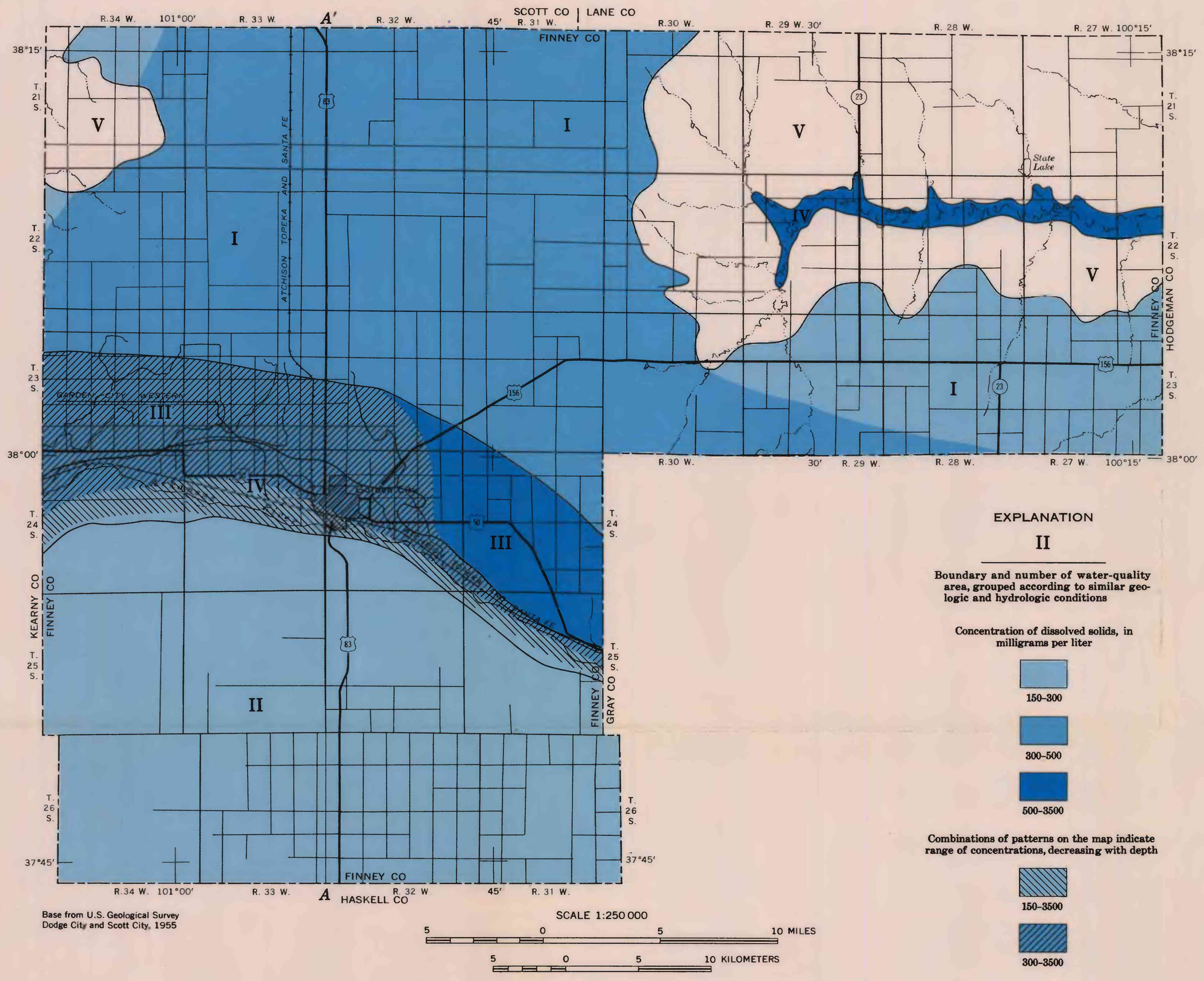
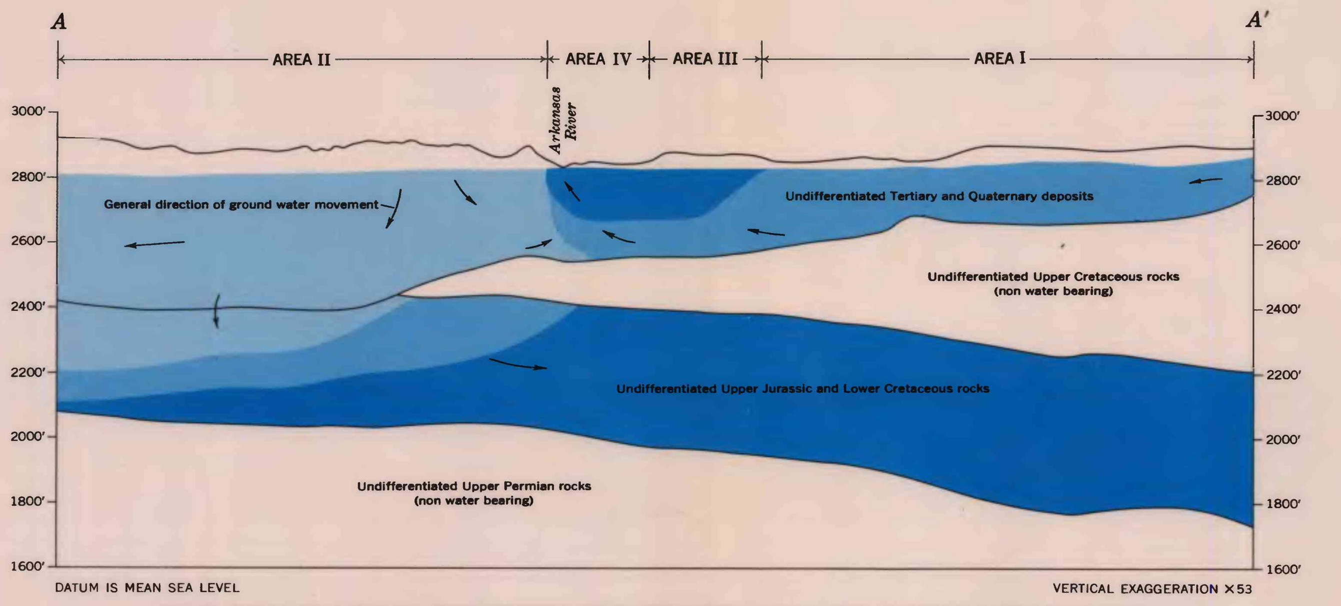
PREPARED IN COOPERATION WITH THE
STATE GEOLOGICAL SURVEY OF KANSAS
KANSAS STATE DEPARTMENT OF HEALTH
KANSAS STATE BOARD OF AGRICULTURE

