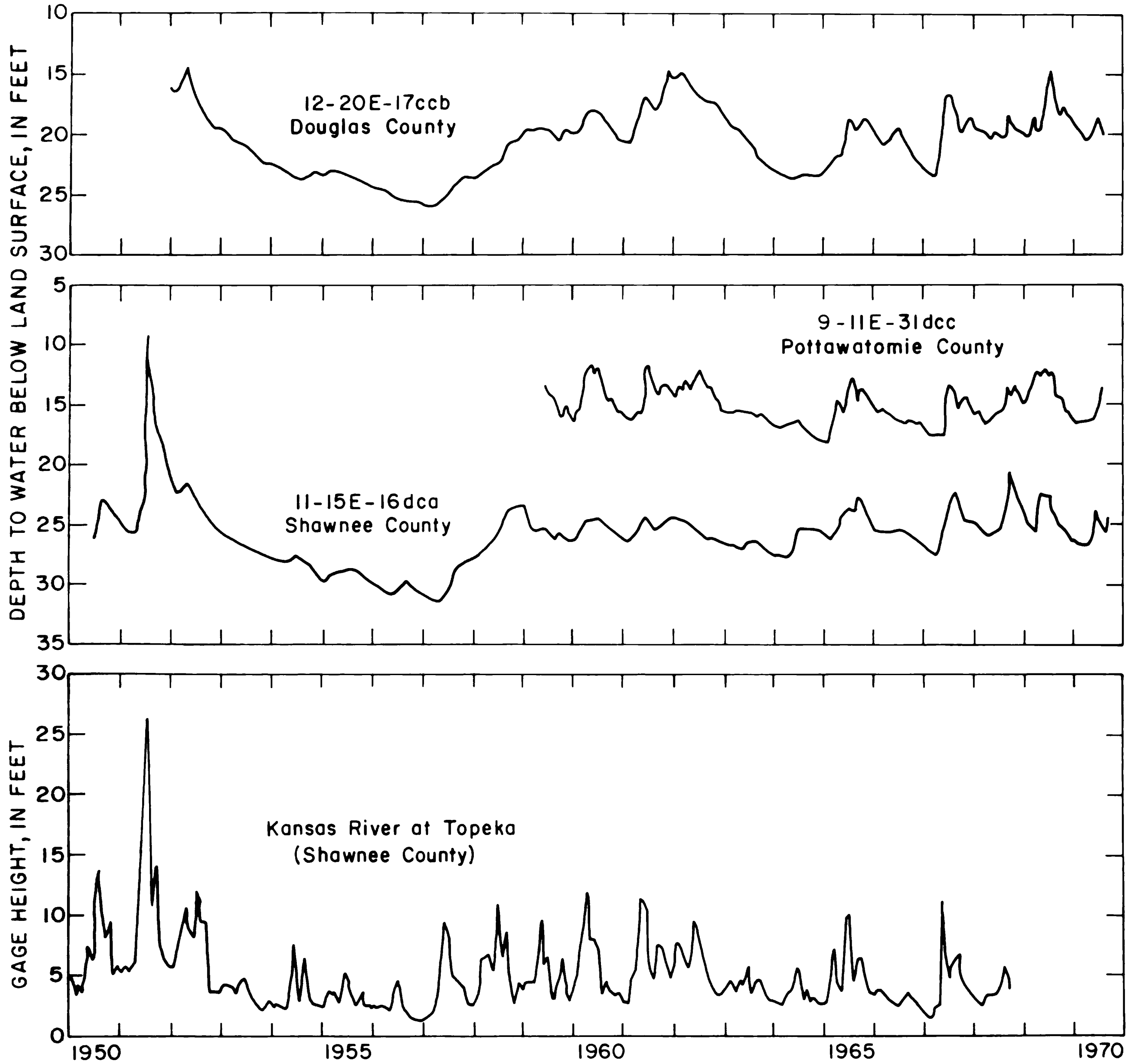

FIGURE 5.—**Hydrographs for selected wells in valley-fill deposits and gage height corresponding to mean-monthly flow of the Kansas River at Topeka.**

Availability of Water

In 1967, about 1 million acre-feet of ground water was in storage in the valley-fill deposits, which have a saturated thickness that ranges from 0 to 90 feet and averages 28 feet. The estimate of storage is based on a storage coefficient of 0.15 and the volume of saturated materials computed from plates 1 and 2.

Ground water for domestic and stock supplies generally is available everywhere in the Kansas River valley. Even where the saturated thickness is less than 20 feet, yields to wells of 500 gpm (gallons per

