

No.	County	Area mi ²	Reference Bulletin & pub yr	Aquifer	Avg. precip (in/yr)	Avg. temp. °F	Recharge from ac-ft/yr (in/yr)			Total recharge (in/yr) ac-ft/yr	Method	Reference	Soils	Topog	Avg. depth to water table	Vegetation and land use	Comments
							precip.	stream	lateral inflow								
3	Wichita	717	KGS B108 1954 KGS Irr. Ser.2 1976	Ogallala is the principal water-bearing fm. Small amt is also obtained from alluvium and Niobrara. Ogallala Fm. (unconsolidated sand and gravel) as much as 300 ft thick, of which as much as 145 ft is saturated. Yields 100 to 2000 gpm. Dakota Fm. (sandstone aquifer) 400-550 ft thick. Similar aquifer in adjacent counties yield 30-300 gpm. Ogallala	18.63	52.5	^{3a} 0.1 in/yr	44 ac-ft of loss per mile as per the study in Whitewoman Creek in July 1972	^{3a} estimated to be about 5000 ac-ft/yr (0.06 in/yr) occurs at western boundary of the county.	negligibly low	author's estimate Darcy's Law (irr & non irr land)+ Lat. in (0.17+.05) +.06 (author's estimate) 10% of pcp. in irrigated & 1% of pcp. in nonirr land. (163000 ac irr & 390000 ac of nonirr land in Greeley and Wichita) 1971-72 mathematical model (steady state) soil-water budget	^{3a} Prescott, G.C. et al, 1954 ^{3b} Slagle and Weakly, 1976 ^{3c} Dunlap, L.E., et al., 1980 ^{3d} Gutentag and Stulken, 1976 ^{3e} KWRB '67 ^{3f} USGS '91	silty	High Plains section of the Great Plains physiographic province. Flat to gently rolling upland plains.	^{3g} 15 ft-40 ft at alluvium ^{3h} 10 ft-80 ft at Ogallala In the period of 1948-1972 water level declined from 10-50 ft in places where irrigation is practiced.	crops and grasses agriculture	^{3b} ref. KGS B108 ^{3b} For Greeley and Wichita combined. Lateral inflow, subsurface outflow & total recharge for Wichita and Greeley combined ^{3b} based on the study in an area of 12 mi ² in northwestern Wichita, west-central KS referred to by the authors as "intensive study area."
4	Scott	724	KGS B66 1947 KGS Irr. Ser. 1 1976	Alluvium ranges from few feet to as much as 200 ft in the southern part. Yields from 250-1500 gpm. Ogallala Fm. is the major aquifer and thickness ranges from few feet to 215 ft in central Scott Co.	18.61	53.3	^{4a} probably less than 1/2 inch				^{4a} Theis, C. V., 1937 (KGS B66)	silty and loamy soils	High Plains section of the Great Plains physiographic province . 85% upland plains & 15% stream flood plains & intermediate slopes.	Based on depth of water table Scott Co. may be divided into: 1. Shallow water area depth between <25 ft to 75 ft. 2. Intermediate depth between <50 ft to 100 ft. 3. Deep water area	Agriculture 38% cropland & 62% for grazing as of 1939 crops and grasses		

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							precip.	stream	lateral inflow	irrig.							
				Sandstone aquifer (Dakota Fm) 430 ft in southwestern Scott to 710 ft in thickness in southwestern Lane Co. Yields from 30-300 gpm.			^{5c} 3,000 ac-ft (0.08 in) in 1971	negligible, as all streams in Lane are ephemeral		^{5c} 6,000 ac-ft (0.16 in) in 1971	nonirr land percolates down to water table	^{5b} Gutentag and Stulken, 1976			^{5f} 25 ft-50 ft at alluvium ^{5f} <25 ft-75 ft at Ogallala		^{5f} ref. KGS B93
				Chalk aquifer (Niobrara Fm.) Thickness of about 400 ft. Not an important aquifer as yield is small.						5,000 ac-ft (0.13 in) in 1972	based on pumpage						
										18,000 ac-ft (0.46 in/yr) in 1971 ^{5c}	pcp+lat.inf +irr						
										20,000 ac-ft (0.52 in/yr) in 1972 ^{5c}	pcp+lat.inf +irr						
										^{5d} about 20% of irr. applied	experiment in Finney Co.	^{5d} Meyer, W.R. et al., 1953					
										8,600 ^{5c} ac-ft (0.22 in/yr)		^{5c} KWRB '67					
Summary (District avg.)										0.33 in/yr ^a (std. dev. 0.10)	¹ arithmetic avg.	^a USGS '91				¹ all averages are calculated considering only the counties included in the GMD.	
										0.19 in/yr ^b (std. dev. 0.07)	¹ arithmetic avg.	^b KWRB '67					
										0.24 in/yr ^c (std. dev. 0.16)	¹ arithmetic avg.	^c KGS Bulletins					

NOTE:

KWRB'67: Irrigation in Kansas. Kansas Water Resources Board, 1967. Report 16c.

USGS' 91: Hansen, C. V., 1991, Estimates of freshwater storage and potential natural recharge for principal aquifers in Kansas: U.S. Geological Survey, Water-Resources Investigations Report 87-4230.

KGS B: Kansas Geological Survey Bulletin

std. dev.: standard deviation

Exponents indicate corresponding information from the same study.