WATER QUALITY



WATER FROM TERTIARY AND QUATERNARY DEPOSITS



MAP AND SECTION SHOWING CONCENTRATION OF DISSOLVED SOLIDS

WATER QUALITY

CHEMICAL QUALITY OF WATER

Ground water in the Tertiary and Quaternary deposits ranges from a calcium bicarbonate type to a calcium sodium sulfate type, and generally is very hard. Water in the undifferentiated Lower Cretaceous rocks ranges from a sodium bicarbonate type to a sodium sulfate type. The areas (I through V) designated on the map, summary table, and section are grouped according to similar hydrologic conditions that affect water quality in the Tertiary and Quaternary deposits.

AREA I—The land surface is mantled by loess with a few small patches of dune sand, and the water is in the Ogallala Formation and the undifferentiated Pleistocene deposits. Concentrations of 150 to 300 mg/l (milligrams per liter) dissolved solids occur in several areas of good surface drainage, whereas concentrations of 300 to 500 mg/l occur in areas of numerous undrained depressions. Ground water beneath some of the large undrained depressions may have concentrations of more than 1,000 mg/l.

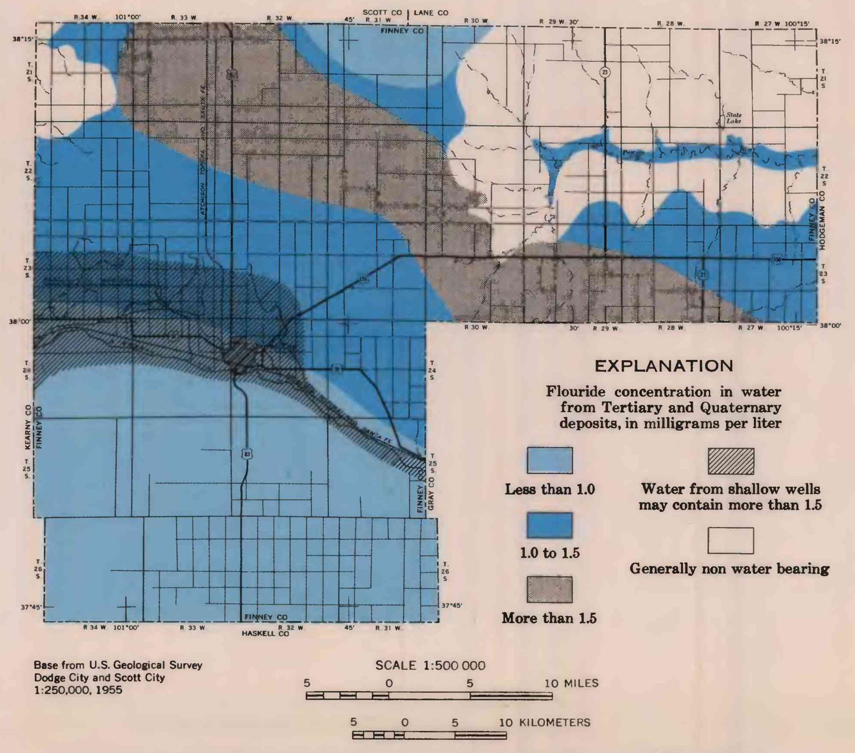
AREA II—The land surface is mantled by dune sand with a few small patches of loess, and the water is in the Ogallala Formation and undifferentiated Pleistocene deposits. A low concentration of dissolved solids (150 to 300 mg/l) is due to rapid percolation of precipitation and small amounts of soluble minerals available in the dune sand.

AREA III—The land surface is mantled by loess, water is in the Ogallala Formation and undifferentiated Pleistocene deposits, and the effects of surface-water infiltration are significant. Concentrations of dissolved solids range widely with depth and with source of recharge. Percolation from precipitation tends to improve the quality of water, whereas percolation from irrigation tends to deteriorate the quality.

AREA IV—The flood plain of the Arkansas and Pawnee Rivers is underlain by silt and sandy clay of Holocene age. The water occurs in upper Pleistocene alluvium at shallow depth and in the underlying Ogallala and undifferentiated Pleistocene deposits. Water quality in the shallow alluvium is affected by infiltration of river water containing a high concentration of dissolved solids and by evaporation from the water table. Water quality in the deposits underlying the shallow alluvium, as shown on the geologic section, commonly improves as the depth of the well increases.

AREA V—Generally non-water bearing in the Ogallala Formation and undifferentiated Pleistocene deposits.

The geologic section shows the direction of ground-water movement as related to the changes in water quality. In Areas III and IV of the undifferentiated Tertiary and Quaternary deposits, the concentration of dissolved solids decreases with depth owing to the subsurface movement of water from Areas I and II toward the Arkansas River valley. The concentrations of dissolved solids in the undifferentiated Upper Jurassic and Lower Cretaceous rocks (as indicated by the summary table and section) increase from less than 300 mg/l to more than 2,500 mg/l as the depth and distance from the area of recharge increase.



MAP SHOWING CONCENTRATION OF FLUORIDE IN WATER FROM TERTIARY AND QUATERNARY DEPOSITS

Summary of water-quality analyses
(Chemical constituents expressed in milligrams per liter)