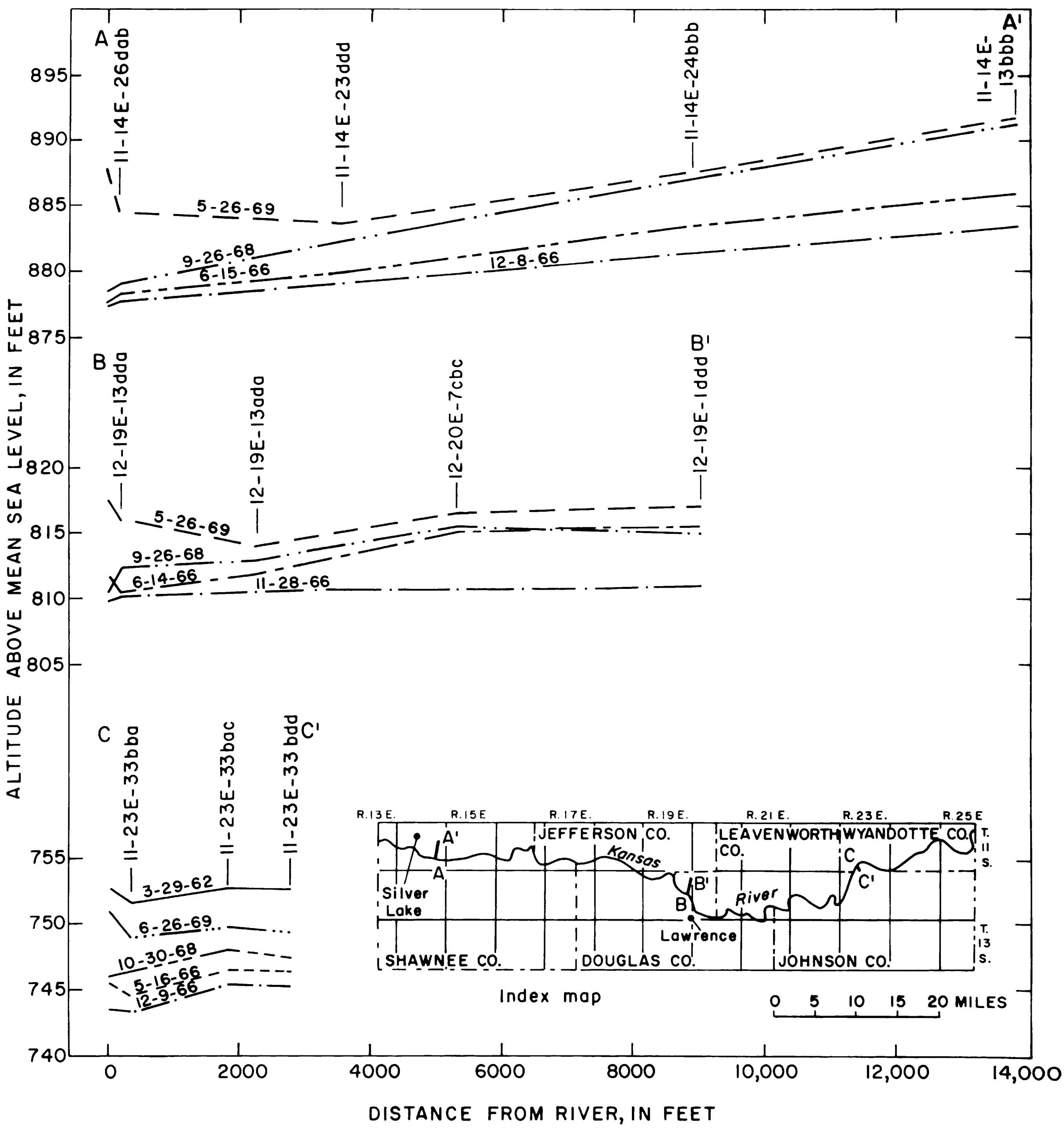

FIGURE 6.—Selected water-level profiles in valley-fill deposits. Altitudes of the river near Silver Lake and Lawrence are extended from the nearest stream-gaging station.

minute) are possible locally. Where the saturated thickness is 20 to 40 feet, yields generally range from 300 to 1,000 gpm. In areas of more than 40 feet of saturated thickness, yields greater than 1,000 gpm are common. However, test drilling to locate the most permeable materials is recommended before a large-capacity well or a well field is installed.

Discharge and Recharge

Discharge from the valley-fill deposits is by seepage to major streams, evapotranspiration, and withdrawals by wells. Seepage to the Kansas River can be estimated if (1) base flow in the river is assumed to be from ground water, and (2) base flow is defined as the 90-percent-duration flow (Q_{90}). From the curves by Furness (1959), Q_{90} is 718 cfs (cubic feet per second) at Wamego and 958 cfs at Bonner Springs. Tributaries contribute another 10 cfs; thus, the ground-water discharge in this reach of stream is about 230 cfs, or 2.2 cfs per mile. Based on this rate, the long-term average seepage to the Kansas River would be about 270,000 acre-feet per year for the study area. In 1956, the fifth year of well-below-normal precipitation, seepage to the river was about 1 cfs per mile in the reach between Wamego and Bonner Springs; in 1970, the fourth year of above-normal precipitation, seepage was about 4.3 cfs per mile. Thus, the ground-water contribution to the river following periods of low to nearly normal precipitation ranges from about 1 to 4 cfs per mile. The discharge by evapotranspiration was not estimated, but it may be about equal to the ground-water discharge to the stream.

Estimates of the withdrawals of ground water from the valley-fill deposits for irrigation, industrial, and municipal uses are given in table 2. These estimates were made from data reported to the Water Resources Division of the Kansas State Board of Agriculture and from additional information collected by the author. The total annual withdrawal ranged from 38,500 acre-feet in 1959 to 64,700 acre-feet in 1966. Based on the estimated annual seepage to the Kansas River of about 270,000 acre-feet per year, the annual withdrawal rate for 1966 could be increased about 4 times without adversely depleting the ground water in storage. However, local lowering of the water table would occur, seepage to the river would be reduced, and the present evapotranspiration rate would be reduced.