EQUUS BEDS AQUIFER (GMD 2 Region)

No.	County	Area mi ²	Reference Bulletin & pub yr	Aquifer	Avg. precip (in/yr)	Avg. temp. °F	Recharge from ac-ft/yr (in/yr)			Total recharge ac-ft/yr (in/yr)	Method	Reference	Topog and Soils	Avg. depth to water table	Vegetation and land use	Comments
							precip.	stream	lateral inflow							
1	McPherson	896	KGS B79 1949	Alluvium Equus Beds	28.91	56				^{1a} 20% of pcp. 7 in/yr or 365 ac-ft/yr/ mi ² for the period of rec- ord 1938- 1943 in Wi- chita well field area (85 mi ²)	^{1a} Water- level fluc- tuation and sp. yield 20%	^{1a} Williams & Lohman 1949	nearly level to gently sloping silty and clayey soils on uplands	10 ft-110 ft	farm and pasture -1945	area covered in B79= 2,340 m ² includes McPherson and parts of Marion, Har- vey, Reno, and Sedg- wick cos.
										6 in/yr or 320 ac-ft/yr/mi ² for normal pcp. in Wichita well field area (0.2*28.91 = 5.8 ≈ 6 in/yr for norm. pcp.)						
										^{1b} 138,000 (2.89 in/yr)		^{1b} KWRB '67				
						^{1c} 9,220 (0.19 in/yr)					soil-water budget	^{1c} USGS '91				
						^{1c} 70,700 (1.47 in/yr)				^{1d} 0.1-4.5 in/yr	^{1d} 3-D,finite, diff., ground- water flow model	^{1d} Spinazola, J. M. et al., 1985				^{1d} recharge for predevelop- ment period (before 1940)
2	Reno	1262	KGS B79 1949		28.53			quantity not known but small com- pared to that from pcp.		^{2a} 20% of pcp. 0.2*28.53= 5.7 in/yr	^{2a} ground- water level fluctuation and sp. yield (20%)	^{2a} Williams and Lohman, 1949	nearly level to moderately sloping loamy soils on uplands; nearly level, loamy and sandy soils on floodplains	<10 ft- 50 ft	farmland and pasture	area covered in KGS B79= 2,340 mi ² in- cludes Mc- Pherson and parts of Mar- ion, Harvey, Reno, and Sedgwick cos.
			KGS B64 1946		27.83	54.3				^{2b} 20% of pcp. 300 ac-ft/mi ² / yr in the Ar- kansas River valley (5.56 in/yr)	^{2b} water- table fluc- tuation records and sp. yield ests.	^{2b} Williams, C.C., 1946				
								^{2c} 500 ac-ft/mi into McPherson Fm.=1.07 in/yr			^{2c} permea- bility, water- table gra- dient, well logs (Dar- cy's Law)	^{2c} Williams, C.C., 1946				^{2c} 500*11.4= 5,700 ac-ft/yr =1.07 in/yr in 100 mi ² of study area in vicinity of

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							precip.	stream	lateral inflow							
4	Sedgwick	1000	KGS B79 ^{4a} 1949 KGS B119 ^{4a} 1956 ^{4b} USGS WRIR 88-4225- 1989	Alluvium Equus Beds	30.2 (1917– 1944) 28.6 (1888– 1985)	57 56.3	^{4b} avg. from 0.1–8.8 in/yr depending on local condition (from sum- mary; no source)	^{4b} streams are in equili- brium with ground water or are gain- ing	^{4b} no inflow from north but gains from east and west but outflow from southern boundary is probably equal so net effect on recharge is insignificant	^{4a,a} 20% of pcp. approx. 6 in/yr or 320 ac-ft/yr/mi ² ^{4b} 0.4–5.5 in/yr in Ar- kansas River valley of Sedgwick Co. and adj. areas ^{4c} 193,000 (3.59 in/yr) ^{4c} 0.4–5.5 in/yr (2.5–5.5 in/yr in Arkansas River valley of Sedgwick Co. and adj. areas)	^{4a,a} ground- water level fluctuation and sp. yield (20%) ^{4ab} 3-D, finite, diff., ground- water flow model soil-water budget ^{4c} 3-D, finite, diff., ground- water flow model	^{4a} Williams and Lohman, 1949 ^{4a} Stramel, G. J., 1956 ^{4a} Spinazola, J.M. et al., 1985 ^{4c} KWRB '67 ^{4d} USGS '91 ^{4c} Spinazola, J. M. et al., 1985	nearly level to moderately sloping loamy soils on uplands nearly level, loamy and sandy soils on floodplains	<10 ft– 30 ft	farmland and pasture	^{4a} Area covered in this report is 2,340 sq mi in- cludes Mc- Pherson and part of Marion, Reno, Sedgwick, and Harvey ^{4b} The study area includes Sedg- wick and parts of Reno, King- man, Harper, Harvey, Sumner, Marion, Butler, and Cowley cos. ^{4c} Recharge for predevelopment period (before 1940)
	Summary	11,523		Lower Ar- kansas unit that includes the Equus Beds aquifer	<22 to >32	57	^a 20% of pcp. in Equus Beds	streams are ef- fluent	some from adjacent areas to the west but insignificant	precise esti- mate cannot be made based on available data (1960). Be- cause of the var- iable local con- ditions annual recharge could range from prac- tically zero to as much as 50% of annual pcp. in some areas.	^a KWRB, 1980				includes Rice, McPherson, Reno, Harvey, Sedgwick, and Ellsworth cos.	
	Equus Beds modeling area	240 (area select- ed in the re- port as in- dicated in cited refer- ence)	^b KWRRI 1982 (Sopho- cleous et al.)	Equus Beds	30		^b Non-sand dune Equus Beds model area: 4.2 cm/ yr or 1.65 in/yr. Sand dune area north of Burrton 16.3 cm/yr or 6.4 in/yr.			^b ground- water flow model (steady- state ground- water flow in two dimen- sions) param- eters used trans- missivity, areal recharge, leak- age of the stream beds and specifi- ed head.	^b Sophocleous, M. A. et al., 1982					