	Depth (feet)	Temperature (°C)	Dissolved solids	Silica (SiO_2)	Iron (Fe)	Manganese (Mn)	Calcium (Ca)	Magnesium (Mg)	Sodium and potassium (Na+K)	Bicarbonate (HCO_3)	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Nitrate (NO_3)	Hardness: Total	Hardness: Carbonate	Hardness: Noncarbonate
Area I																	
Maximum	265	15	518	42	5.2	0.00	101	36	73	347	195	50	3.6	12	350	284	145
Minimum	39.5	14	271	22	.01	.00	37	23	21	200	29	17	.8	.0	188	164	0
Average	173	14	412	30	.73	.00	60	27	47	243	105	29	1.8	6.6	263	199	64
Area II																	
Maximum	394	16	249	25	2.9	0.12	66	13	27	207	46	12	0.5	42	206	170	66
Minimum	71	16	178	17	.04	.00	37	7.8	1.6	151	9.5	2.5	.3	4.9	128	124	0
Average	189	16	214	21	.85	.02	50	9.1	13	180	23	6.3	.4	9.7	162	146	16
Area III																	
Maximum	327	15	2,180	25	0.77	0.00	280	151	195	254	1,190	211	2.3	14	1,320	351	1,130
Minimum	23.5	14	402	22	.01	.00	53	31	34	232	107	22	1.0	4.8	260	190	68
Average	201	15	1,120	24	.22	.00	140	75	116	242	546	91	1.4	11	656	214	458
Area IV																	
Maximum	324	17	3,420	22	12	0.11	386	165	512	368	2,030	186	2.5	53	1,640	302	1,430
Minimum	24.5	13	225	7.2	.00	.00	39	7.8	21	134	6.8	6.0	.2	2.2	138	110	0
Average	179	15	1,140	17	.66	.01	146	53	141	220	581	62	1.0	14	580	180	402
Undifferentiated Lower Cretaceous rocks																	
Maximum	640	19	2,490	9.0	6.9	0.16	136	160	485	522	1,160	282	6.5	5.3	977	428	569
Minimum	400	18	594	8.0	.13	.00	6.4	2.0	199	254	199	81	2.6	2.2	24	24	0
Average	510	18	1,280	8.0	1.1	.08	53	56	321	374	497	156	4.4	3.3	358	175	190

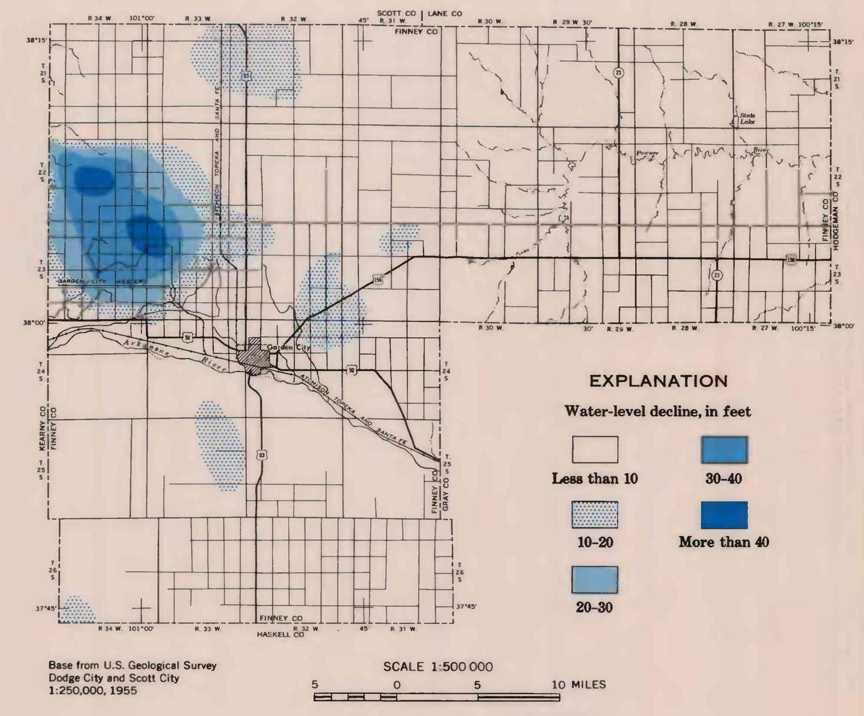
Hardness of water classified by U.S. Geological Survey as follows: 0–60 mg/l, soft; 60–120 mg/l, moderately hard; 120–180 mg/l, hard; and 180 mg/l or more, very hard.