Recharge to the valley-fill deposits is by direct infiltration of precipitation on the valley, by seepage from streams and ponds, by return flow from irrigation, and by seepage from the shale, sandstone, and limestone that border and underlie the valley. The amount contributed from each of the above sources is not known, but the recharge over a long period of time is assumed to equal the discharge as the hydrologic system in the past has been in approximate equilibrium.

Aquifer Characteristics

The quantity of water that an aquifer will yield to wells depends on the hydrologic properties of the aquifer material. The ability of an aquifer to transmit water is measured by the transmissivity (T), which is the rate at which water of the prevailing kinematic viscosity is transmitted through a unit width of saturated aquifer under a unit hydraulic gradient. The units for transmissivity are cubic feet per day per foot, which reduces to square feet (sq. ft.) per day. The term "transmissivity" replaces the term "coefficient of transmissibility," which was formerly used by the U.S. Geological Survey and which was reported in the inconsistent units of gallons per day per foot. To convert a value for coefficient of transmissibility to the equivalent value of transmissivity, multiply by 0.134; to convert from transmissivity to coefficient of transmissibility, multiply by 7.48.

TABLE 2.—Withdrawals of ground water by wells.

County	Withdrawal, in acre-feet, for indicated year								
	1959	1960	1961	1962	1963	1964	1965	1966	1967
Douglas	4,900	5,000	5,100	5,100	4,300	6,100	5,100	5,000	5,000
Geary	4,500	4,700	4,300	4,600	4,900	4,700	4,000	5,200	3,900
Jefferson	1,100	1,200	700	900	1,200	1,300	600	1,400	700
Johnson	800	1,000	800	800	1,000	1,900	1,100	1,300	1,800
Leavenworth	0	0	0	100	100	100	400	500	1,100
Pottawatomie	5,000	5,600	5,700	6,500	8,300	8,900	7,000	11,100	7,800
Riley	1,500	2,300	2,200	2,200	3,100	3,600	2,000	3,300	2,100
Shawnee	9,300	11,000	9,400	11,300	12,700	12,600	10,200	16,000	10,800
Wabaunsee	500	600	300	800	1,300	1,100	800	1,300	500
Wyandotte	10,900	10,700	13,900	19,400	21,200	21,400	21,700	19,600	20,500
Total	38,500	42,100	42,400	51,700	58,100	61,700	52,900	64,700	54,200

The storage coefficient (S) of an aquifer is defined as the volume of water it releases or takes into storage per unit surface area per unit change in the component of head normal to that surface. The storage coefficient for unconfined-aquifer conditions is practically equal to the specific yield, which is defined as the ratio of the volume of water that a saturated material will yield by gravity to its own volume.

Aquifer Tests

The results of 18 aquifer tests that were analyzed using standard formulas outlined by Wenzel (1942), Bentall (1963), and Ferris and others (1962) are given in table 3. Transmissivities from these tests range from 5,300 to 48,000 sq. ft. per day; transmissivities estimated from specific-capacity tests of wells are as large as 59,000 sq. ft. per day. The storage coefficients determined by the tests range from 0.0005 to 0.20. Coefficients in the low end of the range are from short-duration tests. If all tests had been conducted for several days, the resulting storage coefficients probably would range from 0.05 to 0.20 and average about 0.15.

A plot of transmissivity and saturated thickness at the aquifer-test sites is shown on figure 7. A least-squares fit of the data gives a line with an intercept of -3,280 sq. ft. per day and a standard error of estimate of 8,960 sq. ft. per day (about 35 percent at the average transmissivity of 25,800 sq. ft. per day). For the range of data shown, figure 7 can be used to approximate the transmissivity at any given site where the saturated thickness is known. For example, the altitude of the water table at the SW cor. sec. 25, T. 10 S., R. 12 E., is 914 feet (pl. 1) and the altitude of the bedrock surface is 873 feet. The difference in water-table and bedrock altitudes, 41 feet, is the saturated thickness. From figure 7, the transmissivity at the site is estimated to be about 28,000 sq. ft. per day.

CHEMICAL QUALITY OF WATER

Water in the valley-fill deposits is generally very hard; it contains total iron in concentrations that range from 0.00 to 58 mg/l (milligrams per liter). The water is usable for most industrial, municipal, irrigation, stock, and domestic purposes, except in the area of and downstream from the East Kansas Avenue

TABLE 3.—Results of aquifer tests in valley-fill deposits.