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							precip.	stream	lateral inflow							
		1406	^c USGS WRIR 85-4336 (Spinazola et al.)	Equus Beds	^c 30.37 preceding 1940 30.58 1951– 1980)	56.6	^c (1.70 in/yr) 1940 (predev.)	0.02 in/yr 1940 (predev.)	^c (0.14 in/yr) 1940 (predev.)	1.86 in/yr	^c A modular 3-D finite diff. ground- water flow model (Mc- Donald and Harbaugh, 1984)	^c Spinazola, J. M. et al., 1985				^c Parts of Harvey, Marion, McPher- son, Reno, and Sedgwick cos.
										2.32 in/yr	^c from fluc- tuation of water table and sp. yield	^c Williams and Lohman, 1949				
											^c change in storage	^c Stramel, G. J., 1956				
										^d 5.92 in/yr (std. dev. 0.15)	¹ arithmetic avg.	⁴ KGS Bulletins				¹ all averages are calculated considering only the coun- ties included in the GMD.
										^e 3.41 in/yr (std. dev. 0.54)	¹ arithmetic avg.	⁶ KWRB '67				¹ recharge for Equus Beds
										^f 1.59 in/yr (st. dev. 0.68)	¹ arithmetic avg.	¹ USGS '91				
										^g 0.18–5.13 in/yr (std. dev. 0.15)	¹ arithmetic avg.	⁸ Spinazola et al., 1985				

NOTE: KWRB '67: Irrigation in Kansas, Kansas Water Resources Board, 1967, Report no. 16e.
 USGS '91: Hansen, C. V., 1991, Estimates of freshwater storage and potential natural recharge for principal aquifers in Kansas: U.S. Geological Survey, Water-Resources Investigations Report 87-4230.
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SOUTHWEST KANSAS (GMD 3 Region)

No.	County	Area mi ²	Reference Bulletin & pub yr	Aquifer	Avg. precip (in/yr)	Avg. temp. °F	Recharge from ac-ft/yr (in/yr)			Total recharge ac-ft/yr (in/yr)	Method	Reference	Topog and Soils	Avg. depth to water table	Vegetation and land use	Comments
							stream	lateral inflow	irrig.							
1	Hamilton	992	KGS B49 1943		17.67	53.9	High in sand hills area due to porous soil and presence of basins without surface drainage. Relatively low in upland area due to impermeable soil. ^{1a} Ark. Valley area 1000 or >1000 ac-ft/yr		Flow occurs southeastwards inflow occurs from Prowers Co., Colorado, and from Greeley Co.				Nearly level to gently sloping silty soils on uplands; nearly level, loamy and sandy soils on floodplains; rolling to hummocky sandy soils on uplands.	Alluvium <10 ft–25 ft dune sand 25 ft–50 ft rest>50–200 ft		
				Alluvium High Plains (Ogallala)			^{1a} 0.96 in/yr (1970–74) ^{1a} 1.59 in/yr (1975–79)			^{1a} Water balance inflow= outflow (neglecting the contribution of subsurface flow as it is low) ^{1b} USGS 2-D finite element ground-water flow model ^{1c} 5,400 ac-ft/yr (0.1 in/yr)	^{1a} McLaughlin, T. G., 1943 ^{1b} Barker, R. A., et al., 1983 ^{1c} KWRB '67					^{1b} In Arkansas River valley in Hamilton and Kearny Co. A=110,000 acres
						^{1c} 2,980 (0.06 in/yr) ^{1c} 9,410 (0.18 in/yr)				^{1c} Soil-water budget	^{1c} USGS '91					
2	Kearny	861	KGS B49 1943		15.85	53.9	High in sand hills area due to porous soil and presence of basins without surface drainage. Relatively low in upland area due to impermeable soil. ^{2b} Arkansas Valley area	^{2a} 19000 ac-ft/y (4.24 in/yr) over the alluvial area of 53,760 ac from Hartland to Garden City along Arkansas River.	Inflow occurs in north from Wichita and in west from Hamilton				Sloping silty soils on uplands; nearly level, loamy and sandy soils on floodplains; rolling to hummocky sandy soils on uplands.	Alluvium 10 ft–25 ft dune sand 25 ft–50 ft rest>50–200 ft		
										^{2b} Difference in discharge at different points along the stream ^{2b} Water balance inflow=outflow	^{2a,2b} McLaughlin, T. G., 1943					