SUITABILITY OF WATER QUALITY

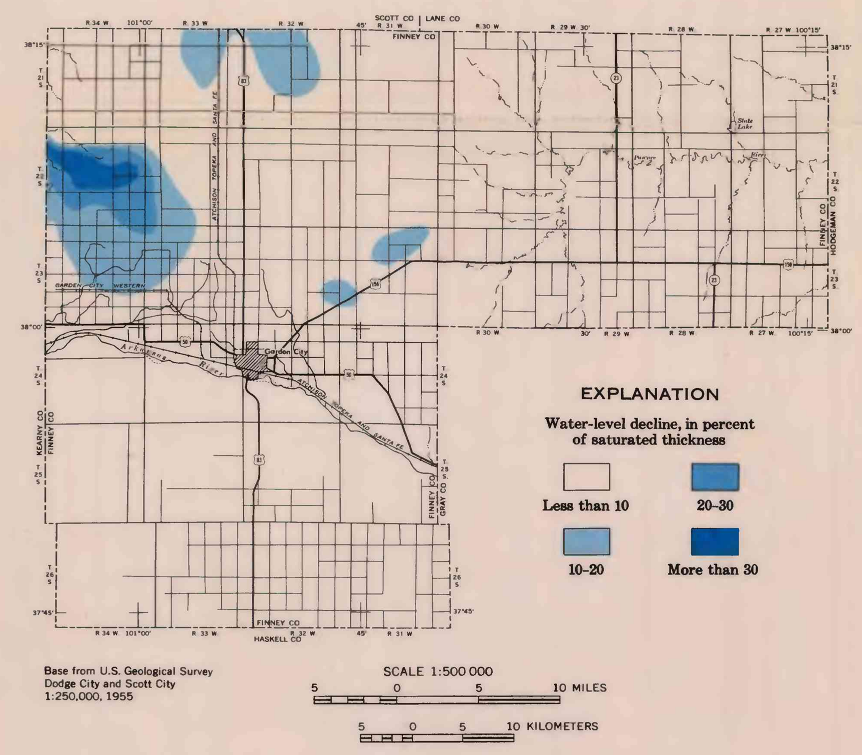
Ground water of suitable quality for domestic and stock use generally can be obtained throughout Finney County. Locally, concentrations of some chemical constituents exceed the limits established by the U.S. Public Health Service for drinking water standards. High concentrations of nitrate (more than 45 mg/l) and iron (more than 0.3 mg/l) usually are preventable by proper well construction. High concentrations of dissolved solids (more than 500 mg/l) are undesirable, especially when high sulfate concentrations cause the water to have laxative effect. A fluoride content of more than 1.5 mg/l (see map of fluoride concentrations) may cause dental fluorosis in the formation of permanent teeth; however, a concentration of at least 1.0 mg/l is desirable to inhibit dental caries. Most of the water from the undifferentiated Lower Cretaceous rocks has a high enough concentration of fluoride to cause an objectionable discoloration of teeth.

Where ground water is available for irrigation, the quality generally is suitable. In areas where the concentration of dissolved solids exceeds 500 mg/l, special irrigation practices may be necessary on some types of soils. Water from undifferentiated Lower Cretaceous rocks commonly contains a high percentage of sodium, which is undesirable for irrigation on "tight" soils.

WATER-LEVEL CHANGES



MAP SHOWING WATER-LEVEL DECLINE, 1940–68



MAP SHOWING WATER-LEVEL DECLINE, 1940–68, IN PERCENT OF SATURATED THICKNESS

WATER-LEVEL CHANGES

GENERAL TRENDS

The increasing utilization of ground water for irrigation has resulted in a decline in water levels with an accompanying loss of water from storage. Water-level changes are not uniform in rate or amount, but reflect the aquifer's response to climate, hydrologic conditions, and irrigation development. To evaluate the change in the Tertiary and Quaternary aquifer, water-level data collected during 1940 (Latta, 1944) are compared with measurements made in 1968. Because ground-water pumpage prior to 1940 was insignificant, the data are considered to be representative of equilibrium conditions (recharge equal to discharge). Water levels for 1968 were measured in January to minimize the effects of pressure changes related to seasonal pumpage for irrigation. The nature of these pressure head changes is described in the section on hydrographs for wells.

Water-level declines from 1940 to 1968 (see map showing water-level decline) range from less than 10 to more than 40 feet. The greatest decline occurs in the deep semiconfined aquifer in the northwestern part of the county where intensive ground-water irrigation is practiced. Water levels remain almost unchanged in the shallow unconfined aquifer of the Arkansas River valley, because pumpage is essentially equal to infiltration from surface- and ground-water irrigation. Water-level declines in the deep semiconfined aquifer in the southern part of the county are moderate (10 feet) and show the effects of locally intensive pumpage for irrigation.