Well number	Date of test	Duration of test (min.)	Average well yield (gpm)	Transmissivity (sq. ft. per day)	Storage coefficient	Remarks
			Douglas County			
12-19E- 1dbc	Nov. 1955	145	780	47,200	0.0005	Observation well at 400 feet
12-20E-29aca	June 1955	30	200	5,300	.006	Observation well at 26 feet
35ccc3	Jan. 1968	7,000	1,000	19,600	.043	Observation wells at 48 and 103 feet
13-20E- 2bcb	Aug. 1963	780	1,090	17,400	.003	Observation wells at 40 and 80 feet
			Johnson County			
12-22E-24ccc2	June 1964	1,100	1,000	18,700		Observation wells at 25, 75, 250, and 500 feet
25bbc	June 1964	1,460	1,080	24,000	.05	Observation wells at 25, 75, 250, and 250 feet
			Pottawatomie County			
10- 8E- 8cac2	Aug. 1952	183	1,330	36,000	.20	Observation wells at 131, 218, 384, and 588 feet
8daa2	Jan. 1969	5,760	2,520	47,000	.13	Observation wells at 50, 50, 100, 100, 100, 200, 200, 500, 500, and 1,000 feet
10- 9E-13dcb	Aug. 1967	52	615	38,100	......	
			Riley County			
10- 8E- 4dbb	July 1965	......	......	17,300	......	Two observation wells (Henry Beck, oral commun., 1966)
			Shawnee County			
10-13E-30baa	Aug. 1953	......	......	16,000	......	
11-13E- 3dbd	July 1956	780	850	24,300	.02	Observation wells at 60 and 90 feet
11-15E- 7cdc	July 1966	620	700	14,700	.02	Observation wells at 19 and 100 feet
13dac	Jan. 1958	1,440	225	48,000	.09	Observation wells at 110 and 270 feet
			Wyandotte County			
11-24E-21ddd	Mar. 1960	4,320	525	22,100	.12	Observation wells at 50, 150, 300, 400, and 400 feet
29cdc	Dec. 1959	4,320	610	18,600	.18	Observation wells at 50, 150, 300, 300, 395, 445, and 500 feet
31dab	Jan. 1960	4,320	560	18,200	.11	Observation wells at 45, 144, 198, 300, 382, 422, and 500 feet
32aba	Feb. 1959	4,320	740	32,000	.18	Observation wells at 50, 100, 125, 276, 300, 300, 487, and 550 feet

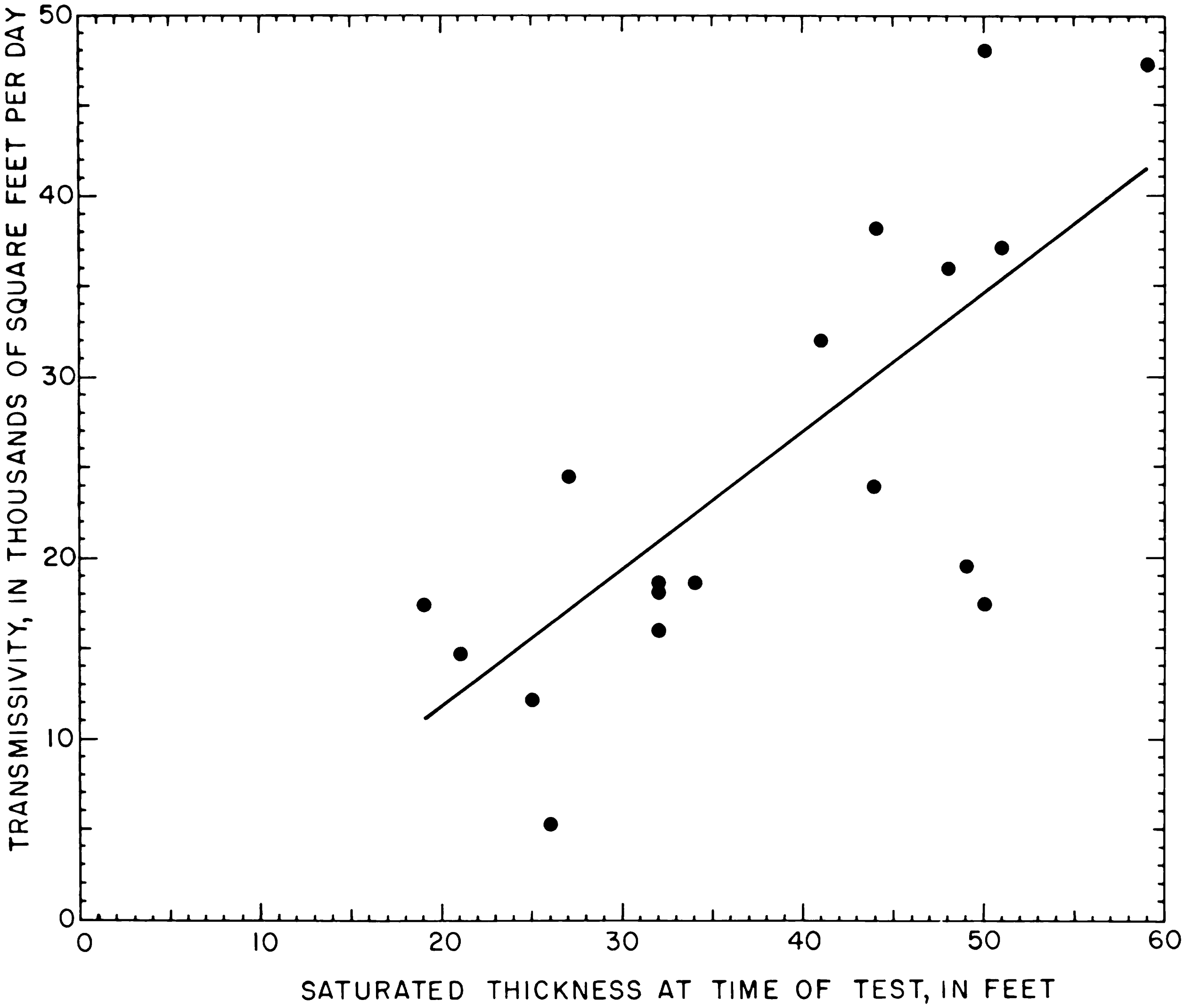

FIGURE 7.—Relation of transmissivity to saturated thickness.