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							precip.	stream	lateral inflow irrig.								
							1,000 or > 1,000 ac-ft/yr										
							^{2c} 0.96 in/yr (1970–74) 1.59 in/yr (1975–79)					(neglecting the contribution of subsurface flow as it is low)					
							^{2d} 2.08 in/yr (1974– 1980) for sandhills and Ar- kansas River valley 0.5 in/yr for High Plains	^{2d} 1.10 in/yr (1974–1980) for sandhills and Arkansas River valley 0.9 in/yr for High Plains			^{2c} 1.95 in/yr (1970–74) 4.21 in/yr (1975–79) (pcp+irr-ET)	^{2c} USGS 2-D finite element ground-water flow model	^{2c} Barker, R. A., et al., 1983			^{2c} In Arkansas River valley in Hamilton and Kearny Co. A= 110,000 acres	
				Alluvium High Plains (Ogallala)			^{2f} 1,750 (0.04 in/yr) ^{2f} 25,700 (0.56 in/yr)				^{2d} USGS 3-D model (Trescott, 1975)	^{2d} Dunlap, L. E., et al., 1985				^{2d} Model area of upper aquifer (Arkansas River valley+ Sand dunes area)=603 mi ² and for lower aquifer (main High Plains aquifer)= 1,227 mi ² in Kearny and Finney Cos.	
							^{2f} 10,800 (0.24 in/yr)				^{2f} soil-water budget	^{2c} KWRB '67					
3	Finney	1302	KGS B55 1944		20.22	54.7	^{3a} 1.4 in/yr (1940–1952) period of above-nor- mal pcp.				^{3a} Change in water level in observa- tion wells S=0.2 and delta h=7 ft	^{3abed} Meyer, W.R., et al., 1970	Rolling to gently sloping to nearly level sandy, loamy, and silty soils on the uplands; near- ly level loamy and sandy soils on floodplains.			^{3abed} Area under consideration 552,960ac	
							^{3b} 45,000 ac-ft/yr 0.98 in/yr over the area consid- ered, from the west and north of Scott Co. But the dis- charge from the co. was 47,000 ac/yr (area=552960 ac)	^{3c} 15% of irr. applied 10% for ditches			^{3b} Using water level map of Latta-1944 and Q=TIL ^{3c} Experi- ment on irr. efficiency and measure- ment of Q in two points of canal.					^{3d} 2.7 in/yr reflects additional recharge resulting from re- cycled ground wa- ter for irrigation & an accompanying increase in effec- tive recharge from	
							^{3d} 124,000ac-ft/ ^{3d} water-bal- yr or 2.7 in/yr (1940–1964) <0.5 in/yr pre- development period (1922– 1930) consid- ering equili-				^{3d} water-bal- ance equa- tion						

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							precip.	stream	lateral inflow							
4	Gray	873	KGS B55 1944	High Plains (Ogallala)	21.43											
5	Ford	1082	KGS B43 1942	Alluvium High Plains (Ogallala)	20.5	54.3	small; esti- mated to be about <0.5 in/yr due to low perme- ability, high evaporation and high ET Data not ade- quate for quantitative estimate but considered to be low	small as Ar- kansas River was effluent (gaining) most of the times in a year and so were other small rivers	some in places in the vicin- ity of irr. ditches and fields							
6	Stanton	685	KGS B168 1964		15.03											

^{3p}0.5 in/yr in vegetated sand dune area, but higher in the barren sand dune area

^{4b}43700 ac-ft/yr (0.94 in/yr)

^{5d}370 (0.006 in/yr)
^{5c}54400 (0.94 in/yr)

^{3q}0.02–0.04 in/yr for irr. land

^{4a}14,800 ac-ft/yr (0.32 in/yr)

^{5c}34,700 (0.6 in/yr)

^{6c}11,700 (0.32 in/yr)

^{3p}neutron probe

^{3q}heat dissipation sensors and Darcy's Law

^{4b}soil-water budget

^{5d}soil-water budget

^{6a}Difference in flow at two different locations

^{3p}Study area located in dune sand area in the Arkansas River valley near Garden City for the period 1964–66 (period of high rainfall)

^{5b}Water budget for 1980 conditions over 700 mi² underlain by Ogallala aquifer of the Arkansas River

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							stream	lateral inflow	irrig.								
						^d 0.34 in/yr (0.45 in/yr in Meade, Seward, and eastern Stev- ens but 0.23 in/yr in Mor- ton and west- ern Stevens)					^d 2-D finite difference USGS model (Trescott, 1976)					^d active node model area 14,208,000 ac (includes part of Oklahoma and Morton, Stevens, Sew- ard, and Meade Cos. in Kansas)	
					^e 0.6 in/yr over total area; 175,000 ac-ft\				^e period (1922– 1930) consider- ing equi- librium of system	^e 10% of pcp. in irr. land and 1% of pcp. in nonirr. land	^{e,f,g} Gutentag, E. D., et al., 1981						
					1.5 in/yr in irr. area of 1,400,000 ac and 35,000 ac-ft\				<0.05 in/yr long term avg. (1940–	^f 20% of ap- plied irr.							
					0.15 in/yr in nonirr. area of 2,824,000 ac in 1975 based on 15 in. of pcp. during growing sea- son		^h inflow from north and west of co. to 8,400 ac-ft/yr\	^h 420,000 ac-ft/yr to 560,000 ac-ft/yr (1.2–1.6 in/yr)		^h Darcy's Law							
							0.024 in/yr; outflow 15,300 ac-ft/yr 0.04 in/yr to east										
									^h 165000 ac-ft/yr (0.29 in/yr)								
									ⁱ 0.57 in/yr (0.3 in/yr in nonirr. land and 1.8 in/yr in irr. land)		^h based on previous recharge estimates from pcp. and irr. to Ogallala aquifer in different subregions in western KS (1977)	^h KS Governor's Task Force report, 1977 ⁱ O'Connor and McClain, 1982					
									ⁱ 0.70 in/yr (std. dev. 0.26)		^j arithmetic avg.	^j USGS '91				^j arithmetic ave. for Ogallala	
									^k 0.30 in/yr (std. dev. 0.11)		^k arithmetic avg.	^k KWRB '67				^k all averages are calculated considering only the cos. included in the GMD	
									^l 0.35 in/yr (std. dev. 0.09)		^l arithmetic avg.	^l KGS Bulletins					

Note: KWRB'67: Irrigation in Kansas: Kansas Water Resources Board, 1967, Report no. 16e.

USGS '91: Hansen, C. V., 1991, Estimates of freshwater storage and potential natural recharge for principal aquifers in Kansas: U.S. Geological Survey, Water-Resources Investigations Report 87-4230.