To relate the long-term effects of irrigation withdrawals to ground-water storage in Finney County, the water-level decline is expressed in percent reduction in saturated thickness (see map of water-level decline in percent). For example, a water-level decline of 40 feet in T.23 S., R.33 W., represents a reduction of about 15 percent in the saturated thickness. Near the northwest corner of T. 22 S., R. 34 W., a water-level decline of 20 feet represents a 30-percent reduction in saturated thickness. A decline of this magnitude in the latter area, where the saturated thickness ranges from 50 to 100 feet, results in a significant reduction in well yields.

WELL DEVELOPMENT

Data on the number of wells on applications to appropriate ground water, as shown on the graph, are from the records of the Division of Water Resources of the Kansas State Board of Agriculture. On the effective date of the Kansas Water Appropriation Act (June 28, 1945), about 240 irrigation wells existed in Finney County. Since that date, the number of wells on applications to appropriate ground water has increased at an average rate of about 40 wells per year.

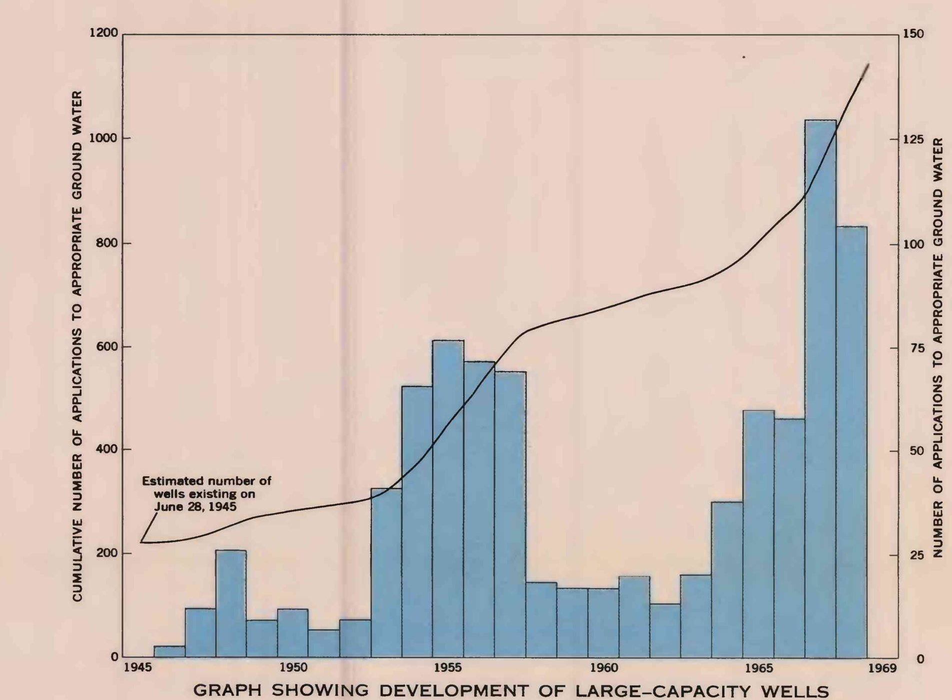
Increased interest in irrigation development is evident during and immediately following extended periods of below-normal precipitation. The great increase in the number of wells on application to appropriate ground water in 1967 and 1968 primarily reflects the rapid growth of irrigation development in the sandhill area of southern Finney County.