Bridge (23rd Street) in Kansas City, Wyandotte County, where the water contains a concentration of chloride as great as 4,000 mg/l. Maximum and minimum concentrations of selected constituents for all samples of water collected from the valley-fill deposits since 1940 are given (by county) in table 4.

Water samples for chemical analysis have been collected from 359 wells and test holes in the study area since 1940. Selected analyses are given in table 5.

TABLE 4.—Maximum and minimum concentrations, in milligrams, per liter, of selected chemical constituents by county for all samples of water collected from valley-fill deposits since 1940.

County	Dissolved solids			Calcium and magnesium hardness			Chloride			Total iron		
	Max.	Min.	Avg.	Max.	Min.	Avg.	Max.	Min.	Avg.	Max.	Min.	Avg.
Douglas	990	318	551	740	220	460	150	1.5	29	49	0.00	4.4
Geary	709	324	470	470	170	340	84	3.0	28	2.9	.00	.40
Jefferson	576	230	385	470	190	310	30	5.0	14	21	.00	4.8
Johnson	553	365	463	450	260	410	66	7.0	17	25	.00	7.2
Leavenworth	549	155	450	480	280	370	74	6.0	21	18	.00	6.0
Pottawatomie	790	307	483	590	160	360	160	8.0	47	23	.00	4.1
Riley	704	360	515	630	200	410	110	6.0	33	38	.00	3.6
Shawnee	1,070	353	457	660	170	370	110	5.0	26	11	.00	5.9
Wabaunsee	599	354	485	500	270	360	86	10	29	12	.00	2.9
Wyandotte	7,270	353	1,050	1,500	210	560	4,000	7.0	250	58	.00	12

TABLE 5.—Chemical analysis of water from selected wells.
[Analyses given in milligrams per liter, except as indicated. Analyses by Kansas State Department of Health.]

Well number	Depth (feet)	Geologic source[1]	Date of collection	Temperature (°C)	Dissolved solids (evaporated at 180° C)	Silica (SiO_2)	Total iron (Fe)	Total manganese (Mn)	Calcium (Ca)	Magnesium (Mg)	Sodium and potassium (Na+K)	Bicarbonate (HCO_3)	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Nitrate[2] (NO_3)	Hardness[3] as $CaCO_3$: Calcium, magnesium	Hardness[3] as $CaCO_3$: Noncarbonate	Specific conductance (micromhos at 25°C)	pH
									Douglas County											
12-19E-13dda	52	Qal	5-23-66	14.5	416	30	14	1.6	110	19	34	420	12	34	0.2	3.5	340	1	730	8.0
12-20E- 8bcb	82	Qn	4-25-66	14.0	340	24	2.6	.61	93	13	14	332	26	5.0	.1	1.3	290	14	550	7.4
29aad	56	Qal	11-15-66	14.5	360	31	5.9	.27	100	9.7	16	322	25	18	.3	.4	290	28	560	7.4
									Geary County											
11- 6E-30caa	70	Qal	1- 9-68	12.0	383	26	.22	......	70	......	....	277	60	23	.5	.6	240	13	620	7.6
12- 5E- 1bba	67	Qal	4- 1-60	24.0	452	27	.16	.2	90	17	37	285	35	29	....	27	290	190	450	7.7
									Jefferson County											
11-17E-20cac	70	Qn	4- 8-66	14.0	576	26	2.3	.87	150	20	22	376	140	30	.2	.9	470	160	880	7.6
11-18E-26ccd	57	Qal	5-26-66	14.5	389	32	8.0	1.0	110	15	11	376	28	6.0	.2	2.7	330	26	600	7.9
11-19E-27bcc	33	Qb	12- 2-50	14.0	230	12	.35	......	61	5.4	11	181	12	9.0	.1	30	170	26	......	....
									Johnson County											
11-23E-33acc	51	Qal	7- 1-44	15.0	365	...	10	......	100	14	6.7	265	82	16	.1	1.3	310	94	......	...
12-22E-29bbd	46	Qal	5-11-67	14.5	480	26	12	.61	140	11	16	407	70	11	.2	4.2	400	63	730	7.6
									Leavenworth County											
12-22E-20cad	48	Qal	5-16-67	14.5	460	23	3.9	.20	140	11	9.6	420	56	8.0	.2	1.3	400	60	730	7.6
28aaa	62	Qal	5-15-67	15.0	461	24	11	.41	130	9.1	26	356	59	39	.2	1.5	350	60	730	7.8
									Pottawatomie County											
9-11E-30bbd	90	Qn	5- 5-66	14.0	612	28	8.7	.58	140	25	50	568	74	13	.1	1.8	460	0	910	7.4
10- 8E-13aad	50	Qn	8-19-67	15.0	471	27	4.5	.62	120	19	33	425	34	31	.1	1.3	370	22	770	7.5
14cba	69	Qn	3-29-67	18.5	536	16	4.3	.86	110	19	63	285	89	100	.1	1.5	340	110	900	7.5
10- 9E-14dcb	65	Qn	6-23-66	.....	376	63	.03	.31	110	12	16	339	41	10	.2	1.3	310	36	600	7.6
									Riley County											
9- 8E-30dac	79	Qn	3-30-67	15.0	469	19	2.7	1.6	120	21	19	425	54	19	.2	1.5	400	50	770	7.5
10- 7E-35aad	46	Qal	7- 5-66	16.5	618	26	4.3	2.0	110	16	99	383	84	97	.3	1.5	330	16	1,010	7.8
									Shawnee County											
11-14E- 9cad	47	Qn	9- 7-67	.....	384	30	.01	.00	100	8.8	20	307	40	13	.1	20	290	36	590	7.5
11-15E-13cbc	77	Qn	4- 8-66	14.0	480	26	3.8	.57	130	17	23	368	80	26	.2	.9	280	82	740	7.6
24bdd	53	Qal	4- 8-66	14.5	684	23	1.1	.66	180	20	29	420	190	28	.2	6.2	530	180	1,020	7.4
									Wabaunsee County											
10-10E-16abb	43	Qal	3-24-67	15.0	354	23	3.5	1.2	93	16	15	312	30	22	.2	.4	300	42	580	7.5
									Wyandotte County											
11-24E-13bad	75	Qal	7-29-68	15.5	710	25	21	2.8	180	18	26	393	180	55	.2	1.1	530	210	1,050	7.6
22caa	64	Qal	4- 4-67	15.0	639	26	.00	.15	170	12	39	381	130	65	.1	6.2	480	160	1,020	7.4
11-25E-11ccc	80	Qal	11-23-43	16.0	4,120	....	10	......	170	25	1,400	786	170	1,900	.2	42	520	0	......	....
11ccc2	80	Qal	11- 4-66	16.0	3,730	25	12	.00	280	24	1,000	649	430	1,500	.3	13	800	260	6,210	7.3
15aba	71	Qal	11- 4-66	15.5	3,720	33	30	1.5	330	57	1,000	742	310	1,600	.2	1.5	1,100	460	6,210	7.5
15ccc	57	Qal	9-22-69	15.5	1,050	23	1.4	.35	220	19	110	417	290	150	.2	.7	620	280	1,640	7.6
U.S. Public Health Service (1962) recommended maximum concentrations for drinking water					500		.3	.05					250	250		45				