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NORTHWEST KANSAS (GMD 4 Region)

No.	County	Area mi ²	Reference Bulletin & pub yr	Aquifer	Avg. precip (in/yr)	Avg. temp. °F	Recharge from ac-ft/yr (in/yr)			Total recharge ac-ft/yr (in/yr)	Method	Reference	Soils	Topog	Avg. depth to water table	Vegetation and land use	Comments
							precip.	stream	lateral inflow irrig.								
1	Cheyenne	1027	KGS B100 1953	Ogallala	18	52			^{1a} 12,200 (0.22 in/yr)		^{1a} KWRB '67	silty soils and loamy and silty soils	flat to rolling upland plains	90–175 ft along southern border 35–90 ft along southwestern border	cropland and pasture much of land is pasture	“Data on permeability and transmissibility are not adequate to permit estimating either subsurface flow into or out from the county.” (KGS B100)	
2	Rawlins	1080	KGS B117 1956	Ogallala	18.5	52.3			^{2a} 10,500 (0.18 in/yr)		^{2a} KWRB '67	silty soils	gently rolling	<10 ft at valleys to >200 ft at upland areas agriculture	cropland and pasture		
3	Decatur	900	KGS B196 1969	Ogallala Fm. avg. thickness 200 ft; avg. saturated thickness 45 ft Alluvial valleys yield range from 300 to 1,450 gpm depending on location Ogallala	18.42	53.2	less than 1/2 inch	^{3b} 5,000 ac-ft/yr at western county boundary (0.10 in/yr)	^{3a} 17,500 (0.36 in/yr)	^{3b} based on sat. thickness of water- bearing strata, water table gradient, and avg. K of 40.1 ft/day	^{3a} KWRB '67	silty soils	gently rolling uplands	about 10–40 ft from surface in valleys to > 100 ft in most places and 200 ft or more in high parts Ogallala Fm. avg. thickness 200 ft; avg. saturated thickness 45 ft (1962)	cropland and pasture		
4	Norton	880	KGS B81 1949	Alluvium Ogallala	20.81	52.8	^{4a} approx. 1/4–1/2 in.		^{4b} 15,400 (0.33 in/yr)		^{4a} Frye, J. C., 1942 ^{4a} KWRB '67	silty soils	Plains border section of the Great Plains physio- graphic province	40 ft in valleys up to 175 ft in uplands; <10 ft in alluvium	cropland and pasture agriculture		
5	Sherman	1055	KGS B105 1953		18	51.9			0.1 inch ^{5a}		^{5a} Frye, J. C., 1942	mostly underlain by depos- its of Ter- tiary Oga-	High Plains section of near-	in upland areas generally >100 ft <10 ft in stream val- leys; avg.	cropland and pasture farmland and pasture		
						lower than	^{5a} approx.			^{5a} estimate							

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							precip.	stream	lateral inflow irrig.								
				Ogallala					21,480 ac-ft/ yr from west and south- west (0.38 in/yr)		based on available data ^a		lala Fm. Silty soils and loamy and silty soils	flat to gently rolling upland plains	slope is 15 ft/mi		
				Ogallala					^b 13,500 (0.24 in/yr)		soil-water budget	^b KWRB '67 ^c USGS '91					
6	Thomas	1070	KGS B59 1945	Ogallala	17.95	51.8	^a 1/4 inch					^a Frye, J. C., 1942	silty soils	flat to gently rolling	>200 ft to only a few feet along valleys <100 ft in east-central part	cropland and pasture farmland	
				Ogallala					^b 20,700 (0.36 in/yr)		soil-water budget	^b KWRB '67 ^c USGS '91					
				Ogallala					^c 21,800 (0.49 in/yr)								
7	Sheridan	893	KGS B116 1956	Alluvium Ogallala	19.35	53.6			about 1/4 in. ^a		author's estimate	^a Bayne, C. K., 1956	silty soils and loamy soils	nearly flat to gently rolling	<10 ft to 160 ft	cropland and pasture agriculture	
				Alluvium					14,000 ^b (0.29 in/yr)		soil-water budget	^b KWRB '67 ^c USGS '91					
				Ogallala					390 ^c (0.01 in/yr) 35,200 ^c (0.74 in/yr)								
8	Graham	891	KGS B110 1955	Alluvium Ogallala	20.56	53.9				^b 7,000 (0.15 in/yr)		author's estimate	silty soils and silty and loamy soils	High Plains section of Great Plains physio- graphic province	few feet to 140 ft	cropland and pasture agriculture; about 40% of land is pasture	^a avg. ET from free water sur- face in growing season is 11.5 in/month, and 75% of pcp. occurs in the growing sea- son, so recharge is low (KGS B110, p. 31)
				Alluvium			^a probably <1/2 in.				soil-water budget	^a Prescott, G. C., 1955 ^c USGS '91					
				Ogallala			^c 2,710 (0.06 in/yr) ^c 32,500 (0.68 in/yr)										
9	Logan	1073	KGS B129 1958		18.97	53.3			^b 1/6 in. (0.85% of the total pcp.)		^a based on ground wa- ter contour map and saturated thickness	^{a,b,c} Johnson, C. R., 1958	silty soils and silty and loamy soils	High Plains section and plains border section in east	>40 ft from surface in uplands	cropland and pasture	^a on the northern upland of the county. Based on Darcy's Law at a section across N-S direction near eastern border of the county.
									^a approx. <25 ac-ft/yr in southern upland, neg- ligible in north- ern upland	10% of applied		^{a,b,c} Johnson, C. R., 1958					
									^c estimated 3,000 in north- ern upland		^c from Darcy's Law at N-S section near						