EFFECTS OF SEASONAL PUMPING

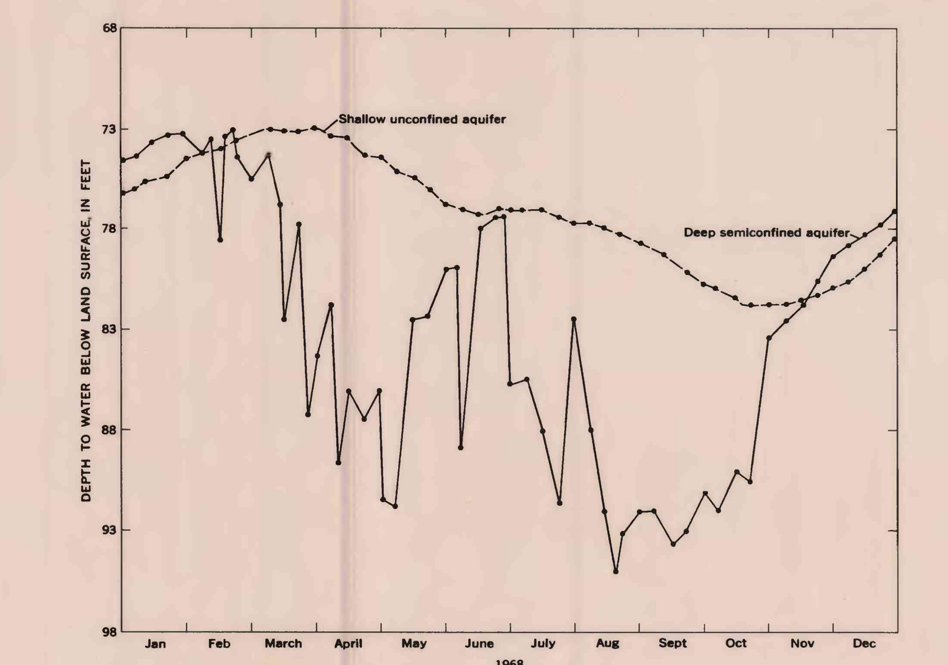
The water level in two wells that are screened in different zones at the same site, as shown by the water-level hydrographs, illustrates the effects of pumping from Tertiary and Quaternary deposits in Finney County. There are three significant hydrologic zones in the ground-water reservoir at the selected well sites: a deep semiconfined aquifer, a confining layer or aquitard, and a shallow unconfined aquifer. Irrigation wells pump water from the semiconfined aquifer at a depth of 190 to 290 feet below land surface. The hydrograph shows that the potentiometric surface of the deep aquifer during 1968 fluctuated between 73 and 95 feet below land surface, which indicates that the ground water is confined under pressure. Although water is removed from storage, these water-level declines primarily reflect changes in pressure rather than the actual reduction in storage volume. In the shallow aquifer (at a depth of 73 to 84 feet below land surface), the water table during 1968 fluctuated in the zone between 73 and 82 feet. Because ground water in the shallow aquifer is not confined, changes in the water table directly reflect changes in the volume of water in storage.

During the 1968 pumping season, which extended from early March to late October, the potentiometric surface for the deep aquifer generally was much lower (10 to 15 feet) than the water table for the shallow aquifer. During the non-pumping season, the potentiometric surface for the deep aquifer generally was higher (1 to 2 feet) than the water table for the shallow aquifer. The hydrograph shows the rapid water-level decline in the deep aquifer resulting from pressure changes due to seasonal pumping. The large fluctuations of short duration reflect changes in the amount of nearby pumping for irrigation. The gradual water-level decline for the shallow aquifer reflects a change in the volume of water in storage during the pumping period. Dewatering of the shallow aquifer results from downward leakage through the aquitard to the deep aquifer. During the non-pumping season, there is a gradual rise in the water table owing to a replenishment of the shallow aquifer and leakage upward through the aquitard.

It is apparent from the hydrographs that estimated changes in storage should be based on water levels measured during the non-pumping season. At this time, water levels in wells screened in the semiconfined aquifer would be least affected by pressure changes due to seasonal pumping.



GRAPH SHOWING DEVELOPMENT OF LARGE-CAPACITY WELLS



HYDROGRAPHS FOR WELLS. (WELLS LOCATED AT IRRIGATION FARM, GARDEN CITY EXPERIMENT FARM, BRANCH, KANSAS STATE UNIVERSITY.)

SELECTED HYDROLOGIC REFERENCES

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Hem, J. D., 1959, Study and interpretation of the chemical characteristics of natural water: U.S. Geol. Survey Water-Supply Paper 1473, 269 p.

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U.S. Public Health Service, 1962, Drinking water standards: U.S. Public Health Service Pub. 956, 61 p.

Winslow, J. D., McGovern, H. E., and Mackey, H. L., 1968, Water-level changes in Grant and Stanton Counties, Kansas, 1939–1968: Kansas Geol. Survey Spec. Distrib. Pub. 37, 17 p.

Note.—Additional information on drillers' logs and well production is available in the office of the U.S. Geological Survey, Garden City, Kans.

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GROUND WATER IN FINNEY COUNTY, SOUTHWESTERN KANSAS

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