[1] Qal, alluvium; Qb, Buck Creek terrace deposits; Qn, Newman terrace deposits.
[2] 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, p. 7).
[3] The U.S. Geological Survey uses the following classification for hardness: 0-60, soft; 61-120, moderately hard; 121-180, hard; more than 180, very hard.

SUMMARY

The depth to water in valley-fill deposits of the Kansas River valley ranges from 0 to 50 feet below land surface and averages about 25 feet. Water levels in wells are generally higher than the stages of the river at adjacent sites.

The saturated thickness of the valley-fill deposits is as much as 90 feet and averages 28 feet. These deposits contained about 1 million acre-feet of ground water in 1967. Large quantities of ground water are available and wells yielding more than 1,000 gpm are common.

The annual rate of withdrawal of ground water in the Kansas River valley ranged from 38,500 acre-feet in 1959 to 64,700 acre-feet in 1966. The withdrawal rate for 1966 probably could be increased as much as 4 times without adversely depleting the ground water in storage.

Data compiled in the report indicate that the transmissivity ranges from 5,300 to 48,000 sq. ft. per day. The long-term storage coefficient is estimated to average 0.15.

Except for the area downstream from the East Kansas Avenue Bridge (23rd Street) in Kansas City, the chemical quality of the ground water is suitable for most uses. However, the water is generally very hard and may contain as much as 58 mg/l of total iron.

LOGS OF TEST HOLES

Logs of six test holes drilled in the Kansas River valley were selected as representative of the types of material in the valley-fill deposits. The logs are given in downstream order. The test holes were drilled by the State and U.S. Geological Surveys; samples were examined by a geologist or hydrologist during drilling.

11-7E-7bbd.—Log of test hole in Riley County in the SE¼ NW¼NW¼ sec. 7, T.11 S., R.7 E., about 1,330 feet north and 670 feet east of W¼ cor. sec. in west road ditch; augered August 25, 1969. Altitude of land surface, 1,048 feet.

	Thickness, feet	*Depth, feet*
QUATERNARY SYSTEM—PLEISTOCENE SERIES		
Alluvium		
Topsoil, silty, black	2	2
Sand, fine, brown	2	4
Sand, very fine, tan	8	12
Silt, clayey, sandy, black	3	15
Silt, sandy, clayey, brownish-black	10	25
Sand, very fine, silty, gray	3	28
Clay, silty, blue; some coarse sand	3	31
Sand, silty; some bluish-gray gravel	6	37
Sand, coarse, and gravel, bluish-gray; some silt and clay	5	42
Sand, coarse, and gravel, bluish-gray	13	55
Gravel, coarse sand, and flat limestone pebbles, grayish-brown	15	70
PERMIAN SYSTEM		
Shale, weathered, whitish-yellow	0+	70+

10-8E-23caa.—Log of test hole in Riley County in the NE¼ NE¼SW¼ sec. 23, T.10 S., R.8 E., about 40 feet south and 20 feet west of center of section; augered August 20, 1969. Altitude of land surface, 997 feet.