No.	County	Area mi ²	Reference Bulletin & pub yr	Aquifer	Avg. precip (in/yr)	Avg. temp. °F	Recharge from ac-ft/yr (in/yr)			Total recharge ac-ft/yr (in/yr)	Method	Reference	Soils	Topog	Avg. depth to water table	Vegetation and land use	Comments
							precip.	stream	lateral inflow								
				Alluvium					(calculated value 2,600 from pcp.) ^{9d} 5,000 (0.09 in/yr)	eastern county boundary	^{9d} KWRB '67						
				Ogallala		^{9e} 1,880 (0.03 in/yr)			^{9e} 9,780 (0.17 in/yr)	soil-water budget	^{9e} USGS '91			20 ft from surface in alluvium aquifer		^{9e} avg. sat. thickness 30 ft $K_{avg} = 58.82$ ft/day	
10	Gove	1070	KGS B145 1960	Alluvium	20.89	53.2			^{10a} 11,000 (0.19 in/yr)	soil-water budget	^{10a} KWRB '67	silty soils and silty and loamy soils	High Plains section	50 ft–150 ft	cropland and pasture		
				Ogallala					^{10b} 1,700 (0.03 in/yr)	soil-water budget	^{10b} USGS '91				agriculture 684000 ac.		
11	Trego	900	KGS B174 1965	Alluvium	21.4				^{11a} at least 10,000 ac-ft/yr (0.21 in/yr)	author's estimate	^{11a} Hodson, W. G., 1965 ^{11b} KWRB '67	silty and loamy	High Plains section	alluvium; few feet to 20 ft Ogallala < 10 ft to 100 ft	cropland and pasture		
				Ogallala					^{11c} 4,350 (0.1 in/yr)	soil-water budget	^{11c} USGS '91				agriculture		
	Summary	8050	USGS OFR 4-75 1975	Alluvium has yield of as much as 1,500 gal/min	¹⁶ 16–21	51–78	0.25 in/yr or about 100,000 ac-ft/yr	most streams in western part lose water by infiltration. Runoff is only 1–2% of total pcp.			¹⁶ Jenkins and Pabst, 1975	loessal	flat to gently rolling	alluvium is as much as 105 ft thick but is saturated =<65 ft	cropland and pasture	¹⁶ mainly during 6 months of growing season (area is different in Open-file Report from the total area, as it reflects only the area in which the study was carried out)	
				Ogallala Fm. has yield of 500–1,200 gal/min										Ogallala Fm. has saturated thickness ranging from 0–270 ft.			
				Dakota Fm. has yield of a few gal/min										Dakota Fm. lies 600–2600 ft below ground surface and its thickness ranges from 200 to 300 ft.			
	District avg. ¹	9059							⁹ 0.48 in/yr (std. dev. 0.25) avg. ¹⁰ 0.23 in/yr (std. dev. 0.09) avg. ¹¹ 0.29 in/yr (std. dev. 0.17) avg.	¹ arithmetic avg. ¹⁰ arithmetic avg. ¹¹ arithmetic avg.	⁹ USGS '91 ¹⁰ KWRB '67 ¹¹ KGS Bulletins					⁹ for Ogallala ¹ all averages are calculated considering only the cos. included in the GMD	

Note: KWRB '67: Irrigation in Kansas: Kansas Water Resources Board, 1967. Report no. 16e.
 USGS '91: Hansen, C. V., 1991, Estimates of freshwater storage and potential natural recharge for principal aquifers in Kansas: U.S. Geological Survey, Water-Resources Investigations Report 87–4230.
 KGS B: Kansas Geological Survey Bulletin
 std. dev.: standard deviation
 Exponents indicate corresponding information from the same study.

GREAT BEND PRAIRIE (GMD 5 Region)

No.	County	Area mi ²	Reference Bulletin & pub yr	Aquifer	Avg. precip (in/yr)	Avg. temp. °F	Recharge from ac-ft/yr (in/yr)			Total recharge ac-ft/yr (in/yr)	Method	Reference	Topog. and Soils	Avg. depth to water table	Vegetation and land use	Comments
							precip.	stream	lateral inflow							
1	Barton	892	KGS B88 1950	GBP aquifer	24.18					^{1a} 83,100 (1.72 in/yr)	soil-water budget	^{1a} KWRB '67 ^{1b} USGS '91	nearly level to gently sloping silty soils on up- lands nearly level silty soils on floodplains	<10 ft>30 ft	farmland	study area in- cludes parts of Ness, Rush, and Barton Cos.
										^{1c} 22,700 (2.19 in/yr) for Walnut Creek valley alluvium	ground- water modeling	^{1c} Nuzman, C., 1990				
										^{1d} 60,000 (1.26 in/yr)	modification from KWRB '67	^{1d} Fader and Morton, 1972				
2	Rice	721	KGS B85 1950	GBP aquifer	25.86 (1898– 1942)	56				^{2a} 74,800 (1.93 in/yr)	soil-water budget	^{2a} KWRB '67 ^{2b} USGS '91	nearly level to gently sloping silty soils on up- lands nearly level loamy and sandy soils on floodplains	20 ft	farmland	
										^{2c} 75,000 (1.95 in/yr)	modification from KWRB '67	^{2c} Fader and Morton, 1972				
3	Pawnee	755	KGS B80 1949	GBP aquifer	23.48			mainly in upland ar- eas and the dune sand areas of the Arkansas River	from west and southwest	^{3a} 52,600 (1.30 in/yr)	soil-water budget	^{3a} KWRB '67 ^{3b} USGS '91	nearly level to gently sloping silty and loamy soils on up- lands. Nearly level silty loamy and sandy soils on floodplains	dune sand: <10 ft–50 ft alluvium; 10 ft–30 ft terrace de- posits: <20 ft– 60 ft. Ogallala: <20 ft→100 ft	agriculture	
										^{3ca} 0.6 in/yr for area of 325 mi ² in Pawnee Riv- er valley	^{3ca} mass bal- ance (equi- librium of inflow and outflow)	^{3ca} Sophocleous, M. A., 1981				
										^{3cb} 0.39 in/yr	^{3cb} soil-mois- ture budget	^{3cb} Sophocleous, M. A., 1981				
										^{3cc} 0.5 in/yr	avg. of ^{3ca} and ^{3cb}	^{3cc} Sophocleous, M. A., 1981				

No.	County	Area mi ²	Reference Bulletin & pub yr	Aquifer	Avg. precip (in/yr)	Avg. temp. °F	Recharge from ac-ft/yr (in/yr)			Total recharge ac-ft/yr (in/yr)	Method	Reference	Topog. and Soils	Avg. depth to water table	Vegetation and land use	Comments
							precip.	stream	lateral inflow irrig.							
4	Stafford	794	KGS B88 1950	GBP aquifer	24.58					above						
							^{4b} 80,400 (1.9 in/yr)		B88, pl. 1 shows that the ground water flows into the county from Pawnee and Ed- wards Cos.	^{4a} 187,500 (4.42 in/yr)	soil-water budget	^{4a} KWRB '67 ^{4b} USGS '91	undulating to gently sloping sandy, loamy, and silty soils on uplands	<20 ft–40 ft	farmland	
5	Reno	1262	KGS B79 1949	Alluvium + Equus Beds and GBP aquifers	28.53			quantity not known but small compared to that from pcp.	^{5a} 20% of pcp 0.2* 28.53=5.7 in/yr	^{5a} ground- water level fluctuation and sp. yield (20%)	^{5a} Williams and Lohman, 1949	nearly level to moderately sloping loamy soils on uplands;	<10 ft–50 ft	farmland and pasture	area covered in B79=2,340 mi ² includes McPherson and parts of Marion, Harvey, Reno, and Sedgwick Cos.	
			KGS B64 1946		27.83	54.3			^{5b} 20% of pcp. 300 ac-ft/mi ² / yr in the Arkansas River valley (5.56 in/yr)	^{5b} water fluc- tuation records and sp. yield estimates	^{5b,c} Williams, C. C., 1946	nearly level, loamy and sandy soils on flood- plains				
								^{5c} 500 ac-ft/mi into Equus Beds from dune sand northeast of Hutchinson =1.07 in/yr. About 20,000 ac-ft/yr=3.75 in/yr from Ar- kansas Valley into the Hutch- inson study area of 100 mi ²	^{5d} 276,500 (4.1 in/yr)	^{5c} permeability, water gradient, well logs (Darcy's Law)	^{5d} KWRB '67				^{5c} 500*11.4= 5,700 ac-ft/yr= 1.07 in/yr in 100 mi ² of study area in vicinity of Hutchinson; in- flow=500 ac-ft/mi/ yr, 11.4 mi=length of inflow boundary for the study area (approx.) (see pl.1, B64, part 5)	
							^{5e} 143,000 (2.12 in/yr)			^{5f} 0.1–5.5 in/yr	^{5f} 3-D, finite diff. ground- water flow model	^{5f} Spinazola, J. M., et al., 1985				^{5g} recharge for predevelopment period (before 1940)
									^{5g} 270,000 (4.01 in/yr)	modification from KWRB '67	^{5g} Fader and Morton, 1972					
6	Edwards	619	KGS B80 1949	GBP aquifer	22.44											
							^{6b} 33100 (1 in/yr)			^{6a} 84,000 (2.54 in/yr)	soil-water budget	^{6a} KWRB '67 ^{6b} USGS '91	undulating to gently sloping sandy and loamy soils on uplands	dune sand: <10 ft–50 ft; al- luvium: 10 ft– 30 ft; terrace deposits: <20 ft– 60 ft; Ogallala: <20 ft–>100 ft	agriculture	
									^{6c} 50000 (1.51 in/yr)	modification from KWRB '67	^{6c} Fader and Morton, 1972					
7	Kiowa	720	KGS B65 1948		22.15	56	^{7a} in sand- hills 2.2%	streams are in-	water enters Meade and	change in storage;	^{7a} Latta, B. F., 1948	gentle to moderate slopes	dune sand: 10 ft– 70 ft; Kingsdown	agriculture farming and		