	Thickness, feet	*Depth, feet*
QUATERNARY SYSTEM—PLEISTOCENE SERIES		
Alluvium		
Topsoil, silty, black	2	2
Sand, fine, silty, brown	15	17
Clay, silty, blue; contains silt layers	4	21
Sand, very fine, silty, gray	8	29
Sand, fine, gray	5	34
Sand, fine to medium, gray	11	45
Sand, medium to coarse; some pea gravel	7	52
Sand, coarse, and fine gravel, gray	12	64
PERMIAN SYSTEM		
Shale, blue	1+	65+

11-14E-14daa.—Log of test hole in NE¼NE¼SE¼ sec. 14, T.11 S., R.14 E., about 300 feet south and 20 feet west of E¼ cor. sec.; augered August 29, 1969. Altitude of land surface, 904 feet.

	Thickness, feet	*Depth, feet*
QUATERNARY SYSTEM—PLEISTOCENE SERIES		
Newman terrace deposits		
Topsoil, silty, black	3	3
Clay, silty, brown	7	10
Silt, sandy, clayey, tan	6	16
Sand, fine, silty, and silty clay layers, tan	4	20
Sand, fine, silty, clayey, tan	15	35
Sand, fine, silty, clayey, gray	5	40
Sand, medium, silty, gray, and pea gravel	10	50
PENNSYLVANIAN SYSTEM		
WABAUNSEE GROUP		
Shale, gray	2+	52+

11-17E-27cbb.—Log of test hole in Shawnee County in the NW¼NW¼SW¼ sec. 27, T.11 S., R.17 E., about 2,400 feet north of SW cor. sec.; augered August 1969. Altitude of land surface, 860 feet.

	Thickness, feet	*Depth, feet*
QUATERNARY SYSTEM—PLEISTOCENE SERIES		
Alluvium		
Sand, coarse, tan	5	5
Sand, coarse, silty, brown	4	9
Sand, fine to medium, tan	14	23
Sand, coarse, tan	11	34
Sand, coarse, and some pea gravel, grayish-brown	10	44
Sand, coarse, and pea gravel, silty, gray	8	52
Gravel, fine, silty, gray	18	70
Gravel and flat limestone pebbles	7	77
PENNSYLVANIAN SYSTEM		
Shale, blue	1+	78+

12-19E-1ddd.—Log of test hole in SE¼SE¼SE¼ sec. 1, T.12 S., R.19 E., about 60 feet west and 40 feet north of SE cor. sec.; augered May 24, 1966. Altitude of land surface, 837 feet.

	Thickness, feet	*Depth, feet*
QUATERNARY SYSTEM—PLEISTOCENE SERIES		
Newman terrace deposits		
Topsoil, silty, black	4	4
Silt, clayey, black	3	7
Clay, silty, brown-black	5	12
Silt, clayey, tan	2	14
Sand, fine, silty, brown	3	17
Clay, silty, tan	9	26
Silt, clayey, tan	4	30
Clay, blue	3	33

Silt, clayey, brown	2	35
Sand, fine to medium, clayey, gray	5	40
Sand, coarse, clayey, gray	6	46
Sand and gravel, brown-gray	9	55
Clay, blue	1	56
Gravel, brown (well did not penetrate to bedrock at an estimated 85 feet)	22+	78+

12-22E-24bbc.—Log of test hole in Johnson County in the SW¼NW¼NW¼ sec. 24, T.12 S., R.22 E., about 1,350 feet north and 20 feet east of W¼ cor. sec.; augered July 24, 1968. Altitude of land surface, 783 feet.

	Thickness, feet	*Depth, feet*
QUATERNARY SYSTEM—PLEISTOCENE SERIES		
Alluvium		
Sand, fine, tan	5	5
Sand, fine, silty, tan	7	12
Sand, fine, tan	3	15
Silt, sandy, tan	2	17
Sand, fine to medium, tan	3	20
Sand, medium to coarse, tan	5	25
Sand, coarse, and medium gravel	15	40
Gravel, medium, gray	14	54
Gravel, silty, gray	3	57
PENNSYLVANIAN SYSTEM		
Shale, blue	0+	57+

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State Geological Survey
of Kansas

GEOHYDROLOGY IN KANSAS RIVER VALLEY, JUNCTION CITY TO KANSAS CITY, KANSAS

Bulletin 206
Part 2
Plate 1

WEST HALF

Prepared by the State Geological Survey of Kansas and the United States Geological Survey with the cooperation of the Division of Water Resources of the Kansas State Board of Agriculture and the Division of Environmental Health of the Kansas State Department of Health

Geology modified from Beck (1959), Jewett (1941), Johnson and others (1967), Latta (1949), Mudge and Burton (1959), and Scott and others (1958)

EXPLANATION

Pleistocene — QUATERNARY

Qal — Alluvium

Qn — Newman terrace deposits

Qb — Buck Creek terrace deposits

Contact
Dashed where inferred on geologic sections

A———A′
Trace of geologic section
Datum for geologic sections is mean sea level and vertical exaggeration x 40

Boundary of project area

———980— — —
Water-table contour
Shows altitude of water table, March 1967. Dashed where approximately located. Interval 5 feet. Datum is mean sea level