No.	County	Area mi ²	Reference Bulletin & pub yr	Aquifer	Avg. precip (in/yr)	Avg. temp. °F	Recharge from ac-ft/yr (in/yr)			Total recharge ac-ft/yr (in/yr)	Method	Reference	Topog. and Soils	Avg. depth to water table	Vegetation and land use	Comments
							precip.	stream	lateral inflow							
				Alluvium and GBP aquifer			of pcp. 0.58 in/yr	fluent but the amount of recharge is not known	Ogallala Fms. of this area from Ford and Clark cos.			porosity= 20%	and nearly flat surfaces with sandy, loamy, and silty soils	silt: >100 ft; Meade and Oga- llala: <20 ft– 60 ft; Ogallala: 20 ft	stock raising	
									A part of water in Meade and Ogallala Fms. is obtained from Dakota Fm.	^{7b} 99,600 (2.6 in/yr)	^{7b} KWRB '67					
							^{7c} 50,070 (1.3 in/yr)				soil-water budget	^{7c} USGS '91				
								^{7d} 500–1,000 (0.013–0.026 in/yr)			Darcy's Law	^{7d} Fader and Stulken, 1978				
										^{7c} 50,000 (1.3 in/yr)	modification from KWRB '67	^{7c} Fader and Morton, 1972				
8	Pratt	729	KGS B205 1973	GBP aquifer	24.04	avg. month- ly: 8.2 in July 3.4 in Jan.	^{8a} 5–10% of pcp; 1.2– 2.4 in/yr avg. 1.6 in/yr; higher recharge if for dune sand area	negligible	^{8a} 0.98 in/yr across the western boundary	5–10% of ap- plied	^{8a} Darcy's Law	^{8a} Layton and Berry, 1973	nearly level to gently sloping silty and loamy soils on up-	alluvium:<10 ft– 12 ft dune sand: <20 ft–50 ft but in south- eastern part >50 ft–80 ft	agriculture	
									^{8a} about 1,500 ac-ft/ yr of saline water leaks upward from Per- mian rocks; actual amount is not known		measure- ment of chemical constitu- ents in stream- flow		Loveland and Crete Fm: 40 ft> 100 ft			
							^{8c} 77,800 (2 in/yr)				soil-water budget	^{8d} KWRB '67		Sappa and Grand Island Fm: 20 ft– 60 ft		
										^{8f} 150,000 (3.86 in/yr)	modification from KWRB '67	^{8f} Fader and Morton, 1972				
										^{8g} 3.5 in/yr from model calibrated ratio q/k= 8*10 ⁻⁶ for k=100 ft/ day	STREAM- AQUIFER (Kemblow- ski, 1982), a model utilizing the inte- grated finite diff. method	^{8g} Moya, P., 1985				^{8g} q=natural recharge rate k=hydraulic conductivity
9	Kingman	864	KGS B144 1960		29.28	57.9		streams are effluent	some from Pratt Co. on the west	negli- gible (1955–	not known		lies in the Great Bend physio-	dune sand:<10 ft– 20 ft; alluvium: <10 ft. Loveland	agriculture farm and cattle raising	

No.	County	Area mi ²	Reference Bulletin & pub yr	Aquifer	Avg. precip (in/yr)	Avg. temp. °F	Recharge from ac-ft/yr (in/yr)			Total recharge ac-ft/yr (in/yr)	Method	Reference	Topog. and Soils	Avg. depth to water table	Vegetation and land use	Comments
							precip.	stream	lateral inflow							
				alluvium and GBP aquifer					56)							
						^{9a} 62,700 (1.36 in/yr)			^{9a} 201,600 (4.47 in/yr)	soil-water budget	^{9a} KWRB '67	nearly level to moderately sloping loamy soils on up- lands	and Crete Fm: 10 ft–20 ft Ogallala: 10 ft– 20 ft. Sappa and Grand Island Fm: 10 ft–70 ft. Fullerton and Holdrege Fm: 20 ft–40 ft			
									^{9c} 150,000 (3.26 in/yr)	modification from KWRB	^{9c} Fader and Morton, 1972					
10	Barber	1146	KGS OFR 29–1 1929	alluvium and GBP aquifer	24.89	57.3			^{10a} 59,100 (0.97 in/yr)	soil-water budget	^{10a} KWRB '67	High Plains in northern and western parts and Plains bor- der in the east- ern part of the county				
						^{10b} 18,280 (0.3 in/yr)			^{10c} 40,000 (0.65 in/yr)	modification from KWRB '67	^{10c} Fader and Morton, 1972	moderately sloping to nearly level clayey and loamy soil				
11	Summary GBP	5400	KGS IR4 1978	GBP aquifer	22.5 at western border to 31.5 at the eastern	2 in/yr 5–10% of pcp. (1951– 1971)				water-level fluctuation in wells	Fader and Stulken, 1978				counties in- cluded: all of Kiowa, King- man, Pratt, and Stafford, and Barber, Barton, Edwards, Paw- nee, Reno, and Rice	
									0.75 in/yr (1950– 1975)	USGS 2-D finite-diff- erence model	Cobb, P. M., et al., 1983					
									0.28 in/yr (1950– 1980)	regional flow model for the High Plains aquifer (USGS 2-D finite dif- ference flow model)	Luckey, R. L., et al., 1986					
									4.3 in/yr (1982– 83) (Rattle- snake Cr. basin)	daily soil- moisture budget	Sophocleous and McAllister, 1990 (KGS GW Series 11)					
									2.87 in/yr (std. dev. 1.25)	¹ arithmetic avg.	KWRB '67					
	District avg.								2.62 in/yr	¹ arithmetic	Fader and				¹ all averages are calculated considering only the cos.	

No.	County	Area mi ²	Reference Bulletin & pub yr	Aquifer	Avg. precip (in/yr)	Avg. temp. °F	Recharge from ac-ft/yr (in/yr)			Total recharge ac-ft/yr (in/yr)	Method	Reference	Topog. and Soils	Avg. depth to water table	Vegetation and land use	Comments
							stream	lateral inflow	irrig.							
										(std. dev. 1.43) 1.33 in/yr (std. dev. 0.62) 1.9 in/yr (1985– 1992) (std. dev. 0.71) 1.4 in/yr (1985– 1990)	avg. ¹ arithmetic avg. ¹ arithmetic avg. area-weighted avg. field measured variables em- ploying Darcy's method and water-budget analysis	Morton, 1972 USGS '91 Sophocleous, 1992				included in the GMD

Note: KWRB '67: Irrigation in Kansas, Kansas Water Resources Board, 1967, Report no. 16.
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 Exponents indicate corresponding information from the same study.