....
Water table
Shown on geologic sections

Irrigation well

Public supply well

Industrial well

Domestic or stock well

Test hole

Observation well

Stream-gaging station

Saturated thickness, in feet

Less than 20

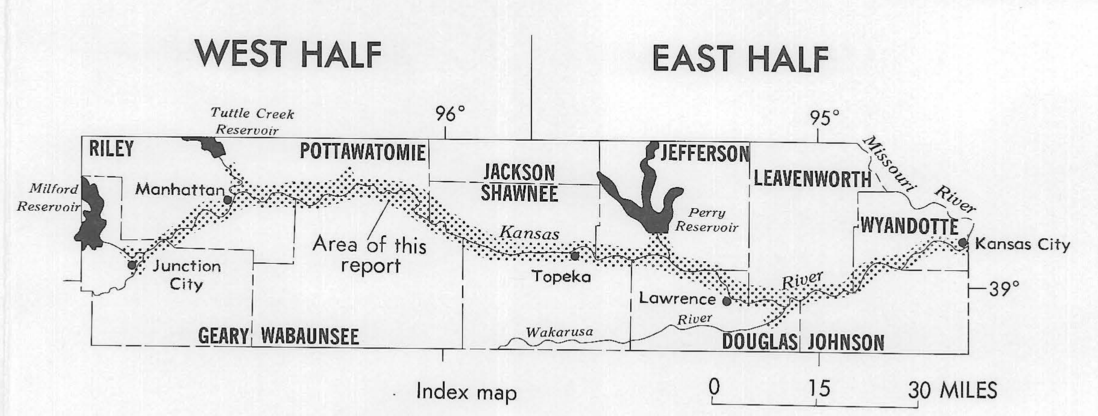
20-40

More than 40

———930———
Bedrock contour
Shows altitude of bedrock surface. Dashed where approximately located. Interval 10 feet. Datum is mean sea level

True North / Magnetic North, 9°
APPROXIMATE MEAN DECLINATION, 1972

Scale 1: 126 720
1 0 ½ 1 2 3 5 MILES



Base from U.S. Geological Survey, 1:24,000 Rossville, Silver Lake, Willard, 1952; Belvue, Maple Hill, St. George, St. Marys, Wamego, 1953; Junction City, Keats, Manhattan, Ogden, Swede Creek 1955

Illustration prepared by Lanna J. Hentsch

State Geological Survey
of Kansas

GEOHYDROLOGY IN KANSAS RIVER VALLEY, JUNCTION CITY TO KANSAS CITY, KANSAS

Bulletin 206
Part 2
Plate 2

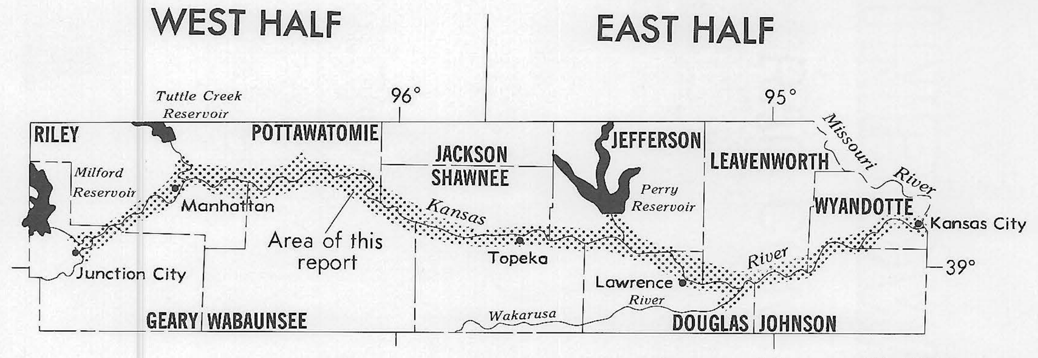
EAST HALF

Prepared by the State Geological Survey of Kansas and the United States Geological Survey with the cooperation of the Division of Water Resources of the Kansas State Board of Agriculture and the Division of Environmental Health of the Kansas State Department of Health

Base from U.S. Geological Survey, 1:24,000
Perry, Williamstown, 1949; Bonner Springs, Edwardsville, Grantville, Lawrence East, Lawrence West, Topeka, 1950; DeSoto, Eudora, 1951; Silver Lake, 1952; Kansas City, Shawnee, 1964

Illustration prepared by Lanna J. Hentsch

Geology modified from Beck (1959), Davis and Carlson (1952), Dufford (1958), Fishel (1948), Johnson and others (1967), and O'Connor (1960, 1971)



Index map

Scale 1: 126 720

1 0 ½ 1 2 3 5 MILES

EXPLANATION

QUATERNARY — Pleistocene

Qal — Alluvium

Qn — Newman terrace deposits

Qb — Buck Creek terrace deposits

Contact
Dashed where inferred on geologic sections

E———E′
Trace of geologic section
Datum for geologic sections is mean sea level and vertical exaggeration x 40

Boundary of project area

785 — Water-table contour
Shows altitude of water table, March 1967. Dashed where approximately located. Interval 5 feet. Datum is mean sea level

Water table
Shown on geologic sections

Irrigation well

Public supply well

Industrial well

Domestic or stock well

Test hole

Observation well

Stream-gaging station

Saturated thickness, in feet

Less than 20

20-40

More than 40

760 — Bedrock contour
Shows altitude of bedrock surface. Dashed where approximately located. Interval 10 feet. Datum is mean sea level

APPROXIMATE MEAN DECLINATION, 1972